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ERRATA

CEYLON JOURNAL OF SCIENCE (SECTION B), VOL. XVI.

p. 6 *Labeo (Morulius) gadeya* Deraniyagala, 1929. Synonymous with *Labeo fisheri* Jordan and Starks, 1917. Ann. Carnegie Mus. Vol. XI, p. 436. A copy of this paper was not available until Dr. G. S. Myers of Stanford University, California, very kindly sent one to the author and pointed out the error.

On page 26, *Garra ceylonensis* Bleeker under heading *Fins* read P. 1·9-15 instead of P. 1·9-12.

ERRATA

CEYLON JOURNAL OF SCIENCE (SECTION B). VOL. XVI.

pp. 24-86. *For* " grs. " *read* " gms. "

pp. 45-54. *For* " 32 day embryo " *read* " 27 day embryo. "

p. 56. *For* " *Emyda granosa ceylonensis* Gray " *read* " *Emyda granosa ceylonensis* (Gray) "

p. 69. *For* " 11,500 " *read* " 1,150 "; *for* " 8,700 " *read* " 870. "

p. 72. (7th line from bottom) and **p. 73** (3rd line from bottom) instead of " 38 to 41 m m " *read* " 35·5 to 38 m.m. "

p. 80. (First line) instead of " 14 " *read* " 12 or 14. "

The Eventognathi of Ceylon

BY

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WITH SIX PLATES

The order Eventognathi is a very large one and is confined to fresh water. It is of Asiatic origin and absent from Australia and South America. As these fishes are necessarily checked in their distribution by salt water their presence is of interest to the geologist in tracing former land connections. In Ceylon there are 30 species, of which 20 are found in India, while 10 are peculiar to Ceylon and are denoted by an asterisk against their names.

I desire to express my indebtedness to the following ladies and gentlemen for help in collecting specimens: Mrs. F. Gooneratne, Miss L. A. Pieris, Ratemahatmayas, P. B. Bulankulame and J. Rambukpotha, Mudaliyars S. W. Illangakoon, E. Tillekeratne and J. E. Perera, Korala D. A. Tennekoon, Dr. J. D. L. Perera, Dr. P. E. Pieris of the Civil Service, Messrs. J. R. P. Perera, D. A. Obeyesekere, C. F. Dharmaratna and G. Pieris. Dr. S. L. Hora of the Indian Museum, Calcutta, was so good as to send me several Indian specimens for comparison with the ones here described. My thanks are also due to Dr. Jacques Pellegrin of the Muséum d'Histoire Naturelle, Paris, for permitting me to examine the type of *Leuciscus thermalis* C. & V., and to Mr. J. R. Norman of the British Museum for comparing my new fishes with specimens in his collection.

The order Eventognathi may be classified as follows :—

I. Family **Cyprinidae**

(*a*) Sub-family **Cyprininae**
1. genus *Cyprinus.*
2. genus *Carassius,*

3. genus *Labeo.*
4. genus *Puntius.*
5. genus *Tor*
6. genus *Garra*

(*b*) Sub-family **Rasborinae**
1. genus *Rasbora.*
2. genus *Esomus.*
3. genus *Amblypharyngodon.*
4. genus *Danio.*

(*c*) Sub-family **Abramidinae.**
genus *Laubuca.*

II. Family **Cobitiidae**

1. genus *Lepidocephalus.*
2. genus *Nemacheilus.*

The following is a definition of the order Eventognathi :—

Mouth edentulous, protractile with or without barbels. Pharyngeal teeth well developed. Pseudobranchiae rarely absent. Branchiostegals three. No adipose fin. With cycloid scales or none. Lateral line present or absent. Anterior four vertebrae often coossified, their ribs connecting auditory organ to air bladder.

Key to Ceylon Families

1. No adipose fold on caudal peduncle. No suborbital spine, eye free, barbels four or less.
.....*Cyprinidae.*
2. Adipose fold on caudal peduncle. Suborbital spine present or absent, eye subcutaneous or free, barbels six or more.
.....*Cobitiidae.*

Family **CYPRINIDAE** Linné

Commonly compressed, rarely depressed, scaly fishes. Pseudobranchiae present. Pharyngeal teeth in 1, 2 or 3 series. Mouth with its upper border of intermaxillaries only. Eye free. Position of lips and jaws vary. Lateral line usually present. Head naked. In all the Cyprinidae, there are four dorsal and four anal spines typically. These

spines are hard or soft, strong or weak, serrate or smooth. Many of them have the basal portion stiff and completely ossified, while the tip is soft and filamentous. The barbels when present are rostral or maxillary or both, and vary considerably in length.

Key to sub-families of Ceylon Cyprinidae

A. Abdomen rounded or flat.
   1. Lateral line runs in middle of tail.
      .....*Cyprininae.*
   2. Lateral line close to ventral edge.
      .....*Rasborinae.*

B. Abdomen partially or entirely compressed.
   .....*Abramidinae.*

Sub-family **Cyprininae**

Key to Ceylon Cyprininae

A. Mouth terminal or subterminal.
   1. Postlabial groove interrupted in middle.
      (*a*) Dorsal with 19-21 rays.
      .....*Cyprinus* or *Carassius.*
      (*b*) Dorsal with 7-9 rays.
      .....*Puntius*
      (Plate I, fig. 4.)
   2. Postlabial groove continuous.
      .....*Tor.*
      (Plate I, fig. 3.)

B. Mouth markedly inferior
   1 Chin with disc
      .....*Garra.*
      (Plate I, fig 1)
   2 Chin without disc.
      .....*Labeo.*
      (Plate I, fig. 2.)

Genus **Cyprinus** Linné

Mouth terminal with four barbels. Dorsal fin long, its origin opposite ventrals, the anterior spines ossified, the last of these serrate posteriorly. Anal short below dorsal, its last spine serrated behind. Scales large, at times absent, lateral line complete and runs in middle of tail. Pharyngeal teeth 3.1.1. Branchial openings wide, reach below hind border of preopercle. Gill membranes broadly united to isthmus,

Cyprinus carpio Linné

Cyprinus carpio Linné Syst. Nat. ed. X. 1758.

Fins. D IV 19, A IV 5, P 1·15, V 1·7, C 19. Dorsal and anal spines moderate, serrate posteriorly.[1]

Scales. Lateral line complete. LL 35. L tr. $\frac{6\cdot5}{5\cdot5}$, predorsals 13, preventrals 21.

Barbels. A well-developed rostral and a maxillary pair.

Measurements. Head 3, eye 5-5·8, interorbit 1·5-2, snout 2, depth of body 2·7, pectoral 5, caudal 4·2 into entire length. An oblong compressed fish with its dorsal outline more convex than the ventral one. Mouth terminal with rather thick lips, post-labial groove interrupted in the middle. Caudal conspicuously emarginate. Attains to a weight of 9,120 grammes in Ceylon.

Colours. Brownish olive with yellowish sides.

Distribution. Introduced into Ceylon from Europe in 1914. Found at Nuwara Eliya, Hakgalla (C.P). In muddy, slow flowing water. Original habitat Korea, introduced to Europe, America, Mexico, Hawaiian Islands, Java, Caspian Sea.[2]

Variation. Under domestication the scales have undergone considerable modification to form varieties which, however, do not breed true to type.

These varieties consist of the leather carp or *Cyprinus carpio* var. *nudus* Bloch, which has none or only a few scales but is covered with a velvety skin and the mirror carp *Cyprinus carpio* var. *specularis* Lacépède which has a row of transversely enlarged scales along the lateral line and on each side of the back and at times on the belly, but none others. The normal form is known as the scale carp *Cyprinus carpio* var. *carpio.*

Genus Carassius Nilsson

Mouth terminal, no barbels. Dorsal fin long, its origin opposite ventrals, last spine serrate posteriorly. Anal short, below dorsal, last spine feeble and serrate posteriorly. Scales large, lateral line complete, running in middle of tail. Pharyngeal teeth in a single row of four. Branchial openings wide, reach below hind margin of preopercle. Gill membranes broadly united to isthmus.

1. Fin spines when ossified are denoted by roman numerals.
2. Borzenko, M.P., in Bull. Ichth. Lab. Baku 2 (1), 1926, says it occurs everywhere in the Caspian Sea especially in depths not over 20 m. and in the less saline parts. Ascends rivers to spawn.

Carassius vulgaris Nilsson

Carassius vulgaris Nilsson, Prodrom. Ichth. Scandinav. 1832.

Fins. D IV 18-21, A IV 6-7, P 1·15, V 1·7, C 19. Dorsal and anal spines feeble and serrate.

Scales. Lateral line complete. LL 33-35. L tr. $\frac{6\text{·}5\text{-}7\text{·}5}{6\text{·}5\text{-}7\text{·}5}$, predorsals 15, preventrals 20.

Barbels. None.

Measurements. Head 3, eye 4·25-5·5, interorbit 1·5-2, snout 1·3-1·8, depth of body 2·5-3, pectoral 5·5, caudal 3·8 into entire length. An oblong compressed fish with its dorsal outline as convex as the ventral one. Mouth terminal, post-labial groove interrupted in the middle. Caudal faintly emarginate. Length of fish 250 mm.

Colours. A yellowish brown to olive, with a dark blotch on caudal peduncle.

Distribution. Nuwara Eliya. Introduced into Ceylon from Europe. Temperate parts of Europe where it is subject to considerable variation. Original home Asia.

Genus **Labeo** Cuvier

Oblong or elongate. No ossified spines to fins. Rostrum prominent, bluntly rounded or obtusely pointed, often covered with tubercles and at times with lateral lobes, the free anterior edge forms a fold covering upper lip. Mouth inferior, wide, transverse and protractile, lips thick, continuous, papillate or smooth. The lower lip either entirely separated from isthmus by a deep post-labial groove, (subgenus *Morulius* Ham. Buch.) Plate I, fig. 2, or only partially separated at corners and widely fused with isthmus, (subgenus *Labeo* Cuvier which is not found in Ceylon). Barbels 4, 2 or none. Eye free with annular gelatinous lid fairly developed. Gill membranes broadly united to isthmus. Pharyngeal teeth 5. 4. 2. Scales moderate or small. Lateral line in middle of tail. Dorsal with more than nine rays, begins before ventrals, ends above or before anal which has five rays.

Key to Ceylon Species of Labeo (Morulius)

A. Lateral rostral lobes present.

(*a*) Origin of dorsal in mid back.

.....*L.* (*M.*) *gadeya.*

(*b*) Origin of dorsal closer to tip of snout than caudal.

.....*L.* (*M.*) *porcellus.*

B. Lateral rostral lobes absent.

.....*L.* (*M.*) *dussumieri.*

Labeo (Morulius) gadeya Deraniyagala *Plate I, fig. 2.

L. (*M*) *gadeya* Deraniyagala, Ceylon Journal of Science, Sec. B. Vol XV, P 75. 1929.

1 *Kalu gadeya, Velli gadeya* (S).

Fins. Paired fins inserted low down. D 3·10-12, A 3·5, P 1·15, V 1·8, C 19.

Scales. Rudimentary and fleshy on chest and disappear as they approach isthmus. Lateral line complete, in old specimens is represented by pits on body, tubes on tail. Scales more rounded than in the other two Ceylon species.

LL 40-42, L tr. $\frac{7·5}{5·5}$, predorsals 17-18, preventrals 30-35, interpectorals 15-18.

Barbels. Hidden in post labial grooves. A maxillary pair equal to half orbit, and at times a rudimentary mental pair.

Measurements. Head 3·85-4, eye 4·8-7·8, interorbit 2-4, snout 2·4-3·9, depth of body 3-3·6, pectoral 4·3, caudal 3·5 into entire length.

A thick-set fish, convex dorsally, flat ventrally, tail rounded. Well-developed tubercles on snout and cheeks, largest on snout. Rostral fold large with conspicuous lateral lobes which are as wide as long, free edge of rostral fold foliate. Eye in posterior half of head or middle.

Width of gape 2·2 into head length. Lips fleshy, lower one distinct from jaw and has an anterior and posterior fringe of papillae, of which the latter forms two clumps near angles of mouth above the mental barbels when these exist. (Plate I, fig. 2.). Annular gelatinous eyelid moderately developed. Preopercle reaches far below level of opercle and heavily covered with muscle. Opercle twice as high as wide. Gill membranes fused to isthmus at level of posterior edge of preopercle. Pharyngeal teeth small. Paired fins inserted low down. Fins generally with well-developed cutaneous marginal lappets to rays. Origin of dorsal in mid back, no scaly sheath, upper margin straight. Pectoral with convex anterior edge, emarginate posteriorly, tip pointed ; longer than ventral which it reaches. Ventral has a fleshy axillary scale and reaches cloaca, resembles pectoral in outline. Anal when depressed reaches 0·75 of caudal peduncle, its outer margin emarginate. No scaly basal sheath. Caudal longer than head, deeply emarginate, its upper lobe at times somewhat longer than the lower. Length of caudal peduncle equals least depth of same. Length of fish 360 mm.

1. Names in front of (S) = Sinhalese, (T) = Tamil.
L tr = transverse row of scales from origin of dorsal to insertion of ventral, exclusive of the predorsal row and the scales of the basal sheath of dorsal.
"Interorbit" and "snout" in eye diameters. Length of fish is that of the largest specimen in the collection and is from snout to base of caudal fin.

Colours. Dark olive dorsally, crimson lunules on olive green sides. Belly white or pale orange. Young possess a dark brown blotch at end of caudal peduncle. Fins usually olive, but some adults have caudal and anal a deep orange.

Distribution. Mountain streams near Kandy (C.P.), Levella, Mahavilliganga, Matale (C.P.)

Ceylon.

Labeo (Morulius) porcellus (Heckel)

Tylognathus porcellus Heckel, in von Hügel's Fische aus Caschmir, IV. 1838.

Tambala vänna, Tambalaya (S.)

Fins. D 3·11-12, A 3·5, P 1·16, V 1·8, C 19.

Scales. Small on chest, lateral line complete. LL 40-42, L tr. $\frac{7\cdot5\text{-}8\cdot5}{5\cdot5\text{-}6\cdot5}$, predorsals 14-17, preventrals 23-25, interpectorals 13–15.

Barbels. 4 or 2. The rostrals when present are minute and located in the middle of each lateral rostral lobe. The maxillary pair are always present and about 0·7 of orbit.

Measurements. Head 4-5, eye 3·6-5, interorbit 2-3, snout 1·6-2, depth of body 2·8-3·15, pectoral 4·5, ventral 4·9-5, caudal 3·8-4·5 into entire length. Eye in posterior half of head or middle.

An oblong fish, convex dorsally, round ventrally. With small tubercles on snout and preorbital. Rostral fold developed and overlaps upper lip, free edge of fold minutely foliate. A small but distinct lateral lobe on each side. Width of mouth is half head length. Lips fleshy, the upper has a single marginal row of papillae and two or three oblique rows of minute papillae on its inner surface. Lower lip has two or three irregular rows of large papillae on its upper surface which are absent from angles of mouth. Height of opercle equals twice its width. Gill membranes fused to isthmus at level of hind edge of preopercle. Annular gelatinous eyelid moderately developed.

Cutaneous marginal lappets to fin rays feebly developed. Origin of dorsal nearly a snout length closer to tip of snout than to base of caudal, its outer margin emarginate. Pectoral convex anteriorly, emarginate posteriorly, tip pointed and remote from ventral which is similar in shape but smaller. The tip of the latter may or may not reach cloaca. This fin has an axillary scale. Base of anal behind that of dorsal with a scaly basal sheath of 3 scales. Its external margin straight.

Anal reaches 0·75 of caudal peduncle when depressed. Caudal deeply emarginate, longer than head. Least depth of caudal peduncle equals its length. Length of fish 350 mm.

Colours. Olive dorsally, greenish yellow sides often with crimson lunules near pectoral, white belly. Fins deep orange, caudal with an olive upper and lower margin. Snout bluish, head green, opercle green with light red reflections. Eye red with thin yellow rim round pupil. A diffuse brown blotch at end of caudal peduncle which disappears after death.

Reproduction. Female with mature ova from Nuwaraveva, Anuradhapura 6.7.26.

Distribution. Tanks of the dry zone where it swims in large shoals and is netted in drift nets and often sent to Colombo during the dry season.

Rembeva, Nuwaraveva, Anuradhapura (N.C.P.).

Ceylon, India.

Labeo (Morulius) dussumieri (Cuv. et. Val.)

Rohita dussumieri Cuv. et. Val, Hist Nat, Poiss. XVI. 1842.
Hiri kanaya (young), *Gan kanaya* (adult) (S).

Fins. D 3·12-13, A 3·5, P 1·15, V 1·8, C 19.

Scales. Chest scales ordinary. Lateral line complete. LL. 48-53, L tr. $\frac{8\cdot5\text{-}9\cdot5}{6\cdot5\text{-}7\cdot5}$, predorsals 22-24, preventrals 32-35, interpectorals 11-13.

Barbels. 4, Rostrals small and usually about 0·3 of eye, while the maxillaries are 0·7 of eye. In old specimens the barbels are at times minute.

Measurements. Head 3·25-5, eye 3·8-5, interorbit 2-3, snout 1·5-1·7, depth of body 3-3·6, pectoral 4·25-5·2, ventral 4·8-5·5; caudal 2·8-4·5 into entire length. An oblong fish, convex dorsally, rounded ventrally with two or three rows of rather large tubercles on snout and preorbital. Rostral fold not well de veloped and does not cover upper lip, its free edge entire. No lateral lobes, although a lateral groove is present on each side of rostrum. Width of mouth 3 into head. Post-labial groove more shallow than in the other two species. Lips fleshy, upper one barely covers upper jaw. Both lips have a single row of large papillae along the outer edge. A double row in middle of lower lip. Height of opercle is 1·5 times its width. Eye in middle of head.

Gill membranes fused to isthmus at level of hind edge of orbit. Annular gelatinous eyelid not developed as in the other two. Faint cutaneous marginal lappets to anterior fin rays. Origin of dorsal closer to tip of snout than to caudal by nearly a snout length. Outer margin of dorsal gently emarginate, last dorsal spine 4·5 into length.

Pectoral convex anteriorly, slightly emarginate posteriorly with a bluntly pointed tip which is remote from ventrals. The latter are bluntly pointed, do not reach cloaca and possess an axillary scale. Base

of anal behind that of dorsal, neither possess scaly basal sheaths. Outer margin of anal straight, when depressed this fin reaches 0·8 of caudal peduncle. Caudal strongly emarginate and longer than head and often has its upper lobe longer than the lower one. Least depth of caudal peduncle equals length of same. Length of fish 350 mm.

Colours. Under 150 mm. in length. A pale golden dorsally with more or less distinct longitudinal fine dark wavy stripes above lateral line. Indistinct red lunules on sides, which are silvery, belly white. Snout bluish, vertex green.

A black spot on caudal peduncle extending over 4 scales from 43rd-53rd scale.

Fins pale olive or grey, anal and ventrals dusted with black. *Over 200 mm.* the fish is a pale green dorsally with bronze reflections. Silvery sides with distinct crimson lunules; belly white, fins grey.

Reproduction. Ova pale bluish green in colour and 1·4 mm. in diameter. A young specimen 24 mm. long was taken from Munesvaramveva (N.W.P.) on 25. 11. 1926.

Gravid females were taken from Periya villuva near Madhu (N.P.) in January, 1928.

Anuradhapura (N.C.P.), August, 1928, August, 1929. Rembeva (N.C.P.), 6. 7. 1926.

Distribution.[1] Supposed to induce fever if eaten during the dry season, *i.e.*, July and August. Very common in many of the larger tanks where they occur in large shoals and are netted in abundance. Absent from Tissamaharama (S.P.)

Nuwaraveva, Anuradhapura, Rämbäva, Mädevachchiya, Nochchiyagama, Tammannava (N.C.P.), Kelaniya, Yakvala, Badurueliya, Kalutara, Veyangoda, Dig Ela, Moratuwa, Gampaha, Kolonnava Canal, Narhenpita Canal (W.P.), Chilaw, Battuluoya, Puttalam, Katupotha (N.W.P.), Murungan (N.P.).

Ceylon, Ind'a.

Genus **Puntius**[2] Hamilton-Buchanan

Oblong, somewhat compressed with belly and caudal peduncle rounded. Snout short, with or without tubercles. Mouth terminal or subterminal, with protractile upper jaw. Lower jaw has no symphysial knob. Post labial groove interrupted in middle of lower jaw. Lips smooth, continuous. (Plate I, fig. 4.) Eye free, with or without a

1 The province to which localities belong is denoted thus:
(C.P.) = Central Province, (U.P.) = Uva Province, (E.P.) = Eastern Province, (S.P.) = Southern Province, (W.P.) = Western Province (N.W.P.) = North-Western Province, (N.C.P.) = North-Central Province, (N.P.) = Northern Province, (Sab. P.) = Sabaragamuva Province.

2. The former genus *Barbus* Cuvier has been found to contain *Puntius* Ham. Buch and *Tor* Gray.

narrow, adipose lid. Suborbitals narrow. Barbels 0, 2 or 4, rostral and maxillary. Dorsal with 7-9 rays, its origin almost opposite to ventrals and has its last spine enlarged and usually strongly ossified. Anal with spines and with 5-7 rays. Bases of dorsal and anal in scaly sheaths. Scales large, smooth with longitudinal striae. Lateral line complete or incomplete, consists of simple tubes, and runs over middle of caudal peduncle. Head smooth. Gill membranes united to isthmus under hind edge of preopercle or eye. Pharyngeal teeth 5-4, 4-3, 2-1.

Key to Ceylon species of Puntius

A. Lateral line complete.

(*a*) Dorsal spine *smooth*

(1) Barbels absent, three bands across body ..... *P. singhala**

(2) Maxillary barbels present

(α) Dorsal spine strong, L tr. $\frac{4\cdot5}{2\cdot5}$ ..... *P. dorsalis*

(β) Dorsal spine slender

1. Spot[1] over base of anal, on tail. ..... *P. filamentosus*

2. Spot behind base of anal or absent.

I. L tr. $\frac{5\cdot5}{3\cdot5}$ ..... *P. chola*

II. L tr. $\frac{4\cdot5}{2\cdot5}$ ..... *P. amphibius*

III. L tr. $\frac{3\cdot5}{2\cdot5\text{-}3\cdot5}$ ..... *P. bimaculatus**

(*b*) Dorsal spine *serrate*.

(1) Barbels absent, three bands across body ..... *P. nigrofasciatus**

(2) Rostral and maxillary barbels present

(α) Lateral band from eye to caudal ..... *P. pleurotaenia**

(β) Spot on caudal peduncle ..... *P. chrysopoma*

1. "Spots" and "bands" black in colour.

B. Lateral line incomplete.

(*a*) Dorsal spine *smooth*, band on dorsal.

.....*P. vittatus**

(*b*) Dorsal spine *serrate*.

(1) Barbels absent.

(α) Two bands across body.

.....*P. cumingi**

(β) Spot on shoulder and on caudal pedunclo.

.....*P. ticto*

(2) Maxillary barbels present.

.....*P. titteya**

Puntius singhala (Duncker)* Plate II, fig, 1.

Barbus singhala Duncker, Süsswasserfische Ceylons, 1912.

Pulli titeya, Iri titiya, Gōma titeya, Titha kadeya (S)

Fins. D III 8, A III 5, P 1·14-16, V 1·6, C 18. Osseous spines of dorsal and anal smooth and fine.

Scales. Lateral line complete. LL 20-22, L tr. $\frac{4\cdot5}{2\cdot5}$, predorsals 7, preventrals 13.

Barbels. Absent.

Measurements. Head 2·75-3, eye 2·5-2·8, interorbit 1, snout 0·6-0·75, depth of body 2·5-3, pectoral 4, ventral 4, caudal 2·75 in entire length.

An elongate fish, gently convex dorsal profile, ventral profile less so. Mouth subterminal, small, and does not reach the large eye. Origin of dorsal somewhat closer to base of caudal than to tip of snout : its last osseous spine smooth and shorter than head. Tip of pectoral reaches ventral, latter reaches anal. Ventrals inserted under origin of dorsal or rather posteriorly. Origin of anal posterior to base of dorsal. Caudal deeply emarginate. Caudal peduncle as long as deep. Length of fish 30 mm.

Colours. Ground colour a very light red. Pale brown dorsally with three dark brown or black cross bands on body. The anterior one arises at the base of the two anterior dorsal rays and crosses the lateral line ending under tip of pectoral. The middle band is about six scales removed and begins from behind base of dorsal and ends near anterior part of base of anal fin. The posterior band is at tip of tail where it joins the caudal fin and is three or four scales distant from the median band. Dorsal fin red with black tip, caudal with red lobes having black tips, base of ventrals black in young specimens.

Distribution. Streams and ponds.

Mulleriyava Tank, Bolgoda, Rajagiriya (W.P.), Ginganga, Vakvella (S.P.), Minneriya (N.C.P.).

Ceylon.

Puntius dorsalis (Jerdon)

Systomus dorsalis Jerdon, Madr. Journ Lit. & Aci. XV. 1849.

Honda pethiya [1] (N.C.P.), *Kattu pethiya* (W.P.), *Kattu kuriya* (C.P.), (W.P.), (S.P.), *Bin gätteya* (W.P.), (S.P.), *Kureya, Kendhaya* (W.P.), (N.W.P.) (S), *Kendhai* (T).

Fins. D IV 8, A III 5, P 1·11-13, V 1·7, C 19. Dorsal spine strong, smooth ; anal weak, smooth.

Scales. Lateral line complete. LL 23-25, L tr. $\frac{4·5}{2·5}$, predorsals 8-10, preventrals 12-14.

Barbels. A maxillary pair only, about as long as eye or shorter.

Measurements. Head 3-3·25, eye 3·5-4·3, interorbit 1-1·6, snout 1-1·6, depth of body 2·8-3·4, pectoral 4-4·9, ventral 5-6·5, caudal 2·8-3·8 into entire length. A rather rounded, elongate fish. Dorsal profile slopes up to vertex in a straight line after which it is gently convex to dorsal. Ventral profile nearly straight. Snout long, pointed. Mouth subterminal, crescentric, ends far from eye. Origin of dorsal in mid back or closer to base of caudal than to tip of snout. The last osseous spine smooth, nearly rounded in cross section, and as long or longer than head without opercle. It has a short filamentous tip which is usually broken off in preserved specimens making the stiff portion slightly shorter than the first dorsal ray. Outer margin of dorsal emarginate, that of anal straight. Pectorals may or may not reach insertion of ventrals, these latter do not reach anal. Caudal peduncle as long as 1·2 times its least depth. Length of fish 250 mm.

Colours. Olive dorsally, sides silvery, belly white. Fins orange. A black blotch on tail which disappears after death. In immature specimens from localities such as Jaffna, Mankulam (N.P.) and Kahavatta (Sab. P.) there is a well marked black lateral band extending from the shoulder along the lateral line to the caudal blotch ; while the posterior half of the basal sheath of the dorsal is also black, and often the upper and lower margins of the caudal are dark. These marks usually persist until the fish is 90 mm. long. Pectoral, ventral and anal pale yellow orange, as is caudal which has dusky upper and lower borders.

Reproduction. Willey states that a specimen with egg strands adhering to it was brought in from the Beira Lake on August 31st, 1910.

1. Day mentions that the Assamese generic name for these fishes is "Pethiya."

Ripe females, Kandy Lake, August 3rd, 1928. Young with dorsal blotch, Mankulam, August 2nd, 1926.

Distribution. In streams, rivers, ponds and lakes. Occurs in large shoals in tanks where like *P. chryspoma* it is used as an ornamental fish.

Colombo, Kelaniya, Yakvala, Athanagalluoya, Badurueliya, Dehivala, Kalutara (W.P.), Batuluoya, Chilaw, Katupota (N.W.P.), Kegalla, Kahavatta (Sab. P.), Baddegama, Menikganga, Vakvella, Tissamaharama (S.P.), Pt. Pedro, Mankulam, Murungan (N.P.), Kandy, Levella (C.P.), Rembeva, Medavachchiya, Nochchiyagama (N.C.P.).

Ceylon, India.

Puntius filamentosus (Cuv. et Val.)

Leuciscus filamentosus Cuv. et Val. Hist, Nat Poiss. XVII. 1844.

Gōmakadaya, Dhankolla pethiya (S).

Fins. D IV 8, A III 5, P 1·15, V 1·8, C 19. Dorsal and anal spines weak, smooth.

Scales. Lateral line complete. LL 22-23, L tr. $\frac{4\cdot5}{2\cdot5}$, predorsals 7, rarely 8, preventrals 12-14.

Barbels. A rudimentary, maxillary pair.

Measurements. Head 3·5-4, eye 3-3·15, interorbit 1-1·2, snout 0·9-1, depth of body 2·5-2·8, pectoral 4·3-5, ventral 4·2-4·9, caudal 3·9-3·4 into entire length.

An oblong compressed fish with equally convex dorsal and ventral profiles. Mouth 3·5 in head, subterminal and does not reach orbit. Origin of dorsal above insertion of ventrals, in mid back or closer to tip of snout than to base of caudal. Tip of pectoral does not reach ventrals which do not reach anal.

Base of anal far behind that of dorsal. Outer margins of dorsal and anal gently emarginate. But in the adult male, dorsal margin palmate with tips of rays elongated into filaments. The longest of these rays is usually the second which is 2-2·5 into length of fish and when depressed reaches caudal fin, whereas in the female this ray is 4-5 into length. Caudal deeply emarginate. Length of caudal peduncle equal to its least depth. Length of fish 110 mm. In male the snout and preorbital are covered with large tubercles.

Colours. Emerald green vertex, olive dorsally, emerald green scale pockets above lateral line. Sides silver or yellowish, belly white. Throat, belly and sides at times tinged with salmon pink. Caudal white tipped, with a dark border beneath the white, rest of fin orange which is most intense near tips of lobes. A diffuse dark band along base of dorsal, more distinct in the male which has the elongated filaments dark. A

large distinct leaf-shaped blotch directed backwards above posterior half of base of anal from 14th-19th lateral line scales. Pectoral, dorsal, caudal and anal orange. Ventrals pale green and in male with a diffuse dark mark. Eye orange.

Reproduction. Egg laden females were obtained at the following places :

Muneswaram Tank (N.W.P.), July 2nd, 1928, Bentota (W.P.), May 23rd, 1926, Pelmadulla (Sab. P.), April, 1928, Colombo (W.P.), March 28th, 1928, Kandy Lake, January, 1928. The eggs are pale yellow in colour.

Distribution. In rivers and tanks.

Colombo, Rajagiriya, Gampaha, Yakvala, Kelaniya (W.P.), Levella, Kandy Lake (C.P.), Bentota, Vakvella (S.P.), Murungan (N.P.), Pelmadulla (Sab. P.), Katupota, Pinkettiveva, Batuluoya, Chilaw (N.W.P.).

Ceylon and India.

Puntius chola[1] (Ham. Buch.)

Cpyrinus chola Ham. Buch. Fishes of Ganges, 1882.

Kotta pethiya, Kotta ipilla. (S).

Fins. D IV 8, A III 5, P 1·15, V 1·7, C 19. Dorsal and anal spines weak, smooth.

Scales. Lateral line complete. LL. 24-27, L tr. $\frac{5\cdot5}{3\cdot5}$, predorsals 9-10, preventrals 12.

Barbels. A maxillary pair only, shorter than eye.

Measurements. Head 3-3·5, eye 3-4, interorbit 1-1·3, snout 0·8-1, depth of body 2·5-2·8, pectoral 4·3-5, ventral 4·3-5, caudal 2·9-3·5 into entire length.

A rather rounded outline, head and caudal fin somewhat small in comparison to depth. Tail thick at base and tapering gradually to caudal fin. Mouth terminal, small, barely reaches front of eye which has a fairly well developed circular gelatinous eye lid. Origin of dorsal in mid back, in rare cases it is nearer to base of caudal than to tip of snout. Stiff portion of dorsal spine as long as distance between lateral line and insertion of ventrals. Outer margins of dorsal and anal gently emarginate. Pectoral and ventral have outer edge straight, inner edge rounded. Pectoral usually does not reach ventral which does not reach anal. Base of anal posterior to that of dorsal. Least depth of caudal peduncle equals its length. Length of fish 95 mm.

1. I have had an opportunity of examining the type of *Leuciscus thermalis* C. & V. in Paris, and I believe it to be identical with *P. chola*. Dr. J. Pellegrin agrees with this view.
Three collections made by me around the hot springs at Kanniya (E.P.) did not contain any Puntius or Esomus, but Rasbora and Lepidocephalus were abundant.

Colours. Young up to 35 mm. in length, show a diffuse shoulder blotch on the 2-5th LL scales. Pale olive dorsally, with green scale pockets, opercles golden, belly and sides silvery. Dorsal fin pale orange with a row of dark blotches along base of fin rays and another parallel row across the middle of fin. A black spot equal to eye or less on the 22-24th lateral line scales extending over one or two scales usually disappears after death. Caudal orange, pectoral and ventral hyaline, yellow or orange.

Distribution. Low-country streams and tanks.

Colombo, Kalutara, Baduruelya, Yakvala (W.P.), Chilaw, Katupota (N.W.P.), Mankulam, Murungan, Marichchukadde (N.P.), Medavachchiya, Rembeva (N.C.P.), Vakvella (S.P.).

Ceylon, India, Assam.

Puntius amphibius (Cuv. et Val.)

Capoëta amphibia Cuv. et Val, Hist Nat. Poiss, XVI. 1842.

Ipilli kadeya, Madda ipilla. (*S.*)

Fins. D IV 8, A III 5, P 1·15, V 1·8, C 19. Osseous spines of dorsal and anal smooth, fine.

Scales. Lateral line complete. LL. 23-24, L.tr. $\frac{4\cdot5}{2\cdot5}$, predorsals 7-8, preventrals 11-13.

Barbels. A short maxillary pair about 0·6 orbits in length.

Measurements. Head 3-3·6, eye 2·8-3·3, interorbit 1-1·2, snout 0·9-1, depth of body 2·9-3, pectoral 4-5, ventral 4·25-5, caudal 3-3·5 into entire length. An elongate fish more convex dorsally than ventrally. Mouth small, subterminal, does not reach eye which has a fairly well developed circular adipose eyelid. Origin of dorsal in mid back or slightly nearer to tip of snout than to base of caudal, the stiff part of its last spine equals distance from lateral line to base of dorsal. Tip of pectoral does or does not reach ventral. This latter does not reach anal, which fin does not reach caudal. Base of anal behind that of dorsal. Least depth of caudal peduncle equals its length. Length of fish 72 mm.

Colours. Pale olive or bluish green dorsally. Sides silvery with yellow reflections, belly white. Dorsal fin orange with an obliquely horizontal band across its lower half well above the bases of the fin rays. A dark blotch at the end of the lateral line which disappears after death. A scarlet lateral band extends from the eye to the end of the caudal fin when the fish nears sexual maturity.

Distribution. In streams and ponds in the low-country. Pugoda, Kalubovilla, Yakvala, Athidiya (W.P.), Udumullai Ella (Sab. P.).

Ceylon, India.

Puntius bimaculatus (Bleeker)*

Gnathopogon bimaculatus Bleeker, Cobit. et, Cypr. Ceylon, 1864.

Ipilli kadeya (*S*).

Fins. D IV 7-8, A III 5, P 1·15, V 1·8, C 19. Dorsal spine smooth.

Scales. Lateral line complete, rarely incomplete or interrupted after about 6-17 scales. LL 24-25, L tr. $\frac{3 \cdot 5}{2 \cdot 5\text{-}3 \cdot 5}$, predorsals 8-10, preventrals 12-14.

Barbels. A maxillary pair only about 0·8 of orbit.

Measurements. Head 3·2-3·9, eye 3-3·75, interorbit 1-1·3, snout 0·8-1, depth of body 3-3·8, pectoral, 4-4·8, ventral 5, caudal 3-4 into entire length. An elongate fish more convex dorsally than ventrally. Mouth small, subterminal with thick lower lip. Origin of dorsal in mid back or slightly closer to base of caudal than to snout tip. Stiff portion of last dorsal spine as long as from lateral line to base of dorsal. Outer margins of dorsal and anal straight. Pectoral does not reach ventral which does not reach anal which does not reach caudal. Base of anal behind that of dorsal. Least depth of caudal peduncle equals its length. Length of fish 60 mm.

Colours. Dorsally olive green, sides and belly silvery. Dorsal with a black spot on the base of 3rd to 8th rays. A black spot at end of lateral line on 23rd and 24th scales. At times a black spot on anal on 2nd to 5th rays. A crimson lateral band on those nearing sexual maturity.

Distribution. Found from sea level to all elevations in streams and ponds and succeeds in ascending mountain torrents insurmountable to others of the genus.

Yakvala, Pugoda (W.P.), Kurunegala (N.W.P.), Mankulam (N.P.), Nuwara Eliya, Diyatalawa, Dambulla, Galpothai Ela, Gampola, Kandy, Kadugannava (C.P.), Nakiadeniya (S.P.), Tammannava (N.C.P.), Kegalla (Sab. P.).

Ceylon.

Puntius nigrofasciatus (Günther)* Plate III, fig. 1

Barbus nigrofasciatus Günther, Catalog. Fishes, Brit. Mus. VII. 1868,

Bulath sapeya (*S*).

Fins. D III 8, A III 5, P 1·12. V 1·6, C 19. Dorsal spine moderately strong, short, smooth at base, serrated in the middle and with a filamentous tip. Anal spine smooth.

Scales. Lateral line complete. LL 20-22 ; L tr. $\frac{4\cdot5}{3\cdot5}$, predorsals 8, preventrals 11.

Barbels absent.

Measurements. Head 3·5-3·8, eye 2·1-2·9, interorbit 1-1·5, snout 0·9-1, depth of body 1·9-2, pectoral 4-4·5, ventral 4, caudal 3 in entire length. An oblong or ovate fish with convex dorsal and ventral profiles which become more so, with age. Mouth subterminal, oblique, does not reach eye. Origin of dorsal in mid back or nearer to base of caudal than to tip of snout and is behind insertion of ventrals. Tip of pectoral reaches insertion of ventral, which fin does not quite reach anal. Base of anal behind that of dorsal, and finishes under tip of latter. Bases of dorsal and anal in scaly sheaths of 6-7 and 3-5 scales respectively. Outer margins of dorsal and anal straight. Caudal deeply emarginate with pointed tips. The caudal peduncle as long as its least depth or shorter. Stiff portion of dorsal spine as long as head without snout. Length of fish 50 mm.

Colours. All shades of olive and coral pink, with three dark, indigo-blue, transverse bands on body. Scales with shiny silver or gold central spots which persist in the dark bands. The anterior band is 2-3 scales wide and begins 3 scales before origin of dorsal, descending to under middle of pectoral. The median band is 3-4 scales wide and extends from base of dorsal to above middle of ventral. The posterior band is 3-4 scales wide and lies just behind base of anal. Head and snout pale crimson. Belly white or crimson in old specimens. Dorsal and caudal orange, other fins hyaline. In old specimens, dorsal, ventral and anal partially or entirely black, caudal a bright red. Eye orange or yellow.

Distribution. A slow swimming fish, found in slow flowing streams. Tun Dola Stream. Kottava, Hiniduma (S.P.), Gilimalé (Sab. P.).

Ceylon.

Puntius pleurotaenia Bleeker.* Plate V, fig. 2.

Puntius (Barbodes) pleurotaenia Bleeker, Cobit & Cypr, Ceylon, 1864.
Hitha massa (S).

Fins. D IV. 8, A III-IV, 4-5, P 1·15, V 1·8, C 19. Dorsal spine strong, serrate ; anal spine weak, smooth.

Scales. Lateral line complete. LL 28-30. L tr. $\frac{4\cdot5\text{-}5\cdot5}{2\cdot5}$, predorsals 9-10, preventrals 16-17.

Barbels. Rostral barbels reach mid eye and are as long as eye. Maxillary barbels reach hind margin of eye and are slightly longer.

Measurements. Head 3·6-3·8, eye 3·2-3·8, interorbit 1-1·3. Snout 1-1·2, depth of body 3·4-3·7, pectoral 4·9-5, ventral 5-5·7, caudal 3·5-3·9 into entire length.

An elongate fish rather more convex dorsally than ventrally. Mouth subterminal, reaches anterior margin of orbit. Origin of dorsal in mid back or slightly closer to tip of snout than to base of caudal, and above or just behind insertion of ventrals. Tip of pectoral does not reach ventral. Ventral does not reach anal. Base of anal far behind that of dorsal. Outer margins of dorsal and anal gently emarginate. Stiff portion of dorsal spine shorter than head by a snout length. Caudal deeply emarginate. The length of caudal peduncle is equal to 1·5 times its least depth. Length of fish 280 mm.

Colours. Back greenish brown, rest of body silvery. A dark band from eye to tip of caudal fin along the lateral line. Below this at times a row of black dots. Above this a yellowish brown streak ; both as wide as orbit. Belly white. Dorsal pale orange, remaining fins pale yellow.

Distribution. Mountain streams.
Kahavatta, Gilimalé, Deraniyagala, Ratnapura (Sab. P.)
Ceylon.

Puntius chrysopoma (Cuv. et. Val.)

Barbus chrysopoma Cuv. et Val., Hist. Nat. Poiss XVI. 1842

Mas pethiya, Vellan kolla pethiya (S)

Fins. D IV 8, A III. 5, P 1·12-16, V 1·7-8, C 19. Dorsal spine strong, serrate posteriorly, anal spine weak, smooth.

Scales. Lateral line complete. LL 26-29. L tr. $\frac{4·5-5·5}{3·5}$, predorsals 8-10, preventrals 15-17.

Barbels. Rostral pair slightly longer than eye. Maxillary pair 1·5 length of eye.

Measurements. Head 3·7-4, eye 3·5-5, interorbit 1-2·3, snout 1-1·4 depth of body 2·6-2·8, pectoral 4·5-5, ventral 4·8-5·7, caudal 3-3·7 into entire length.

An oblong, deep fish. Dorsal profile convex, ventral profile less so. Mouth terminal, reaches anterior edge of eye and is 3·1-3·5 in head. (Plate I, fig. 4). Origin of dorsal in mid back or nearer to base of caudal fin than to tip of snout. Last osseous spine with a filamentous tip and has numerous serrations along its posterior edge, its stiff portion varies

in length from the distance between insertion of ventrals and lateral line or distance from base of dorsal and lateral line or equals head without snout. Outer margin of dorsal slightly emarginate, of anal, straight. Pectoral and ventrals have pointed tips with very emarginate posterior margins. Pectorals do not quite reach insertion of ventrals. Ventrals far from anal which does not reach caudal. Caudal peduncle as long as its least depth. Length of fish 310 mm.

Colours. Dorsally olive, sides silvery with golden reflections. Belly white or pale pink. Barbels reddish brown. Preopercles and opercles golden, vertex olive green. Eye yellow or orange. Fins vary in colour and range from dusky brown to orange. A dark caudal blotch posterior to base of anal and covers three scales ranging from the 21st-25th lateral line scale. In the young up to 27·5 mm., there is in addition a small spot at the shoulder above the lateral line, another under the last dorsal spine and another above the lateral line near caudal blotch.[1] The first and last spots are generally absent.

Reproduction. Young showing dorsal spot ranging from 21·5-27·5 mm. were taken at Murungan (N.P.) on 9.12.27.

Females with ripe ova were taken from Rembeva (N.C.P.), 6.7.26 ; Beirai Lake (W.P.), May 8th, 1928 ; June 6th, 1928; Vellava 8.4.28 ; Kegalla (Sab. P.), July 25th, 1926; Haloluva (C.P.), April 10th; 1927; Levella (C.P.), February 18th, 1926; Katupotha (N.W.P.), August 6th, 1926 ; Vakvella, August 20th, 1926 (S.P.); Kelaniya (W.P.), October, 11th, 1926; Beirai Lake, May 8th and June 6th, 1928; Nambapana (Sab.P.), January 2nd, 1926; Homagama (W.P.), June 20th, 1926.

Distribution. In streams, rivers, ponds and lakes, found in large shoals near the "spills" of tanks where they are fed with raw or boiled rice by the villagers and are often so tame as to enter vessels dipped into the water, even whilst still held in the hand.

Beirai Lake, Colombo, Kelaniya, Yakvala, Athanagalla Oya, Dehivala, Kalutara (W.P.), Batuluoya (N.W.P.), Anuradhapura, Nochchiyagama, Medavachchiya, Kalanderavaveva (N.C.P.), Levella, Peradeniya, Kandy Lake, Mahavilliganga (C.P.), Vakvella, Menikganga, Tissamaharama, Viravillaveva (S.P.), Ambillipitiya (Sab.P.).

Ceylon, India.

Puntius vittatus Day

Puntius vittatus Day, P.Z,S., 1865.

Bandi titteya (S).

Fins. D II·8, A II·5, P 1·11, V 1·8, C 20. Osseous spines weak and smooth.

1. In all probability the young of this fish has been described by Day as *B. innominatus* (Blyth.).

Scales. Lateral line incomplete, disappears after 3-6 scales. LL 20-22, L tr. $\frac{3\cdot5}{3\cdot5}$, predorsals 7-8, preventrals 11-12.

Barbels. On maxillaries only, often rudimentary or absent.

Measurements. Head 3-3·5, eye 2·9-3·5, interorbit 1·5-1·8, snout 0·8-1, depth of body 2·7-3, pectoral 4·3-5·3, ventral 4·5-5·7, caudal 3-3·5. An oblong fish, dorsal profile as convex as ventral profile or more so. Mouth small, terminal, does not reach eye. Origin of dorsal in mid back or nearer to base of caudal fin than to tip of snout. Tip of pectoral does not reach ventral which is inserted under origin of dorsal. Ventral does not reach anal which is far behind dorsal. Outer margins of dorsal and anal straight. Stiff portion of dorsal spine shorter than head by $\frac{2}{3}$ snout. Caudal deeply emarginate, its peduncle as long as its least depth. Length of fish 40 mm.

Colours. Pale olive dorsally, silvery or metallic blue sides and belly. A yellowish green median band from vertex to caudal, and a similar lateral band. Fins orange or yellow. Dorsal has a vertical band arising from base of 5th or 6th ray and ascending to tip of anterior dorsal spine. A black spot at base of caudal and another at cloaca.

Distribution. Fresh water ponds, streams and tanks of the low-country. It is the hardiest member of the genus and is found alive in ponds reduced to liquid mud during the dry season. Under these conditions the fish assumes a heavy coating of slime and the silver colour changes to a metallic blue.

Colombo, Kirindivella, Pugoda, Yakvala, Kelaniya, Panadura, Kalutara, Dehivala, Badugama, Matugama (W.P.), Ratnapura (Sab.P.), Arnamaduaveva, Pinkettiveva, Bathuluoya, Muneswaramveva, Chilaw, Katupotha, Kurunegala (N.W.P.), Baddegama, Vakvella, Telikada, Marambe (S.P.), Medavachchiya, Nochchiyagama (N.C.P.), Jaffna, Murungan, Mankulam, Kuruvichchi Aar (N.P.).

Ceylon, India.

Puntius cumingi (Günther).* Plate II, fig. 2.

Puntius phutunio Bleeker, Cypr. et Cobit. Ceylon, 1864-65
Barbus cumingii Günther, Cat. Fishes Brit. Mus. VII, 1868.

Pōthaya (S).

Fins. D II·8, A III·5, P 1·11, V 1·7-8, C 19. Last osseous spine of dorsal moderately thick, strongly serrate, with a flexible smooth tip. Last osseous spine of anal smooth.

Scales. Lateral line incomplete and disappears after 5-8 scales. LL 19-21, L tr. $\frac{3\cdot5}{3\cdot5}$, predorsals 8, preventrals 11.

Barbels. Absent.

Measurements. Head 3·6-4, eye 2·1-2·75, interorbit 1, snout 0·5-0·75. Depth of body 2-2·5, pectoral 4, ventral 4, caudal 2·9-3·2 in entire length.

An oblong or ovate fish with convex dorsal and ventral profiles. Mouth subterminal, small, oblique, does not reach eye. Origin of dorsal in mid back or slightly closer to caudal than to snout, its osseous spine of medium strength, serrate with smooth filamentous tip. Stiff portion as long as eye and snout. Tip of pectoral reaches ventral, which latter does not reach anal. Ventrals inserted slightly anterior to, or in line with, origin of dorsal, and behind an outer elongate scale. Origin of anal posterior to base of dorsal, margins of dorsal and anal straight. Caudal deeply emarginate. Caudal peduncle as long as deep, with ten scales round its middle. Length of fish 40 mm.

Colours. A silvery fish with yellow reflections on shoulders. Two rhomboid black patches on each side. The anterior one is above the middle of pectoral and includes the 3rd, 4th and 5th lateral line scales. The posterior one is at the base of the caudal peduncle posterior to base of anal. Both blotches are widest at the lateral line. Eye pale yellow or white. Dorsal and ventral orange, with two horizontal rows of 5-7 black spots on dorsal which has a black tip to its anterior spine. Remaining fins yellow.

Distribution. Hill streams.

Katakeda Ela, Nambapana (Sab.P.), Kandegomuaveva, Katupotha (N.W.P.), Peradeniya, Gampola (C.P.), Hiniduma (S.P.).

Ceylon.

Puntius ticto (Ham. Buch.)

Cyprinus ticto Ham. Buch. Fish. Ganges, 1822.

Fins. D II·8, A III·5, P 1·11, V 1·7, C 19. Last dorsal spine moderate, serrate in the middle, with filamentous tip. Anal spine smooth.

Scales. Lateral line incomplete, disappears after 7-15 scales. LL. 20-22. L tr. $\frac{4·5}{2·5\text{-}3·5}$, predorsals 8-9, preventrals 12.

Barbels. Absent.

Measurements. Head 3-3·25, eye 2·9-3·1, interorbit 1, snout 0·6-0·8, depth of body 2·5, pectoral 4·2-4·6, ventral 4-4·6, Caudal 2·8-3.

An oblong fish, mouth small, terminal, gape oblique, does not reach eye. Origin of dorsal in mid back or slightly closer to base of caudal than to tip of snout. Tip of pectoral reaches ventral, which fin barely reaches anal. Base of anal behind that of dorsal. Outer margins of

dorsal and anal faintly emarginate. Stiff portion of dorsal spine equals head without snout. Caudal deeply emarginate. Caudal peduncle as long as its least depth. Length of fish 36 mm.

Colours. Pale olive dorsally, with silver sides and belly. A dusky indistinct spot at origin of dorsal.

An anterior black spot as large as pupil of eye, under third and fourth lateral line scales, and another larger black caudal blotch on the 16th or 17th lateral line scale. This last is as large as eye. In some a lateral row of minute black blotches. Two rows of indistinct spots on dorsal.

Distribution. Fresh water ponds and tanks, chiefly in the dry zone.

Kuruvichchi Aar (E.P.), Nochchiyagama (N.C.P.), Vannivillankulam (N.P.), Marichchukaddi (N.P.).

Ceylon, India.

Puntius titteya Deraniyagala*

Puntius titteya Deraniyagala, Ceylon Journal of Science, Sect. B, Vol. XV, p. 73, 1929.

Lai titeya, Dola titeya, Vairan titeya, Kōndhaya (S).

Fins. D III·7, A III·5, P 1·10, V 2·7, C 17. Dorsal spine weak, faintly serrate, anal spine weak, smooth.

Scales. Lateral line incomplete, disappearing after 3-4 scales. LL 19-20, L tr. $\frac{3\cdot5}{3\cdot5}$, predorsals 7-8, preventrals 11.

Barbels. A maxillary pair 0·9-1·5, orbits long.

Measurements. Head 3·5, eye 3-3·1, interorbit 1, snout 0·8-1, depth of body 2·8-3. Pectoral 4-4·4, ventral 4-4·9, caudal 2·9-3 into entire length.

Dorsal profile convex with an abrupt drop after base of dorsal fin and in old specimens the back humps up behind the vertex. Ventral profile less convex than dorsal, belly smooth, rounded. Mouth small, subterminal, does not reach orbit. Origin of dorsal in mid back and above insertion of ventrals. The third osseous spine equals two-thirds of body depth. Fins rounded in outline. Base of dorsal in a sheath of three scales, and as long as head without snout. Pectorals barely reach insertions of ventrals. Ventrals reach anal, which has a scaly sheath and does not reach caudal. Caudal strongly emarginate, longer than head by half an orbit. Caudal peduncle as long as its least depth with nine scales round its middle. Length of fish 31 mm.

Colours. Chocolate brown dorsally, pink ventrally or a uniform crimson. A dark lateral line runs from upper lip through mid eye to

end of median caudal rays. Above this is a yellow line. Below it are 10 black blotches which are deeper than long and extend from shoulder to base of anal. Below these is another row of two or three blotches. There is a median green line from snout to vertex enclosed in a "U"-shaped black mark which extends a short distance posteriorly, a black line from vertex to origin of dorsal fin. Dorsally olive brown with a crimson band upon the lateral black band, sides yellow, belly white or yellow, with red lunules in some cases. Fins crimson or deep orange.

Reproduction. Young 9 mm. long were taken at Vakvella (S.P.), on July 31st, 1928. Ambagaspitiya, July 6th, 1930.

Distribution. Small streams in the low-country hills.

Ambagaspitiya, Homagama, Kirindivella, Matugama (W.P.), Nambapana (Sab.P.), Vakvella (S.P.), Gilimalé (Sab. P.).

Ceylon.

Genus **Tor** Gray

Elongate, rather compressed, belly rounded. Post labial groove continuous. Snout prominent, mouth subterminal, jaws protractile. Four barbels, rostral and maxillary. Head skin smooth. Suborbital bones narrow. Dorsal and anal with short bases. Scales large, lateral line in middle of tail, complete. Gill membranes fused to isthmus near hind edge of preopercle. Pharyngeal teeth 5. 3. 2.

Tor tor (Ham. Buch.) Plates I, IV

Cyprinus tor Ham. Buch., Fishes of Ganges, 1822.
Lehella,[1] *Hora-palaya* (S).

Fins. D IV·9, A 111·5, P 1·15-17, V 1·8, C 19. Dorsal spine thick, strong, and smooth ; anal usually thinner, both closely invested in adipose connective tissue in old specimens.

Scales. Large, smallest on throat and chest, lateral line complete, curving gently downward and running along middle of caudal peduncle. LL 23-24, L tr. $\frac{3\cdot5}{2\cdot5}$, predorsals 8-9, preventrals 13-14.

Barbels. Rostrals extend nearly, or up to front of eye, maxillaries are somewhat longer and reach mid eye or hind edge of orbit. Barbels 1·5-2·3 orbits in length in adults, but are shorter than orbit in young, 30 mm. long.

Measurements. Head 3-4·7, eye 3-8, interorbit 1·5-3, snout 1-2·6, depth 3·5-4·5, pectoral 4·8-6·7, ventral 5·5-7·9 and as long as anal; dorsal 3·85-8·8 ; caudal 3·8-5·3 into entire length. This species is the

1. Mentioned by the Sinhalese poet Totagamuve in A.D. 1461 in a list of fishes "Lehel, Pethi, Ma-angulu ; Luhul, Valapothu, Theli, Dalu."

largest of the Cyprinidae and is the "Mahsier" of anglers. An elongate fish with a conical snout and convex belly. Mouth subterminal, becomes terminal with age; jaws strongly protractile. Post labial groove continuous, round jaws, but in very young specimens of 33 mm. length it is interrupted at mandibular symphysis where the lip forms a tumid swelling which in later life develops into a labial flap which varies greatly with age and sex. *Tor tor* has been erroneously sub-divided into several species according to the differences of this labial flap which alters with age and sex.[1] In the immature female the labial flap is small and square, just covering the post labial groove. It is rudimentary in both very young and adult, existing only as a slight thickening which barely covers the labial groove. In the male it is an elongate triangular point which reaches level with the angle of mouth with sexual maturity, while the lips thicken. (Plate I, fig. 3).

Vertex of head convex with straight dorsal and ventral profiles, abdomen convex. Preorbital bone developed, old specimens show numerous rough tubercles on suborbitals, preopercles and opercles; a row of conspicuous sense pits present along ventral edge of preopercle. Width of opercle 1·5 in its depth and equals or exceeds width of preopercle. Gill membranes fused to isthmus under hind edge of preopercle. Origin of dorsal in mid back or occasionally somewhat closer to caudal than to snout; last osseous dorsal spine thick, smooth and as long as head or post orbital part of head, in old specimens closely invested with adipose connective tissue, outer margin of dorsal emarginate. Base of dorsal in a sheath of five scales. Origin of anal far behind base of dorsal, its base in a sheath of three scales. Anal may or may not reach caudal, its hind margin straight. Paired fins with acute tips. Pectoral with emarginate inner edge, its tip reaches ventral which is inserted behind two large scales which are often bifurcated in old specimens and arise somewhat behind origin of dorsal. Both pectoral and ventral somewhat longer than dorsal. Caudal strongly emarginate. Length of caudal peduncle 1·5-1·7 times its least depth. Each fin ray overlapped by a conspicuous ensheathing flap of skin attached to the preceding ray. (Plate IV.).

Dimensions. A female taken at Levella (C.P.), 29th December, 1927. Weight 10,916 grs., length 765 mm., depth 220 mm., snout 70 mm., eye 26 mm., head 210 mm., caudal fin 186 mm. Body scale 42 mm. long, 60 mm. deep. A fish of 27,360 grs. said to have been netted here in 1926.

Males with triangular labial flap, not reaching angle of mouth, from Levella, Januray, 1928, are 180–200 mm. long.

1. *Tor longispinis* (Günther), together with *Tor progeneius* and *Tor hexastichus* (McClelland) have been reported from Ceylon.

Male with triangular labial flap reaching angle of mouth, from Maskeliya. 175 mm. long.

Colours. (In alcohol) 30 mm. young. Leaden blue dorsally, silvery below lateral line with a black spot at tip of caudal peduncle. 150-200 mm. specimens, leaden blue dorsally with dark bases to scales. Those below lateral line have no dark bases and are silvery, becoming white on belly. Pectorals, ventrals and anal orange. Caudal leaden with dark upper and lower edge. No spot on caudal peduncle. (Freshly killed). Silvery grey dorsally with reddish brown lunules, belly white, fins yellow, caudal with olive margins.

765 mm. female (freshly killed). Head olive green with emerald green reflections, lips and eyes yellow, gill membranes red, throat white. Dark olive green dorsally with emerald green reflections. Sides silvery, belly white. All the scales have large crimson lunules which become fainter on the belly. Pectoral, ventral and anal fins orange, dorsal olive green, caudal cobalt blue shot with green.

Food. Algal material and fresh water mollusca. Also feeds on leaves and flowers which fall into the stream. When the "Kalla vel" liane and the Induru tree (*Susum anthelminticum*) are in blossom the flesh of this fish when eaten produces nausea and giddiness as it feeds on these flowers. At Bulutota gap (Sab. P.) on 5.4.28 when "Kalla vel" were in bloom, several people suffered from these symptoms after eating Tor taken from the Araporu river. The fish is eagerly sought for by fishermen who take it on hooks baited with coconut, bread or starch, paste or by netting. The flesh is exceedingly fat and very firm and one of the best flavoured of our fresh water fishes.

Reproduction. A female of 10,916 grs. taken at Levella (C.P.) on 29.12.27 was full of ova 2·5 mm. in diameter.

Young specimens 29-33 mm. in length were taken at Bilihuluoya (Sab. P.) on 30.8.28 and 3.9.28.

The female is said to scoop out a nest in the quieter pools of mountain torrents, with a side to side movement of the thick, fleshy anal fin which is frequently worn down in consequence. The eggs are thought to be deposited in batches in different nests.

Distribution. In the deeper pools of mountain streams from 100 metres above sea level. According to Pereira it was common in the Kelaniganga and at Grandpass Fish Market (Colombo) in 1873. While it is still commonly taken from the Kaluganga. Deraniyagala, Rakvana, Ratnapura, Araporu River, Sitalaganga, Panduluoya, Kitulgalla (Sab. P.), Maskeliya, Levella and Alutnuvara, on the Mahavilliganga (C.P.).

Ceylon, India.

Genus **Garra** Ham. Buch.

Elongate, rounded fish with a suctorial disc under chin formed, by modification of lips and lower jaw. Mouth inferior. Jaws with horny covering. Gill membranes broadly fused to isthmus. Barbels four, two or none[1] : Lateral line complete, running in middle of caudal peduncle. Intermaxillaries and maxillaries well developed, each may or may not carry a pair of barbels. Dorsal profile convex, ventral surface flattened. Snout prominent, rounded, with tubercles. Paired fins set on very low down, anal short, caudal emarginate. Postlabial groove continuous. Pharyngeal teeth 5.3.3 or 5.4.2.

Garra ceylonensis Bleeker.* Plates I, V

Garra (Garra) ceylonensis Bleeker, Verslen. Med. Afd. Natuurk. XV, 1863.
Gal panderuva, Gal pandiya, Kal koravai (T).

Fins. D 3·8-9, A 2·5, P 1·9-12, V 1·7, C 19. Bases of fin rays with ensheathing cutaneous lappets more or less developed.

Scales. Moderate, thin. Those on chest rudimentary or absent. Lateral line complete. LL 33-35, L tr. $\frac{4\cdot5}{2\cdot5\text{-}3\cdot5}$, predorsals 9-12, preventals 15-20

Barbels. An intermaxillary and a maxillary pair. The latter usually the shorter of the two in the adult, although in young specimens they are the longer. The former are shorter or slightly longer than eye. Bases of maxillary barbels invested in the rostral and labial folds.

Measurements. Head 3·6-4·5, eye 4-5·5, interorbit 1·6-2, snout 1·9-2·5, depth of body 4-5·25, pectoral 3·75-5, ventral 4·9-6, caudal 3·9-4·7 in entire length. Eye in posterior half of head or middle.

An elongate fish, rounded dorsally, flattened ventrally, with prominent convex snout. Eye free, mouth inferior, transverse, as wide as distance from tip of snout to posterior edge of submental disc. Snout with a shallow, transverse, rostral groove dorsally and a short, lateral groove which ends anterior to intermaxillary barbel. Rostrum prolongated ventrally into a wide cutaneous flap with a finely granular surface and crenulate margin. This flap entirely covers the upper lip and jaw. The lip is a smooth, narrow fold with crenulate edge which does not completely cover the upper jaw. The rostral flap is confluent with the upper and lower lips at the angles of mouth where it invests the bases of the maxillary barbels. The post labial groove

1. Bleeker's sub-division. no longer recognised, is as follows :—
Subgenus *Garra* Ham Buch. 4 barbels.
Subgenus *Discognathus* Heckel 2 barbels.

is ill-defined and continuous.[1] The lateral rostral groove is apt to be mistaken for the post labial groove owing to the fusion of the rostral flap with the corners of the upper lip. The lower lip combines with the submental disc to form an adhering organ by which the fish clings to rocks. This disc, which is of dermal and adipose structure, is an oval pad 1·5 times as wide as long in the adult, and is surrounded by a broad cutaneous ring which has a coarsely granular surface and papillate posterior edge.

This external fold is thrown into well-defined ridges at the angles of mouth where it is confluent with the rostral fold. In young specimens up to 19 mm. in length the disc is barely as wide as the isthmus. The mouth structure of Garra may be represented by three concentric circles. The inner one being the jaws, the middle circle the lips which are thick and simple in the young but reduced and scarcely noticeable in the adult, and the outer circle consisting of the rostral fold which is confluent with the submental disc. (Plate I, fig. 1.)

Origin of dorsal fin nearer to tip of snout than to base of caudal, its margin slightly emarginate, and its height equal to depth of body. The base has a short scaly sheath which is inconspicuous.

Pectoral rounded, terminating in a blunt point and, although reaching to under dorsal, does not touch insertion of ventral which is similar in shape and inserted under 2nd or 3rd dorsal ray. Origin of anal behind tip of ventral and does not reach caudal which is gently emarginate. Margin of anal straight. Length of fish 150 mm. (Plate V, fig. 1.)

Colours. Dorsally a reddish brown or olive with a diffuse yellow lateral band below which is a dark band which runs along the lateral line from a black spot at top corner of gill cleft to tips of median caudal rays. Snout olive green, opercles yellow tinted with red. Belly white or pale yellow. Dorsal and anal fins yellow, pectoral, ventral and caudal orange, or salmon pink. Eye yellow. Old specimens are a uniform olive green, while the lateral band is absent or indistinct.

Reproduction. Young 19-21 mm. long taken in the Mahavilliganga, at Levella (C.P.) on February 18th, 1926, from Rakvana (Sab. P.) on April 7th, 1928. Young 14-17 mm. long from Nanu Oya (C.P.) March 27th, 1929.

Distribution. In flowing water, usually above 50 metres. Feeds on algae and molluscs which appear to be pushed up towards the mouth by the submental disc which is also used for clasping the rocks when the torrent is rapid. Prefers the quieter pools with sandy bottom and, although slow swimming when undisturbed, evades capture, by darting

1. Garra appears to be a higher modification of Tor, not Labeo, as seen from the fins and the post labial groove of the young. Also compare labial flap of Tor with disc of Garra.

to shelter with great rapidity. A hardy fish and can live for nearly ten minutes out of water.

Hantana Peak, Peradeniya, Kandy, Teldeniya, Mahavilliganga, Nuwara Eliya, Nanu Oya (C.P.), Diyatalava, Bandaravela (U.P.), Nambapana, Deraniyagala, Rakvana, Gilimalé, Kahavatta, Veganga (Sab. P.), Gal Oya, Kumana, Kumbukgam Oya (E.P.).[1]

Ceylon.

Sub-family **Rasborinae**

Key to Ceylon Rasborinae

A. Barbels absent

(1) Predorsals 11–17 ..... *Rasbora.*

(2) Predorsals 28–30 ..... *Amblypharyngodon.*

B. Barbels present

(1) No symphysial knob. Anal with 5 rays ..... *Esomus.*

(2) Symphysial knob. Anal with 13–16 rays ..... *Danio.*

Genus **Rasbora** Bleeker

Oblong or elongate. Mouth small, oblique, terminal or undershot, lower jaw with a symphysial knob which fits into a notch in upper jaw. Barbels absent. Fins without ossified spines, dorsal with 7-8 rays, its origin behind ventrals, anal with 5-6 rays. Scales large or moderate. Lateral line complete or incomplete, descends and runs along ventral edge and lower half of tail. Gill openings reach below preopercle. Pseudobranchiae present. Pharyngeal teeth 5-4, 4-2, 2-1.

Rasbora vaterifloris sp. nov. (Plate III, fig. 2)

Hal mal titeya[2] (S).

This form differs from all known Indian and Ceylon species of Rasbora in possessing an incomplete lateral line. The specific name is a latinisation of the Sinhalese "Hal mal." The type specimen sent to the British Museum is 27 mm. long without caudal fin which is 10·5 mm. and possesses four perforated lateral line scales.

Fins. D 2·8, A 2·6, P 1·11, V 1·6, C 20.

1. One specimen taken by the writer, August 23rd, 1927, near Kumana (E.P.) a distance of three kilometres from sea. The river mouth was shut off from the sea by a sandbar at the time.
2. "Hal" = *Vateria acuminata.*

Scales. Lateral line incomplete. Perforated scales 3-4. LL 25, L tr. 6, predorsals 11-12, preventrals 14.

Measurements. Head 3-3·4, eye 2·25, interorbit 1, snout 0·5, depth of body 2·5-2·8, pectoral 3·5-3·7, ventral 3·7, caudal 2·6 in length. An oblong, compressed fish increasing in depth with age. Mouth with a symphysial knob, gape oblique and does not quite reach orbit. Dorsal fin somewhat behind ventrals, its origin in mid back or slightly closer to base of caudal fin than to tip of snout. Height of dorsal 2·8 in length of fish. This fin is elevated and acute with a straight posterior edge. Anal similar but with a faintly emarginate posterior edge and when depressed nearly reaches caudal fin. Height of anal 3·1 into length of fish. Pectorals acute and reach past insertion of ventrals. Ventrals well developed, acute and reach past origin of anal which is under end of base of dorsal. Caudal fin rather long, deeply emarginate and is 2·6 into length. Length of caudal peduncle equals its least depth. In this species all the fins are well developed and possess pointed tips. Gill membranes fused to isthmus below posterior half of orbit which is large.

Colours. Silvery with a bluish olive tint on head and back. Dorsal fin with a black anterior edge, rest a bright orange as is the lower lobe of caudal, resembling in hue the "Hal" flower from which the fish derives its Sinhalese name.

Remaining fins hyaline.

Distribution. The Kaluganga (river) near Illukvattai ferry on the Ratnapura to Gilimalé road, (Sabaragamuwa Province), Ceylon.

Rasbora daniconius (Ham. Buch.)

Cyprinus daniconius Ham. Buch. Fishes of Ganges, 1822.

Kiri dhandiya, Kehel dhandiya, Kudu massa (S).

Fins. D 2·6-7, A 2·5, P 1·13-14, V 1·7-8, C 17-19.

Scales. Lateral line complete and descends two scales. LL 30-34, L tr. $\frac{4\cdot5\text{-}6\cdot5}{1\cdot5\text{-}2\cdot5}$, predorsals 13-17, preventrals 15-16.

Measurements. Head 3·15-3·8, eye 3-4·5, interorbit 0·8-2, snout 0·85-1·5, depth of body 3·25-4, pectoral 4·1-5·5, ventral 5-7, caudal 3-4·8 into entire length. An elongate, rather rounded, compressed fish with a convex dorsal profile and a ventral profile which is less so. In young specimens the head is conical, in old ones, especially females the head is concave dorsally and the snout and jaws elongate. There is usually only a single scale between the lateral line and the insertion of the ventrals which are rather in advance of the origin of dorsal. The common number of predorsal scales is 14 or 15. Mouth opens dorsally,

symphysial knob prominent. Gape 2·8-3 in head and ends in front of or below anterior edge of orbit. Dorsal fin behind ventrals, its origin equidistant from ventrals and origin of anal. Distance from base of dorsal to tip of snout is 1·5-2 times the distance from base of dorsal to base of caudal fin. Pectorals do not quite reach ventrals which reach cloaca. A specimen from Marambe (S.P.) showed no trace of ventrals. All fins with rounded external margins. Caudal deeply emarginate, with rather rounded tips, longer or shorter than head. Length of caudal peduncle is 1·2-1·4 times its least depth, at which place there are 9 scales from lateral line to lateral line over the back. Length of fish 103 mm.

Colours. Greenish yellow dorsally, sides silvery with a blue black lateral stripe. Snout reddish brown, opercles bright yellow, subopercle silvery. Vertex emerald green with a green, nuchal stripe from head to origin of dorsal. Dorsally pale olive to steel blue with green reflections. A more or less dark blue lateral line from below nostril through mid eye and angle of opercle to base of median caudal rays. Above this a bright yellow or orange line between gill slit and anal fin, this line gives off short extensions ventrally which do not reach the lateral line. Sides silvery, with pink reflections, belly white. Dorsal, anal and caudal orange. Pectorals and ventrals hyaline or pale yellow. Iris orange. When in the water the fish often shows a large yellow blotch in mid back.

Food. Worms, mosquito larvae, vegetable matter.

Reproduction. Ova a pearl pink in colour.

Gravid females were collected from Athidiya (W.P.), 27.2.28; Point Pedro (N.P.), 9.10.27; Narhenpita Canal (W.P.), 22.11.28.

Distribution. Streams, ponds and tanks.

Nambapana, Gilimalé, Polmadulla, Deraniyagala (Sab. P.), Marichchukadde, Mankulam, Vannivillankulam, Point Pedro (N.P.), Kelaniya, Badduruelіya, Yakvala, Colombo, Kalutara S., Athidiya, Homagama, Narhenpita Canal (W.P.), Baddegama, Vakvella, Dedduva Lake, Marambe (S.P.), Kumana, Kanniya near Warm Springs (E.P.), Katupota, Batuluoya, Chilaw, Kurunegala (N.W.P.), Anuradhapura, Tammannava, Medavachchiya (N.C.P.).

Ceylon, India, Burma, Zanzibar.

Genus **Esomus** Swainson

Elongate, compressed. Profile from snout to dorsal fin nearly straight or slightly concave at head and gently convex at back, tail descending abruptly from dorsal fin. Mouth small, oblique, superior. No symphysial knob to lower jaw. Rostral and maxillary barbels present. Dorsal with 6 rays and almost above anal which has 5 rays.

Scales moderate. Lateral line curves down and runs close to ventral edge and along lower half of tail, at times absent. Gill openings extend to below eye. Pseudobranchiae present. Pharyngeal teeth in one series of 5.

Esomus danrica thermoicos (Cuv. et Val.)

Nuria thermoicos, Cuv. et Val., Hist. Nat. Poiss. XVI, 1842.

Rävul dhandiya (S).

Fins. D 2·6, A 3·5, P 1·10-12, V 1·7, C 19. Dorsal and anal spines smooth, weak, soft.

Scales. Lateral line complete,[1] rarely wanting on tail. LL. 31-34, L. tr. $\frac{5·5}{1·5}$, predorsals 17-20, preventrals 22-23.

Barbels. Premaxillary pair three-fourths of orbit and reach mid eye. Mixillary pair reach from tip of pectoral, to as far as the anal, but are shorter in the young.

Measurements. Head 3·5-4, eye 3-3·75, interorbit 1-1·5, snout 0·8-1, depth of body 3·7-4·5, pectoral 3-3·5, ventral 5·5-6, caudal 3-3·4. Dorsal profile straight, ventral profile convex, belly smooth, rounded. Mouth terminal, straight, remote from orbit. Margin of dorsal faintly convex, of anal emarginate. Base of dorsal anterior to that of anal, height of dorsal is head minus snout. Distance from dorsal to caudal is 2·4 in distance from dorsal to snout. Caudal deeply emarginate with lower lobe slightly longer than upper. Caudal peduncle as long as 1·8 times its least depth. 14 scales around it. Length of fish 63 mm.

Colours. Pale olive dorsally with a greenish yellow lateral stripe above a steel blue one. A yellow or brown median nuchal band from vertex to caudal. Eyes pale yellow. Belly and sides silvery. Dorsal, anal and caudal pale yellow, pectoral and ventral hyaline.

Food. Organic matter, insect larvae.

Reproduction. Ova pale yellow. Mature ova in fishes from Athidiya. April 2nd, 1929.

Distribution. Fresh water ponds, tanks and ditches. A hardy fish and is often found in ponds reduced to liquid mud during droughts. Useful as a mosquito larvicide and frequently employed as live bait by fishermen.

Kirivella, Kelaniya, Athidiya, Colombo (W.P.), Pinkettiveva, Batuluoya, Katupota (N.W.P.), Mankulam (N.P.), Tammannava (N.C.P.), Ceylon, Burma, South India.

1. Incomplete in some Indian sub-species, absent in others. *Esomus alta* (Blyth) from Burma and *Esomus barbatus* (Jerdon) from South India appear to be colour variations of the Ceylon Subspecies.

Genus **Amblypharyngodon** Bleeker

Compressed oblong, abdomen rounded, pseudobranchiae present. Dorsal and anal with short bases. Mouth superior, with a symphysial knob on lower jaw which has a thin, short labial fold on each side. No upper lip. Barbels absent. Eyes without adipose lid, extend below gape. Gill membranes wide. Tongue free, ventrals in advance of dorsal. Scales small, lateral line incomplete, no scales on head. Eye extends below level of gape. Opercles large, suborbitals narrow. Pharyngeal teeth 3.2.1.

Amblypharyngodon melettinus (Cuv. et Val.)

Leuciscus melettinus Cuv. et Val., Hist. Nat. Poiss. XVII, 1844.

Sōreya (S).

Fins. D 2·7, A 3·5, P 1·13-14, V 1·7, C 19.

Scales. Small, lateral line incomplete, ending after 11-18 scales. LL 45-50, L tr. $\frac{8\cdot5\text{-}10\cdot5}{4\cdot5\text{-}5\cdot5}$, predorsals 28-30.

Measurements. Head 3-3·5, eye 2·9-4·5, interorbit 1-1·25, snout 0·8. Depth of body 3·5-4, pectoral 5, ventral 6, caudal 3·1-3·5. A somewhat compressed fish with ventral profile more convex than dorsal. Mouth superior with a prominent knob at mandibular symphysis which develops a fleshy flap which curves well over the upper jaw during the breeding season. Gill membranes very wide, separate, free. Lateral line incomplete, curves downward and does not extend beyond insertion of ventrals. Eye free, set in anterior half of head and extends well below gape. Length of caudal peduncle equals 1·5 times its least depth. Dorsal spine, soft, weak, smooth. Origin of dorsal behind ventrals and closer to base of caudal fin than to snout tip. Hind margin of dorsal straight, its tip remote from caudal. Base of anal finishes under tip of dorsal. Anal fin also remote from caudal, its hind margin concave. Pectorals short, do not reach ventrals which latter do not reach anal; caudal strongly emarginate, its lower lobe slightly longer than the upper. Length of fish 80 mm.

Colours. Sides silvery, back yellowish brown, vertex bright green. Pupil of eye shows a strong red reflection in lamp light.

Reproduction. A cutaneous symphysial flap develops during breeding season and overlaps tip of upper jaw. Egg-laden females with elongate symphysial flap were taken from Mankulam 7.3.28. Eggs yellow in colour.

Distribution. Ponds and streams.

Katupotha, Kurunegala, Muneswaram, Batuluoya (N. W. P.), Kelaniya, Yakvala, Colombo, Athidiya (W.P.), Nochchiyagama, Rembeva (N.C.P.), Mankulam (N.P.).

Ceylon, India.

Genus **Danio** Ham. Buch.

Oblong, compressed. Mouth small, oblique, undershot with a symphysial knob on lower jaw. Barbels, a rostral and maxillary pair. Preorbital quadrangular, suborbital broad. Dorsal 7-16 rays, its origin in front of anal. Scales large or moderate. Lateral line present or absent; bends abruptly down and runs close to ventral edge. Pseudobranchiae present. Gill membranes fused to isthmus.

Pharyngeal teeth 5. 3. 2. Divided into two sub-genera.

Danio with 12-16 dorsal rays, lateral line complete.

Brachydanio with 7 dorsal rays, lateral line incomplete or absent. (Not found in Ceylon).

Danio (Danio) malabaricus (Jerdon)

Perilampus malabaricus Jerdon, Madr. Journ. Lit. & Sc. XV, 1849.
Salaya, Suddara, Dan kolla salaya, Rath kailaya.

Fins. D 2·10-12, A 3·13-16, P 1·11, V 1·6-7, C 19.

Scales. Medium, small on throat, lateral line complete. LL 37-40, L tr. $\frac{7\cdot5\text{-}8\cdot5}{1\cdot5\text{-}2\cdot5}$, predorsals 16-17, preventrals 20-24.

Barbels. A rostral and a maxillary pair, the former as long as half orbit or shorter, the latter usually rudimentary or absent.

Measurements. Head 3·5-4, eye 2·6-3, interorbit 0·9, snout 0·9, depth 2·9-3·9, pectoral 4·15-4·5, caudal 3-4. A compressed oblong fish with rounded belly. Dorsal outline of head concave, vertex to dorsal fin straight, belly convex. The lateral line curves abruptly downward and runs close to lower edge of belly and caudal peduncle. Origin of dorsal slightly anterior to that of anal which has a longer base. Distance from dorsal to caudal contained 2-3 into distance from dorsal to tip of snout. Caudal peduncle as long as its least depth.

Pectoral short, its tip may or may not reach ventral fin which does not reach anal. Neither anal nor dorsal reach caudal which is strongly emarginate. Edges of dorsal and anal straight and slant downward posteriorly. Pectoral and ventral with pointed tips. Bases of dorsal and anal in scaly sheaths. Gape reaches front margin of orbit. Length of fish 78 mm.

Colours. A bright metallic blue, greenish dorsally, with two or three parallel lateral longitudinal lines of yellow which break up into spots and bars between ventral and pectoral fins. Eye and fins vary from yellow to deep orange. A dark shoulder patch present. A diffuse dark band runs between the yellow lateral bands and extends along median rays of caudal.

Distribution. Small streams, ponds and tanks.

Kadugannawa, Nuwara Eliya, Nanu Oya, Kandy, Peradeniya, Galpothai Ela, Levella (C.P.), Kegalla, Pelmadulla, Nambapana, Ratnapura (Sab. P.), Kirindivella, Yakvala, Kaluaggala, Kosgoda (W.P.), Katupotha, Batuluoya (N.W.P.), Mankulam (N.P.), Bandarawela (U.P.)

Ceylon, India.

Sub-family **Abramidinae** Cuvier

Genus **Laubuca** Bleeker[1]

Rhomboid, strongly compressed with a carinate ventral edge from throat to cloaca. Mouth undershot without a knob at mandibular symphysis. No barbels; eye free. Dorsal short, anal long, ventrals inserted slightly above abdominal edge, possess a single filamentous outer ray; pectorals elongate, caudal forked. Head scaleless. Lateral line curves downward and runs close to ventral edge. Pseudobranchiae present. Pharyngeal teeth uncinate, in 3 rows.

Laubuca (Laubuca) laubuca (Ham. Buch.)

Cyprinus laubuca Ham. Buch. Fishes of Ganges, 1822.
Kara Ädeya, Thatu dhandiya (S).

Fins. D II·7-8, A III·17-19, P 1·9-11, V 1·5, C 19.

Scales. Medium, but small below lateral line and on throat and belly. Lateral line complete. LL 33-35; L tr. $\frac{6\cdot5\text{-}7\cdot5}{1\cdot5\text{-}3\cdot5}$, predorsals 17-19, preventrals 22.

Measurements. Head 3·5-4·3, eye 2·8-3·15, interorbit 0·9-1.5, snout 0·8-1, depth 3-3·2, pectoral 2·5-3, caudal 2·5-3. A rhomboid

1 *Eustira ceylonensis* Günther, possesses a pectoral fin shorter than the head, the origin of dorsal is ahead of that of the anal and the lateral line descends abruptly. Weber and Beaufort have divided the genus Laubuca into the subgenera Laubuca and Eustira. The writer has examined numerous specimens of Laubuca, but failed to discover any approaching Günther's description which reminds one forcibly of the genus Danio in which the barbels are often rudimentary.

compressed fish with carinate, convex belly. Slightly concave behind head, convex near origin of dorsal, descending abruptly to caudal fin. No barbels or symphysial knob ; gill membranes fused to isthmus at level of hind edge of preopercle. Lateral line curves gradually downward and runs close to lower edge of belly and tail. Caudal peduncle as long as its least depth. Dorsal situated far back, its distance to snout is 3·1-3·3 times its distance to caudal fin. Origin of dorsal posterior to that of anal, a short scaly basal sheath anteriorly, the fin ends above middle of anal. Margin of dorsal straight and the fin is almost equal in height anteriorly and posteriorly. Anal high anteriorly, very low posteriorly, outer edge strongly emarginate, its base in a scaly sheath. Pectoral inserted behind two enlarged rounded scales, its outer ray is single, elongate, flattened. This fin is 2·6-3 into length and almost reaches origin of anal. Ventral with the single outer ray prolonged into a filament, which is about 2·9 into length. Caudal deeply emarginate, lower lobe longer than the upper and contained 2·5-3 into length.

Mouth undershot, oblique, does not quite reach lower edge of orbit. A single row of large pores on each side of interorbital space and along each mandibular and preopercle. Length of fish 60 mm.

Colours. A bright metallic blue with hyaline fins. A dark shoulder spot and in young specimens a black spot at end of caudal peduncle connected with former by a faint brown line.

Distribution. In rivers, tanks and ponds, common in the dry parts of the low-country, scarce in elevated localities.

Ratnapura, Gilimalé (Sab. P.), Vakvella, Tellikada (S.P.), Mankulam (N.P.), Rambeva, Anuradhapura, Nochchiyagama, Tammannava, Kopakulam (N.C.P.), Pinkettiveva, Batuluoya, Arnamaduva Tank (N.W.P.).

Ceylon, India, Burma, Assam, Sumatra.

Family **COBITIIDAE.** Plate VI

Compressed fishes at times depressed anteriorly. Paired fins inserted low and carry a single outer ray. Eye free, with adipose eyelid, or subcutaneous, with or without a bifid suborbital spine. Dorsal short or long, anal short, mouth inferior, bordered by intermaxillaries. Barbels six or eight. Scales small or rudimentary. Lateral line complete, incomplete or absent. Gill membranes broadly united with isthmus, pseudobranchiae absent. Pharyngeal teeth in a single series. Anterior part of air bladder in a bony capsule, posterior part small or rudimentary, branchiostegals 3. Body elongate.

Key to Ceylon species

A. Suborbital spine present.
.....*Lepidocephalus thermalis.*

B. Suborbital spine absent.
1. Body scaly.
.....*Nemacheilus botia.*
2. Body naked.
.....*Nemachellus notostigma.*

Genus **Lepidocephalus** Bleeker

Elongate, compressed; nostrils contiguous, eye small, subcutaneous, with erectile, bifid, suborbital spine. Mouth small, inferior with simple fleshy lips. Barbels 6-8. Scales on body, and below and behind eye and at times on vertex and opercle. Lateral line absent. Gill opening a vertical slit only reaching to insertion of pectoral; dorsal with short base, its origin nearly opposite base of ventral; anal short, caudal truncate or emarginate.

Lepidocephalus thermalis (Cuv. et Val.) Plate VI, fig. 1

Cobitis thermalis Cuv. et Val. Nat. Hist. Poiss. XVIII, 1846.
"*Ähirava, Ähiraya, Pulli Ähirava* (S), *Airay* (T)."

Fins. D 2·6, A 2·5, P 1·6, V 1·6, C 16.

Scales. Lateral line absent, scales small and inconspicuous, absent from snout, vertex and opercle, present on preopercle, under eye and on body and tail.

Barbels. Eight, reach just beyond orbit and consist of one pair rostral, one pair intermaxillary, one pair maxillary which last are fleshy and are joined by a membrane with the pair of mental barbels.

Measurements. Head 4·7-5, eye 4·5-5, interorbit 0·9-1·1, snout 1·5-2, depth of body 4·9-5.5, pectoral 4·75-6.5, ventral 6·5-7, caudal 4-4·25.

Dorsal profile convex, ventral profile flat, gape small, with a well developed rostral fold and smooth fleshy lips (Plate VI, fig. 1'), tail compressed with adipose fold extending from caudal fin to 0·75 the length of caudal peduncle. Eyes subcutaneous, small. A hooked, bifid, erectile, suborbital spine under anterior part of eye. The inferior hook is the stronger and both are directed horizontally and posteriorly. Gill opening a vertical slit not extending below insertion of pectoral fin. Origin of pectoral fleshy, the outer ray single, the

inner usually flattened and ossified in adults. Ventrals inserted midway between insertion of pectorals and end of base of anal. Anal when depressed nearly reaches caudal. Origin of dorsal closer to base of caudal than to tip of snout and is one or two rays anterior to insertion of ventrals. Dorsal, anal and ventrals rounded, caudal faintly emarginate. Length of fish 50 mm.

Colours. Yellow with iridocytes on head. Brown spots and reticulation on head, back and sides. Eleven or twelve irregular brown blotches which are slightly larger than eye, extend along lateral line. Caudal with a black spot on upper part of base and 5-6 "V"-shaped brown stripes directed posteriorly, 5 rows of brown spots on dorsal and a few spots on outer rays of pectoral. In old specimens some of the spots on back fuse to form an irregular line or lines above the lateral row of blotches, while a similar line extends from eye to rostral barbel. Posterior ossified, pectoral ray pink.

Reproduction. Gravid females were taken from Yakvala, 2.9.1927. Athidiya, 2.4.1929 (W.P.).

Distribution. The type specimen was taken in the hot springs at Kanniya (E.P.), and the fish owes its specific name to this accident. It is common in most parts of Ceylon and is found up to an altitude of 1,600 ft. at Kandy (C.P.). It prefers the loose silt and fine vegetable sediments of quiet pools, to flowing water. The fish is the last Cyprinoid to survive in puddles in the N.C.P. during the dry season and may be seen wriggling in the thick, fast drying mud which abounds with dead bodies of other fishes. Although essentially a vegetarian it is believed to have a partiality for mosquito larvae.

Specimens have been taken from :—

Katupota, Kurunegala (N.W.P.), Vakvella, Marambe (S.P.), Colombo, Kelaniya, Yakvala, Gampola, Veyangoda, Mirigama, Panadura, Bolgoda, Kalutara (W.P.), Nochchiyagama, Anuradhapura, Medawachchiya, Rembova (N.C.P.), Vellava, Ketakeda Ela (Sab. P.), Kanniya Hot Springs (E.P.), Jaffna, Mankulam, Marichchukaddo (N.P.), Peradeniya (C.P.).

Ceylon, South India.

Genus **Nemacheilus** van Hasselt

Elongate, slightly compressed, orbit free, suborbital spine absent. Mouth inferior and crescentric. Six barbels, the rostral pair close together, four on upper jaw, none on mandibulars. Paired fins inserted low on body. Origin of dorsal above or just behind insertion of ventrals, anal short and much behind ventrals. Scales absent or small, absent on head. Gill openings end near base of pectorals.

Nemachellus botia botia (Ham. Buch.) Plate VI, fig. 2

Cobitis botia Ham. Buch. Fishes of Ganges.
Pol dhirava, Vairan dhirava (S).

Fins. D 3-4·10, A 3·5, P 1·10, V 1·6, C 18.

Scales. Small, distinct, imbricate, absent from head. Lateral line complete.

Barbels. Six, reach considerably beyond orbit but not to gill cleft. One pair rostral, one pair intermaxillary, one pair maxillary.

Measurements. Head 3·6-4, eye 3·6-4, interorbit 1-1·2, snout 1·5, depth of body 3·9-4·8, pectoral 3·6-4, caudal 3·1-3·9. Dorsal profile rising in a straight line from snout to eyes which are somewhat raised. Vertex to origin of dorsal slightly convex. Body cylindrical, tail compressed with dorsal adipose fold extending from caudal to above end of base of anal or less. Mouth small with two or three rows of blunt fleshy papillae on upper lip and two globose clusters of papillae on lower lip. (Plate VI, fig. 2). Eye free with a narrow annular adipose lid. A suborbital subcutaneous prominence directed posteriorly present or absent. Sense pits of head not enlarged. Gill opening a vertical slit extending below insertion of pectorals. Lateral line distinct, extending to base of caudal fin. Eye in middle of head.

Origin of dorsal in mid back or nearer to snout than to caudal, outer margin straight, base as long as head or pectorals, which latter usually reach ventrals. Ventrals inserted midway between insertion of pectoral and origin of anal and are under 3rd-5th dorsal branched ray. Anal reaches caudal. Pectorals, ventrals and anal rounded. Caudal faintly emarginate with rounded corners. Length of fish 42 mm.

Colours. Pale olive, yellow or orange with 12-14 brown cross bands on body which may or may not be broken, and are as wide as the interspaces. A brown line from tip of snout to eye, another joining the eyes dorsally. A black ocellus on upper part of base of caudal. Maxillary barbels white, rest light red. Fins pale yellow, dorsal with 4 or 5 oblique rows of brown dots, caudal with a vertical bar under ocellus and five or six "V"-shaped cross bands which are narrower than interspaces and open anteriorly.

Distribution. Small streams in low-country up to an elevation of about 300 metres.

Nambapana, Vallagalla Ela (Sab. P.), Yakvala, Kirindivella, Pugoda (W.P.), Vakvella (S.P.).

Ceylon, India.

Nemacheilus botia aureus Day

N. botia var. *aureus* Day. Fishes of India.

Is similar in many respects to the above but differs in having a suborbital groove under the preorbital which has a blunt suborbital process directed posteriorly. The lateral line may be complete or incomplete and, if so, does not extend beyond base of anal. Pectoral does not reach ventral, and base of dorsal is shorter than pectoral. The scales are larger and more distinct than in *N. botia botia.*

Fins. D 4·10-11, A 3·5, P 1·12, V 1·7, C 18.

Scales. L tr. $\frac{16\text{-}18}{11\text{-}15}$, predorsals 42.

Measurements. Head 4, depth 4·25, caudal 4·25 in length, base of dorsal shorter than head ; pectoral does not reach ventral. Length 58 mm.

Colours. Same as *N. botia botia.*

Distribution. Pimbura (W.P.), Gilimalé, Vallagalla Ăla, Nambapana (Sab. P.).

Ceylon, India.

Nemacheilus notostigma Bleeker.* Plate VI, fig 3.

Nemacheilus notostigma Bleeker, Cobit. et. Cypr. Ceylon, 1864.
Pol ehirava, Gōmera ehirava, Kandu ehirava (S).

Fins. D 3·6-8, A 3·5, P 1·7-9, V 1·6, C 16-18.

Scales. Rudimentary ; lateral line incomplete.

Barbels. Six. Do not reach gill cleft. Rostrals reach nares, intermaxillaries reach mid eye, maxillaries reach midway between eye and gill cleft.

Measurements. Head 3·9-4·2, eye 5-6·5, interorbit 1·5-2, snout 1·6-2, depth of body 5-6·75, pectoral 4·5-5, ventral 5·2-5·5, caudal 4-4·6. Eye in anterior half of head or middle.

Dorsal profile, slightly convex, interorbital space and ventral profile flat. Body rounded, tail compressed with adipose fold extending from caudal to above origin of anal. Mouth small, inferior, lips smooth and faintly crenulate. (Plate VI, fig. 3'). Eye fixed. No suborbital prominence. Sense pits on head large. Gill opening a vertical slit extending to below insertion of pectoral. Lateral line well developed as far as tip of pectoral or origin of dorsal after which it becomes rudimentary and disappears. Origin of dorsal above insertion of ventral and usually closer to caudal than to snout, rarely in mid back. Outer margin nearly straight, oblique, with rounded corners, base as long as

depth of fish. Pectoral does not reach ventral; the latter does not reach anal. Ventral has a fleshy rudimentary axillary scale. Origin of anal behind tip of dorsal, its tip does not reach caudal. Caudal emarginate with rounded lobes of which at times the upper is somewhat longer. Length of fish 57 mm.

Colours. Vary in individuals from different streams. Pale olive or varying shades of yellow with 12-14 brown more or less distinct cross bands on body which may be broken up into blotches. These bands are equal to, or wider than, the interspaces and do not meet ventrally on belly. A dark spot at origin of dorsal and 2-3 oblique rows of brown spots on the fin itself. A dark vertical band at base of caudal which has 5 "W"-shaped vertical rows of spots opening posteriorly. In very young specimens the cross bands on the body are represented by numerous black dots, while a well defined longitudinal row of larger spots runs along the lateral line as in *Lepidocephalus thermalis*. These lateral spots commence on the tail and extend anteriorly, they are seen in specimens 18 mm. in length.

Reproduction. Young 9 mm. long were taken at Nakiadeniya (S.P.), July 30th, 1928.

Distribution. Found only in mountain streams, at 440 metres and above, where it ascends to higher and steeper levels than any other fish, although it has no specially developed clasping apparatus.

Kadugannava, Peradeniya, Kandy, Teldeniya, Matale, Mādugoda (C.P), Nambapana, Väganga, Kahavatta, Rakvana (Sab. P.), Nakiadeniya (S.P.).

Ceylon.

GLOSSARY

Sinhalese.	*English.*	*Sinhalese.*	*English.*
Ādeya.	crooked.	Lai.	blood.
Bandi.	stout.		
Bulath	betel leaf.	Madda.	mud.
Bulath sapeya	betel quid.	Mal.	flower.
Bin.	ground.	Mas.	meat.
		Massa.	fish.
Dola.	streamlet, rill.		
Gal	stone.		
Gōma	blotched.	Pol	coconut.
Gōmera.	blotched.	Pulli	spotted.
Gan	river.		
Hal.	*Vateria acuminata* (tree)	Rathu	red.
Hītha	cold	Rāvul	bearded.
Hiri.	striped.		
Honda.	trunk.		
		Suddaru.	white (fish)

Sinhalese.	*English.*	*Sinhalese.*	*English.*
Iri.	striped.		
		Tambalaya.	bronzed.
		Thatu.	winged.
Kalu.	black.		
Kara.	neck.		
Kattu.	bony.	Vairan.	striped.
Kandu.	mountain.		
Kehel.	banana.		
Kiri.	milk.		
Küriya.	fish.		
Kolla.	leaf.		
Kudu.	small.		

EXPLANATION OF PLATES

Plate I Mouths of Ceylon Cyprinidae

fig. 1 *Garra ceylonensis* ×4
fig. 2. *Labeo (M.) gadeya* ×1
} a. upper jaw.

fig. 3. *Tor tor* × 0·8
fig. 4. *Puntius chrysopoma* ×1
} b. upper lip.

Plate II fig. 1. *Puntius singhala* ×7
fig. 2. *Puntius cumingi* ×2

Plate III fig. 1. *Puntius nigrofasciatus* ×1
fig. 2. *Rasbora vaterifloris* sp. nov. × 1·8

Plate IV *Tor tor, adult female* $\times \frac{1}{20}$

Plate V fig. 1. *Garra ceylonensis* ×1
fig. 2. *Puntius pleurotaenia* ×0·6

Plate VI Ceylon Cobitiidae.
fig. 1. *Lepidocephalus thermalis* 1′ mouth. × 1·8
fig. 2. *Nemacheilus botia* 2′ mouth. × 1·8
fig. 3. *Nemacheilus notostigma* 3′ mouth. × 1.8

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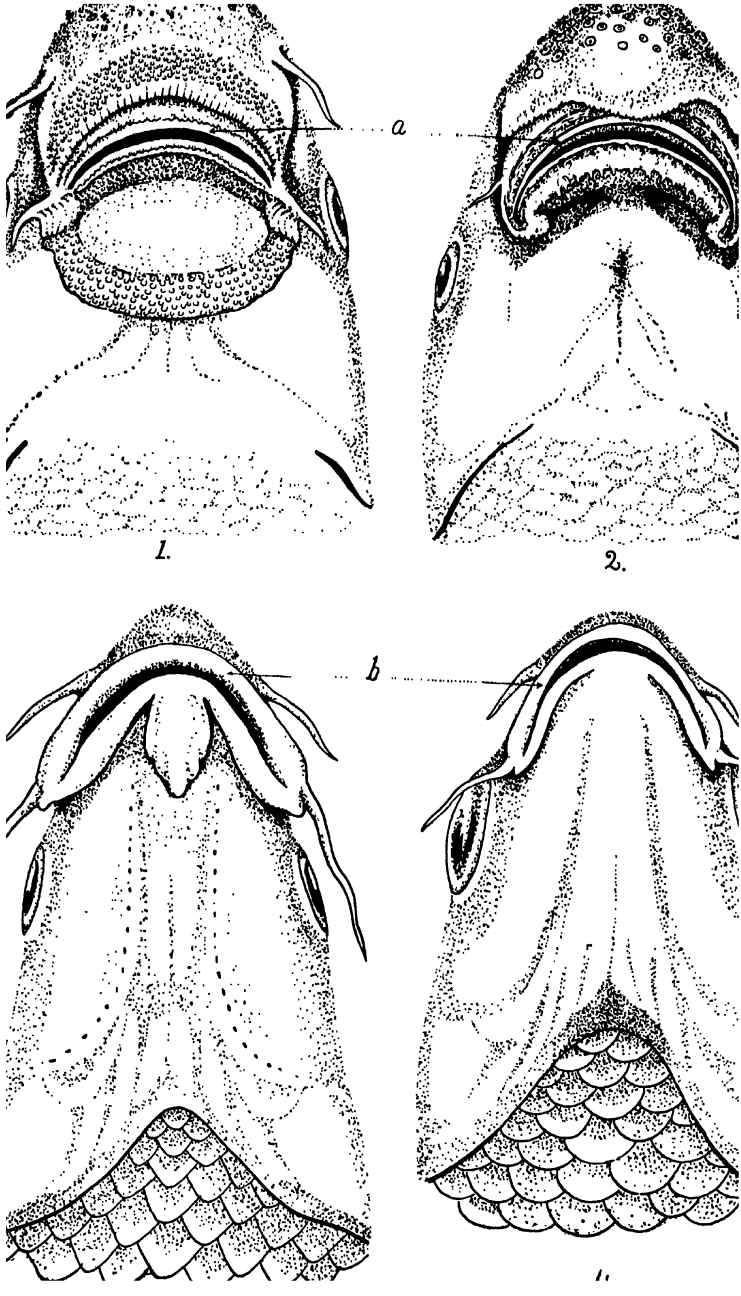

Mouths of Ceylon *Cyprinidae*

P. E. P. Deraniyagala del.

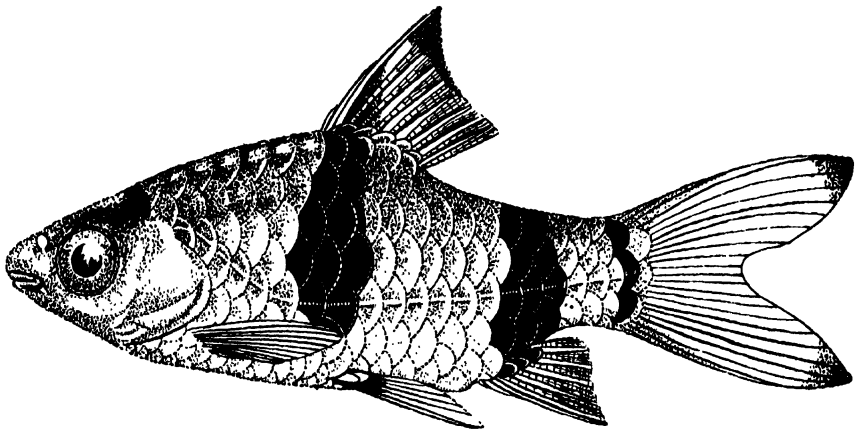

Fig. 1

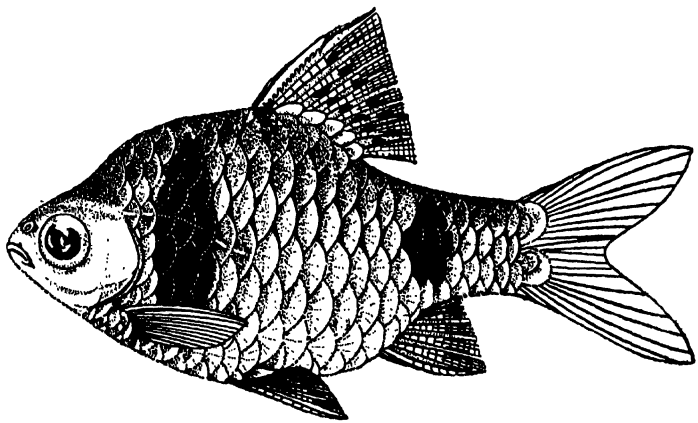

Fig. 2

Fig. 1.—*Puntius singhala.* Fig. 2.—*Puntius cumingi*

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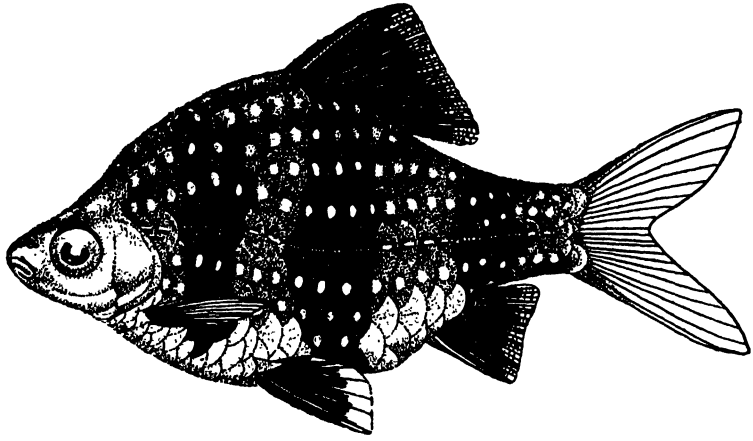

Fig. 1

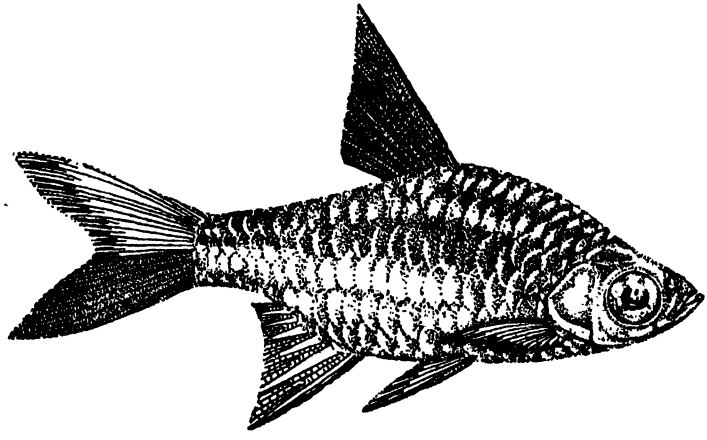

Fig. 2

Fig. 1—*Puntius nigrofasciatus*. Fig. 2—*Rasbora vaterifloris* sp. nov.

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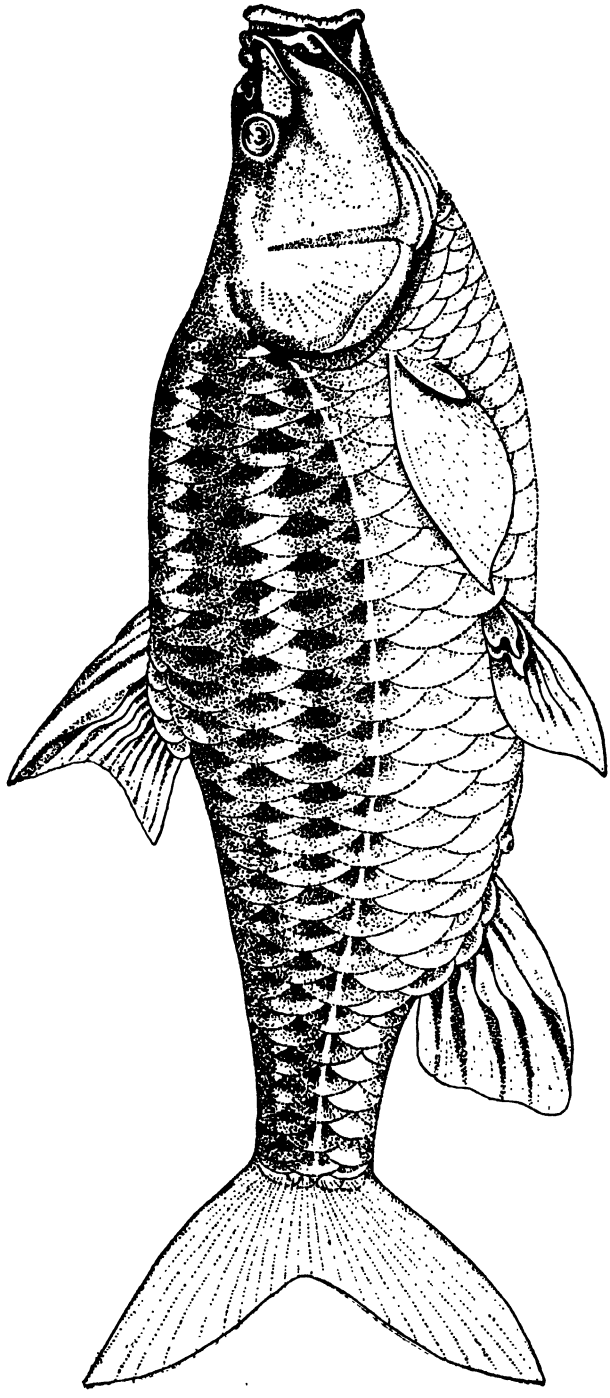

Tor tor, adult female

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C. J. of Sc., Section B—Vol. XVI, Part I

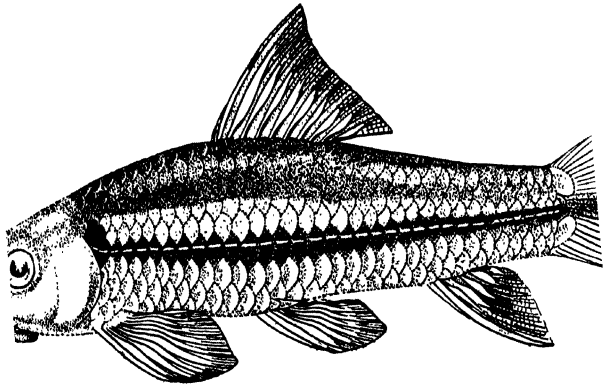


Fig. 1

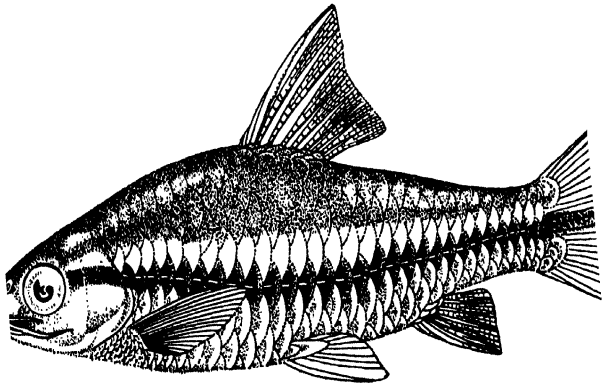
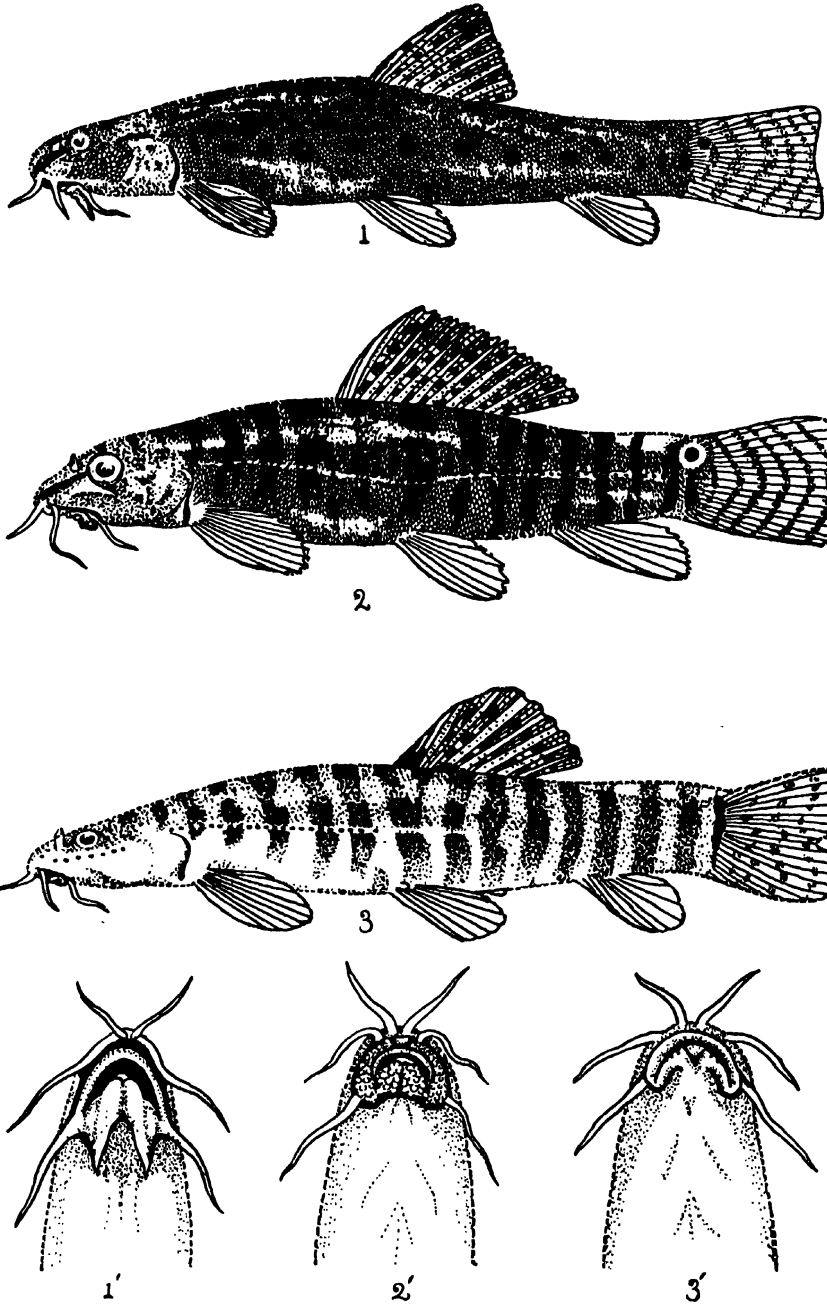


Fig. 2

Fig. 1.—*Garra ceylonensis*. Fig. 2.—*Puntius pleurotaenia*

J. E. P. Peraniyagala del.



Ceylon *Cobitiidae*

P. E. P. Deraniyagala del.

The Testudinata of Ceylon[1]

BY

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WITH SEVEN PLATES

INTRODUCTION

The Testudinata of Ceylon are represented by four marine genera, one aquatic, one amphibious and one terrestrial. The marine ones are of economic value and one of them Dermochelys is, according to several well-known European zoologists, quite the most interesting animal coming from Ceylon. In a paper on Testudinate Evolution to be published in the near future I have set forth my reasons derived chiefly from fossil and embryological knowledge, for adopting the classification used in this paper.

I here wish to express my thanks to Dr. Thomas Barbour, Director of the Museum of Comparative Zoology, Harvard (U.S.A), for information concerning Atlantic and Pacific specimens, to Dr. Jules Richard of the Musee' Oceanographique, Monaco, Dr. M. F. Angel, Museum D'Histoire Naturelle, Paris, Messrs. Malcolm A. Smith and H. W. Parker of the British Museum of Natural History for permitting me to examine the material in their valuable collections and also to the following, Mrs. J. de Alwis, Hon. Mr. R. N. Thaine, Messrs. J. D. Brown, and A. Hallock Wijeynathan of the Civil Service, Mudaliyars E. Tillekeratne, S. W. Illangakoon and W. A. Goonetilleke, Fisher Mudaliyar S. J. Rodrigo, Mr. B. D. Stephen of the Veterinary Department and Messrs. W. D. Martin, O. G. de Alwis, H. Stork and L. de Alwis for their kind assistance with specimens.

The order Testudinata Batsch may be sub-divided as follows :—

I. Suborder **Atheca** Cope
Family *Dermochelidae* Stejneger
genus *Dermochelys*

II. Suborder **Thecophora** Dollo

A. Superfamily *Trionychoidea* Fitzinger
Family *Trionychidae Bell*
genus *Emyda*

B. Superfamily *Cryptodira* Cope

(*a*) Family *Testudinidae* Gray
(1) genus *Testudo*
(2) genus *Geoemyda*

(*b*) Family *Cheloniidae* Gray
(1) genus *Chelonia*
(2) genus *Eretmochelys*
(3) genus *Caretta*

The Testudinata may be defined as follows :—

Skull with a single temporal arcade, quadrate fixed, nasal opening undivided anteriorly, jaws edentulous, in horny beaks, tongue adnate. Body protected by a more or less osseous corselet consisting of a carapace dorsally and a plastron ventrally. Pectoral and pelvic girdles enclosed by the ribs which are single headed. Sternum absent. Copulatory organ single. Oviparous. Two suborders.

Key to suborders

1. Carapace bones dermal, free from skeleton.....*Atheca.*
2. Carapace bones skeletal, fused.....*Thecophora.*

Suborder ATHECA Cope

Skull without descending parietal processes. Carapace consists of external ossified scales embedded in a thick layer of connective tissue which is supported by the ribs, vertebrae, and nuchal bone. Ribs do not form costal plates and are free as are the nuchal bone and vertebrae. Plastron with or without a few rows of external ossified scales set in a thick layer of connective tissue which is supported by eight bones, the entoplastral bone being absent. This suborder contains a single family, the Dermochelidae.

Family **DERMOCHELIDAE** Stejneger

Skull with temporal region completely roofed over, choanae open immediately beneath nares, ear hidden. Carapace a mosaic of numerous ossified dermal scales and has strong longitudinal ridges. Plastron cutaneous, with longitudinal ridges of ossified dermal scales or none. Limbs strongly depressed, paddle shaped, digits bound together, phalanges without condyles. Digits of hand greatly elongate. Reproduction by numerous spherical soft-shelled eggs. A single genus. Neck and limbs not retractile. Habit marine (oceanic).

Genus **DERMOCHELYS** Blainville

Upper beak with a frontal cleft bounded on each side by a triangular projection. Lower beak weak. Margins of both sharp and smooth, their tips acutely pointed. Mouth with numerous long, acute fleshy papillae internally. No alveolar ridges. Eye opening an almost vertical slit,[1] the upper lid shorter than the lower. Limbs clawless in adult, with one or two claws in some embryos and young. Tail compressed, with a dorsal cutaneous ridge and is connected to each leg by a well developed cutaneous fold. Cloaca remote from plastron. Skin broken up into large scales on head and smaller subequal ones on limbs and body in young, but becomes smooth and entire in the adult. Choanal papillae absent. Parasphenoid bone enlarged. A single species.

Dermochelys coriacea (Linnè). Plates VII, VIII, IX

The leathery turtle

Testudo coriacea Linnè, Syst. Nat. 1. 1766.
Dermochelys coriacea Blainville, Bull Soc. Philom. Paris, 1816.
Sphargis coriacea Merrem, Syst. Amphib. 1820.

Dhara käsbäva, Pulli käsbäva, Vavul käsbäva, Thel käsbäva, Nävu käsbäva, Oru käsbäva, Mavalla (Male) (S),[2] *Dhoni-amai, Yeluvari amai* (T).

Corselet without scutes. Carapace triangular, with an anterior hump over nuchal bone and with seven longitudinal ridges which converge posteriorly to form a narrow, truncate, supracaudal portion. Carapace completely ossified, composed of numerous flat polygonal, osseous platelets sutured together, while each of the seven ridges consists of a single row of larger carinate platelets which are usually interrupted by one or two small flat platelets between every two or three large ones. The carina of each platelet forms a protuberance which breaks up the ridge into a series of knobs. In some specimens these ridges are partially or entirely smooth.[1] In embryos the carapace ridges consist of the

1. Throughout the order Testudinata the eyelids appear to meet in an oblique plane. In Dermochelys this tendency has attained to its maximum.
2. Names in front of (S) = Sinhalese, (T) = Tamil.

following numbers of platelets. Neural 28-30, the nuchal hump ending after the seventh or eighth platelet ; costals 30-35, supramarginals 21-25, marginals 26-30. In the adult the number of platelets appears to have increased. Plates VII and VIII.

Nuchal bone always free from carapace bones and skeleton. A flat, bat-shaped bone with numerous processes on the two wings and with an elongate posterior median prolongation which is connected to the eighth vertebra by a ligament. The plastron is short, and of cutaneous structure and has five longitudinal rows of small carinate platelets which may be rudimentary or entirely absent. The median sternal ridge consists of a double row of platelets, while the humeral and axillary ridges consist of a single row each. Plastral bones lack the entoplastral element and consist of eight narrow splints which enclose a large fontanel. In embryos the ends of the hyo and hypoplastral bones are widely separate, but in the young and adult they overlap and are constant in shape throughout, from birth till death. (Plate IX).

Head scaly in young but covered with smooth skin which even extends over the beaks in the adult. The cephalic scales vary considerably and may, in some individuals, be represented by numerous small scales. Their general arrangement is as follows: Prefrontals one or two pairs, frontal single or represented by numerous small scales in a longitudinal series ; when single it may be confluent with the single frontoparietal or distinct. Temporals and malars small, in 3-4 longitudinal rows, parietals 2 or azygos, occipital either single and distinct or confluent with parietals which are then azygos. Preoculars 3 or 4 conspicuous ; supraoculars 5 to 8 wide, short ; postoculars 8 to 10 small. Throat scales small with a row of 14 to 18 enlarged scales along posterior border of lower beak. This row is either continuous or interrupted in the middle behind the mandibular symphysis. Snout acutely conical and prominent in newly hatched, more rounded in adult. Upper beak with a median frontal cleft between two acutely triangular lateral lobes, lower beak with a regular margin, weak, and with a sharp point at symphysis. In the young the horny beaks are well developed but become restricted in the adult and are invested in skin, Margins of jaws very sharp and smooth. Interior of mouth and posterior margins of lower jaw fringed with pointed, elongate, fleshy papillae which are present in the embryo. Alveolar surfaces flat. The choanae open immediately beneath the nares and are not furnished with papillae. Eyelids close in an almost vertical plane which is very characteristic. The upper lid is the shorter and ends beneath the lower at the posterior or upper

1. Some fossil genera show a similar condition, while the ventral armature is nearly as perfect as the dorsal.

corner of eye. Flippers strongly depressed, at times with one or two rudimentary claws in the embryo and young but always clawless in the adult. These claws are often barely discernible, lying flush with the surface as diminutive round knobs which glisten on rubbing the edge of the flipper with a finger. Each is situated between two small black scales which interrupt the larger, white, marginal scales of the flipper. Flippers triangular in outline, the arms elongate and acute in the adult, bluntly rounded in the young, the legs short and broad with a somewhat bilobate posterior margin. Plate VII.

A wide cutaneous fold extends along posterior edge of each thigh to base of tail. Tail compressed distally, furnished with a dorsal, cutaneous ridge which consists of a single row of scales in the young, but becomes low, fleshy and barely perceptible knobs in the adult. Skull with temporal area roofed over, while in the adult the extremity of the supraoccipital process is barely visible externally. A median notch present between the premaxillaries bounded on each side by an anterior maxillary notch. Alveolar surface flat, pterygoids widely separated posteriorly by the basisphenoid. Prefrontals narrowly contiguous anteriorly. Bones of lower jaw slender, mandibular symphysis very narrow and terminating in a sharp tip which fits into a pit in the premaxillaries. This pit opens posteriorly into the nasal cavity. An intertrabecular cartilage in skull of young. Parasphenoid bone very large.

Liver consists of two broad lobes connected together by two narrow bands ; although nearly equal in length the right lobe is much the larger and both are thrown into one or two short ill-defined folds.

Colours. Dorsally a uniform slaty black spotted with bluish white, ventrally white, with black reticulation along the margins. The young, which have white dorsal and plastral ridges and flipper margins, are of an intenser black than the adult. These white stripes are the first to appear on the hyaline 32-day embryo which has dark eyes. The 38-day embryo is a greyish brown with white ridges and this grey increases in darkness until full colouration is attained in the 60-day embryo which is black dorsally with white corselet ridges. The seventh or eighth neural platelet, which terminates the nuchal hump, usually has dark outer edges. The upper eyelid and the outer halves of the supraocular scales are white as are the jaws, throat and outer margins of the flippers. The anterior part of the plastron is blotched with white which joins the white plastral ridges. The bases of the flippers are also blotched with white, while several rows of white spots extend along the neck, each in a single series as continuations from the white dorsal ridges. In the new born a dark band runs behind the postmandibular scales and there is a black median gular band. The white dorsal ridges are restricted and

are a pale blue as are the spots on the head. An adult female taken at Kalutara South was a slaty black with numerous diffuse, small, white spots dorsally. The rows of spots on the neck persisted but the carapace ridges were black. Flippers had no white margin but showed numerous large white polygonal spots on their ventral surface. Head black with a few white blotches, jaws white, blotched with black, throat a pinkish white with dark reticulation. Plastron white with black reticulation near margin. An adult male netted off Colombo was similar. Plate VIII.

Carapaces and limbs of slaughtered specimens were always black and white. The Colombo Museum contains two mounted adults. One is normal, the other which has smooth ridges is a uniform black (*Dimensions*, No. 8) and is probably a variation.

Food. Stomach contents of Kalutara and Wadduwa females consisted of small quantities of fine blue green algae. The Colombo male contained Scyphomedusae. In captivity the newly hatched young fed on chopped fish.

Reproduction. The nest is dug fifteen or twenty metres away from the water's edge. The eggs which are spherical, soft-shelled and white are 90-150 in number and a characteristic feature of this turtle is that ten or fifteen eggs in each nest are abnormal, being either very small and round or at times dumbell shaped or of the usual size but ellipsoid. These eggs are infertile and always contain only albumen and remain fresh until the date of hatching. Normal eggs range from 50 to 54 mm. in diameter. Several batches are laid during the year and turtles slaughtered immediately after oviposition usually contain numbers of half developed eggs. One female examined contained 850 such, ranging from 26 to 39 mm. in diameter, of which those with a diameter of 35 to 37 mm. were most common. May and June are the chief months for oviposition but eggs are found all the year round.

The period of incubation is probably 65-70 days as calculated from two eggs laid on two different dates which, when buried in ordinary earth and examined 60 and 62 days after oviposition, yielded embryos 82 and 83 mm. long with yolk sacs of 36 by 25 mm.

The young, which are 85 mm. long and weigh 32·62 to 33·57 grs. on hatching unlike young Cheloniidae, can swim fast and dive easily using their arms. They apparently travel into oceanic water far from land and remain there until full-grown and sexually mature when they approach the shore to oviposit. At such times the males[1] appear to

1. A male Dermochelys from Senegal in the Muséum d'Histoire Naturelle, Paris (Specimen No. 903) has the carapace ridges smooth anteriorly and tuberculated posteriorly over the hips and supracaudal region. The tail is elongate and extends considerably farther than the hind limbs. In other respects the male resembles the female. A male taken off Colombo had the dorsal ridges nearly smooth anteriorly. The ventral platelets were greatly reduced. Body depth of male much less than that of female. Profile from eye to snout more concave in male than in female which has it convex at times.

follow the females, and the "Māvalla" is occasionally taken in drift nets set out 4 to 5 kilometres from shore. Such captures are rare although females are often taken thus and are then invariably ovigerous. The adolescent stage of this turtle has never been seen by anyone. This turtle at times appears to come ashore in small troops and seven females were reported to have been captured in one night in May, 1929, on the beach from Paiyagala to Maggona (W.P.), while on the morning of July, 1928, the writer saw nine nests at Bentota beach, all within a distance of two kilometres. Four ovigerous females were taken at Wadduwa on June 14th, 1930, between 9 and 11 p.m, Male narrower across hips than female and furnished with a grooved hemipenis as in other turtles. Tail elongate, plastron concave.

Oviposition. The following is an account of the nesting habits of this turtle, according to Mudaliyar E. Tillekeratne of Bentota, who has twice seen the process. The animal, after digging two or three "false" nests, selects a suitable spot and dispels the loose sand with its arms. The smaller nest hole is then excavated within this crater, by means of the legs, the sand being flung to a considerable distance. It differs from other turtles, in flinging the sand far out, in digging a much deeper hole, and in emitting a strong fishy odour when laying its eggs.

The animal is said to continue laying in spite of men or noise and, after covering up the eggs, it ploughs up the sand for about 10 square metres all round the nest so that, unless the eggs are removed prior to this, it is almost impossible to locate the nest. On a subsequent visit to Bentota on July 28th, 1928, the writer was shown nine nests which the Mudaliyar assured him belonged to this form and the wide flipper marks of the ingress and egress trails appeared to support his statement. Connecting these two trails in each nest was an area about 6 metres in length by 2 metres in width where the sand was so churned up as to resemble the arena of a buffalo fight and all efforts at finding the eggs proved futile. Later in the day a *Varanus salvator* was disturbed whilst digging for the eggs, but even with its keen sense of smell the lizard had burrowed in three different places without being able to locate the nest.

Ovigerous turtles were captured or the eggs obtained on the following dates :—

Negombo,	June 20th, 1908.
Modera,	May 16th, 17th, 22nd, 1929. Netted in drift nets.
Moratuwa,	May 19th, 1929, at 8-9 p.m.
Wadduwa,	July 17th, 1929.
Kalutara South,	January 7th, May 14th, 22nd, June, 10th, 28th, July 25th, August 6th, 1929, June 15th, 1930.
Bentota,	August 31st, 1928, at 8.30 p.m.
Matara,	January 18th, 1929.

Hambantota,	June 27th, 1929.
Kirinda,	January 5th, 1929.
Kalutara North,	September 3rd, 1929, A nest of 116 eggs, of which 9 had hatched while 102 contained mature dead embryos, 5 eggs being infertile. Cause of death unknown. Possibly exposure of eggs to sun.
Wadduva,	June 14th, 1930. Four females. One had 95 normal and 18 small mature eggs and a clutch of half ripe eggs inside.

Eggs were of the following dimensions:—

Locality.	*Diameter.*	*Weight.*
Hambantota	52 mm.	75·25 grs.
June 27th, 1929	52	76·35
	55 × 53	84·32
	53	81·32
Kalutara South.		
May 14th, 1929.	53·5	70·8
	53·5	69·6
	53	69·19
	53	69·02
	53	68·6
	52	69·38
	51	65·95
Kalutara South.	52	74·3
June 28th, 1929.	52	72·9
	53	73·69
	53	72·82
	57 × 49	70·8
	51	69·2
	51	61·8

Ellipsoid eggs from a nest at Bentota containing 142 eggs were of the following dimensions: 40 × 32 mm., 31 × 27 mm., 40 × 34 mm., 28 × 18 mm., small, spherical eggs ranging from 22-42 mm.

The abnormal eggs of the Wadduva female ranged from 10 mm. to 42 mm.

The embryonic stages of this turtle were obtained and their age in every case reckoned from the date the eggs were deposited in the beach. Three batches of eggs were examined; the first was laid on August 31st, 1928, the second on May 14th, 1929, the last was found ready to hatch on September 3rd, 1929. The 21-day embryo is 9·6 mm. long. The head is flexed in the usual manner and is 2·6 mm. long in a straight line from upper tip of prosencephalon to end of mesencephalon. Width of head 1·9 mm. Axilla to groin 3·5 mm., tail 1·9 mm., width of body 1·5 mm. Anterior limb bud 0·84 mm. thick, 0·7 mm. long, posterior limb bud 0·5 mm. thick, 0·24 mm. long. At this stage the embryo is entirely colourless and lizard-like in shape without a corselet. Branchial clefts distinct.

The 32-day embryo is 13 mm. long with a carapace length of 8·0 mm. At this stage the animal has assumed the turtle-like shape. The eyes

have darkened and, although the rest of the animal is hyaline, the corselet ridges are coloured white.[1] At 38 days the total length is 42 mm. with a carapace length of 23-24 mm. By now the animal is faintly but entirely pigmented with a pale greyish brown, while the corselet streaks are white. Lepidosis is not yet apparent on the head and limbs although distinct on the corselet. The nuchal bone, skeleton and plastral elements are ossified, but the ends of the latter are remote from each other, while the corselet platelets have not yet ossified.[2]

At 50 days the total length is 65 mm. with a carapace length of 45 mm. Lepidosis and pigmentation are complete but faint. At 60 days the total length is 83 mm. with the carapace 55 mm. long. Lepidosis and pigmentation are intensified and the tips of the plastral elements overlap each other except those which come near the line of flexure of the embryo over the yolk sac. These are the posterior process of the hyoplastron and the anterior process of the hypoplastron. These do not overlap until after birth, and it is not till then that the scaly platelets of the corselet commence to ossify. Plates VII and VIII.

Strange to say, although the platelets are as distinctly marked on the plastron as on the carapace in both the embryo and in the newly hatched young, yet with the exception of a few rows, they entirely fail to ossify in the plastron. The platelet divisions fuse with each other and disappear to form a leathery plastron in which usually five rudimentary rows of osseous platelets are present.[3] This process of ossification is homologous with that known to occur in the order Emydosauria where the Caiman is known to possess rudimentary, ventral osseous platelets. The occurrence of twin embryos in the same egg is also of interest. Out of a nest of 102 mature embryos from Kalutara North September 3rd, 1929, two eggs contained twin embryos in each. In one egg one was normal, the twin being half its size; in the other, one was normal, the twin very small.

Age.	*Length.*	*L. of C.*	*Remarks.*
21 days' embryo (in alcohol)	9·6 mm.	none.	Lizard-like shape, colourless, limb buds and gill slits present.
32 days' embryo (in alcohol)	13 mm.	8 mm.	Turtle shape. Eyes pigmented. White corselet ridges, rest hyaline.

1. These embryos will be described and figured separately.
2. Embryos were stained in alizarin which forms a permanent "lake" with the calcareous portions, the stain was then removed from the flesh and cartilage and the specimen cleared in glycerine and examined.
3. As a result of its long marine existence Dermochelys is losing its ossification as seen by comparison with fossil forms which possess an almost complete ventral armature and the lepidosis of young Dermochelys supports this fact.

Age.	*Length.*	*L. of C.*	*Remarks.*
38 days' embryo	42 mm.	23-24 mm.	Faintly pigmented. Lepidosis on corselet only. Skeleton and nuchal bone ossified. Ends of plastral elements widely separate.
50 days' embryo	65 mm.	45 mm.	Pigmentation and lepidosis complete but faint. Arm shorter than carapace.
60-62 days' embryos	82-83 mm.	55 mm.	Pigmentation and lepidosis intensified, ends of plastral elements overlap. Corselet platelets not yet ossified. Arm as long as carapce.
Just hatched, 2 specimens	85 mm.	58-60 mm.	Weight 32·62-33·57 grs. Head scales thickened. A black median gular streak on throat.
17 days' old	98 mm.	67 mm.	Corselet not ossified. Two claws on each hand.

A *Dermochelys coriacea* hatched on Kalutara beach on September 3rd, 1929. It was fed on chopped fish and at this stage no claws were noticeable on any of the flippers.[1] On September 19th the animal died and, on examination, was found to have developed two prominent claws on each hand but none on the feet. The dimensions of the animal now in the British Museum, were as follows :

Total length 98 mm., length of carapace 67 mm., width of carapace 39 mm., length of plastron 52·5 mm., length of arm 55 mm., length of head 25 mm., length of gape 14 mm., axilla to groin 30 mm.

Distribution. This species is a pelagic form which only enters coastal waters prior to coming ashore to oviposit. It is the largest living marine turtle and the most specialized aquatic chelonian known, fossil or recent. Hitherto regarded as a rare form, it appears to be quite common in Ceylon waters as the eggs are brought for sale as often as those of *Caretta caretta*, but the turtle itself is seldom captured owing to the difficulty of "turning" so large an animal and the aversion to eating the flesh of so weird-looking a creature.[2]

1. Specimen No. 901 of the Museum d'Histoire Naturelle, Paris, is the original figured by Dumeril and Bibron in Hist. Rept. T. 2. P. 560 and was captured in the Mediterrancan. Its left hand shows a cavity filled with what appears to be congealed blood and apparently held a well developed claw which was broken off during capture.
The position of this claw is identical with that of Ceylon specimens; while the animal is of the same species. The post-mandibular scales decrease in size behind the symphysis. The dimensions are as follows : Total length 140 mm., length of carapace 75 mm., length of head 26 mm. Two young specimens in the British Museum were clawless.

2. It is stated at Weligama (S.P.) that during certain seasons the flesh posseses stupefying properties. However the writer tasted some excellent curry made from this turtle which was as good as, if not superior to, that made from *Chelonia mydas*. The skin and corselet contain an abundance of oil, conspicuous even in embryos and this feature has earned the turtle the name of 'Thel kāsbāva.' This oil is of considerable value as canoe varnish. A male netted off Colombo realised Rs. 30—on its flesh.

Specimens or portions of slaughtered specimens were examined from Karaitivu Island in Gulf of Mannar, Negombo, Modera, Moratuwa, Wadduva, Kalutara (W.P.),[1] Bentota, Matara, Hambantota, Kirinda (S.P.). A photo of an adult taken in the otter trawl of the Fisheries Department trawler on September 24th, 1925, at 25 kilometres ESE of Point Pedro (N.P.) in Lat. 9°44′ N. Long. 80° 44′E., also reported from Rameswaram Island, Mannar (N.P.), Chilaw, Arne erekkam (N.W.P.), Paiyagalla, Maggona (W.P.), Weligama (S.P.), Batticaloa (E.P.), and said to have been taken by a Norwegian trawler in the sea off Galle. A male netted 4 kilometres off Colombo, June 11th, 1930; four females turned at Wadduva, June 14th, 1930.

Ceylon, India, Tenasserim, Malay Archipelago, Japan, Philippines, Australia, New Zealand, Arabia, Tropical regions of Indian, Atlantic and Pacific oceans, occasionally wanders into temperate seas and reported from Brittany, British Isles, Mediterranean, South America.

Variation. The carapace ridges which are normally broken up into numerous knobs, may be partially or entirely smooth. A specimen from Matara had the knobs restricted to the region behind the hips, while one from Moratuwa had the ridges entirely smooth. The osseous platelets of the plastron may be rudimentary or altogether absent as seen in specimen 10 from Kalutara. The cephalic shields of newly hatched specimens vary considerably, and the row of enlarged postmandibular scales may be either continuous or interrupted in the middle. Colour variation also appears to exist and an all black specimen with smooth ridges taken at Moratuwa is mounted in the Colombo Museum. Examination of a nest of fully developed embryos showed that a claw is at times present on some flippers. No specimens were found to possess more than two limbs bearing a claw.

Eighty-five embryos of head lengths ranging from 18 to 25 mm. were examined with the aid of a dissecting microscope. Of these, one had a claw on the right hand, two had a claw on the right foot, fourteen had a claw on the left foot, nine had a claw on each foot, the remainder were clawless.

Dimensions in millemetres

No.	*Locality.*	*L. of C.*	*W. of C.*	*L. of P.*	*W. of P.*	*L. of Hd.*	*Arm.*	*Leg.*	*Ax. to Gr.*	*S. to T.*
1	Bentota embryos									
2	50 days' old.	45	30	—	—	18·5	34	17	—	65
3	60-62 days' old.	54-55	36	—	—	23·5	55	29	26	82-83

1. (E.P.) = Eastern Province, (S.P.) = Southern Province, (W.P.) = Western Province, (N.W.P.) = North-Western Province, (N.P.) = Northern Province,

No.	Locality.	L. of C.	W. of C.	L. of P.	W. of P.	L. of Hd.	Arm.	Leg.	Ax. to Gr.	S. to T.
4	Kalutara South embryos	23	14	16	13	12	10	7	11	42
5	,, 38 days' old	24	14	17	13	12	10	7	11	42
6	,, 62 ,, ,,	55	36	35·5	—	23	55	28	27	80
7	,, 2 just hatched	58-60	36	46	31	24	55	29	28	85
8	Moratuwa	1,540	700	—	—	280	830	400	—	1,770
9	Stuffed adults	1,250	630	—	—	260	740	360	—	1,610
10	Kalutara South	1,590	920	1,240	830	—	—	520	680	—
11	,,	1,475	680	1,090	680	280	880	580	520	1,875
12	Matara	1,460	810	—	—	—	—	—	—	—
13	Modera	1,550	—	—	—	300	—	—	—	—
14	Colombo	1,520	750	1,140	750	300	—	—	620	2,060
15	Wadduva	1,479	739	1,173	739	290	—	—	637	—

A female of normal size taken on the beach at Kalutara South on May 14th, 1929, and a male netted off Colombo, June 11th, 1930, measured as follows :—

	♀	♂		♀	♂
Weight kgms.	301·63		Carapace to tip of foot ..	580	..
Carapace curve along	mm.	mm.	Head length ..	280	300
neural ridge ..	1,475	1,520	Head width ..	210	215
Length of plastron ..	1,090	1,140	Snout ..	70	65
Width of plastron ..	680	750	Gape ..	180	190
Axilla to groin along axillary			Orbit ..	80	70
ridge ..	520	620	Neck girth ..	867	900
Tip of snout to tip of tail	1,875	2,060	Greatest girth, under arms	1,993	2,090
Arms tip to tip when spread	2,937	2,730	Least girth round groin ..	1,049	..
Legs tip to tip when spread	1,040	1,490	Tip of snout to carapace ..	445	430
Arm (to wrist) ..	880	..	Tip of tail to plastron ..	445	590
Greatest width of arm ..	290	..	Tip of tail to cloaca ..	120	170
Least width of arm ..	120	..			

A female captured at Modera measured as follows :—

Carapace curve along neural ridge ..	1,550	Snout ..	69
Head length ..	300	Orbit ..	72
Head width ..	230	Gape ..	200

Suborder THECOPHORA Dollo

Skull with descending parietal processes. Carapace consists of callous expansions arising from ribs and vertebrae which fuse with each other and with the nuchal bone. The last three components are usually free in the embryo and embedded in a thick layer of connective tissue which they eventually replace. Plastron more or less completely ossified

and consists of nine separate bony elements which in the embryo are embedded in connective tissue, but later form callous expansions and fuse partially or entirely with each other. Limbs clawed.[1] Reproduction by hard or soft-shelled eggs.

Key to Superfamilies of Ceylon Thecophora

(1) Marginal bones incomplete or absent, soft skin on corselet ; nares tubular.

.....*Trionychoidea.*

(2) Marginal bones complete, horny scutes on corselet ; nares holes in snout.

.....*Cryptodira.*

Key to families of Ceylon Cryptodira

(1) Ear exposed, claws 4 or 5.

.....*Testudinidae.*

(2) Ear hidden, claws 1 or 2.

.....*Cheloniidae.*

Superfamily **Trionychoidea** Fitzinger

Family **TRIONYCHIDAE** Bell

Smooth skinned, depressed, without scutes or scales ; head and limbs completely retractile, skull without temporal roofing. Nares form a proboscis, choanae posterior, ear hidden, jaws with fleshy lips. Corselet incompletely ossified, marginal bones absent or incomplete and free from ribs. Pygal bone absent from carapace. Plastron connected to carapace by ligaments and has extensive fontanels between the osseous elements which latter expand and fuse with dermal callosities. The "V"-shaped entoplastron separates the epiplastra from the hyoplastra. Limbs short, depressed, digits distinct, completely webbed, only the inner three possess claws, the fourth with four or more phalanges. Tail always very short. Reproduction by hard-shelled eggs. Habit aquatic. A single Ceylon genus.

Genus **Emyda** Gray

Posterior ends of nuchal bone under first pair of costals. A prenuchal bone present. Seven to nine marginals free from carapace and

1. This character, although placed here for the sake of contrasting the two suborders, is a purely generic feature.

along its posterior border. Eight pairs of costal plates, the last widest in the adult carapace and like the seventh pair are contiguous along the dorsal median line. Hyoplastron fused to hypoplastron, a few weeks after birth. Seven callosities on plastron. Plastron with cutaneous inguinal flaps which together with the anterior lobe are compressible against carapace. Jaws strong, beaks narrow. Choanae open between orbits.

Emyda granosa ceylonensis Gray Plate X

The soft terrapin

Emyda punctata Kelaart, Prod. Faun. Zeyl. 1852.
Emyda vittata Peters, M.B. Akad. Berl, 1854.
Emyda ceylonensis Gray, Cat. Shield Reptiles 1, 1855.
Emyda granosa ceylonensis Annandale. Rec. Ind. Mus. vii, 1912.

Kiri ibba (S), *Pal amai* (T).

Without scales or scutes, entirely invested in skin which is thrown into numerous short longitudinal granular folds on carapace of young. Carapace depressed, plastron with inguinal flaps. Limbs depressed with distinct webbed digits, of which only the first three have claws. The distal phalanges in the last digit of each limb set at right angles to each other. Head large, ellipsoid, with tubular snout and fleshy lips around horny beaks ; eyes small, elevated. Neck elongate and with a sigmoid flexure. Tail short in both sexes, does not protrude beyond margin of carapace.

Carapace plates develop dorsally as callous expansions arising from vertebrae and ribs when the animal is one week old ; later they extend downward ventrally to margin. Plastron contains the usual number of osseous elements which expand into the corneous plastral tissue and irrupt through it to form large rugose areas which are covered with thin skin during life.

An ellipsoid prenuchal plate lies in front of nuchal and is separate from rest of carapace. Nuchal incompletely fused to carapace from which it remains separate for several weeks after animal emerges from egg; possesses numerous digitate processes, the interspaces of which partially fill up with age. In young with carapace 80 mm. long the nuchal is widely separate from first pair of costal plates but fuses incompletely later in life consequent on the expansion of both. Neurals seven ; the first two are between the anterior pair of costals, of which there are eight pairs. Seventh and eighth pairs contiguous on dorsal mid line, the eighth being the widest of the costals. Marginals show a tendency to fuse ; seven to nine on each side, separate from carapace and around its posterior half. The first is about four times as long as the last, which is

widely separated from the others and is contiguous with its fellow from the opposite side.[1] No pygal bone.

In young specimens of a carapace length of 80 mm. the prenuchal is in an incipient stage of ossification, while the marginals are entirely absent. The nuchal is nearly separate from the first pair of costals to which it is connected ventrally by its processes. At this stage the eighth pair of costals are the smallest, widely separate from each other and in an incipient stage of ossification. Free edges of plastron can be compressed against carapace. Skull depressed, choanae located between orbits, alveolar surface smooth, lower jaw strong. Liver bilobate, the right lobe much larger than the left. Each choana protected by a cutaneous valve.

Colours. Olive green dorsally with darker irregular bands which disappear in the adult. Plastron a creamy yellow tinged with pink with six translucent callosities. Head olive with or without dark bands and spots dorsally, lips and throat yellow. Males darker in colour than females. When kept in glass aquaria, the sunlight acts on the plastra of young specimens producing dark cloudings which disappear a few weeks after the animals have been transferred to a cement tank which occludes light from below. Plate X.

Food. Carnivorous ; fishes, crustaceans and decaying matter.

Reproduction. The tail is very short in both sexes. Several batches of ten or twelve white, spherical hard-shelled eggs are buried in the ground close to water during the season. The eggs are 30 to 33 mm. in diameter. Five eggs were obtained from Boralasgomuwa (W.P.) March 15th, 1904. A large female opened on June 5th, 1930, had five hard-shelled eggs in the left oviduct and six in the right, and also carried 18 immature eggs ranging from 25-20 mm. in diameter. The newly-hatched young are circular in outline with the carapace skin thrown into numerous short longitudinal granular folds which persist until the carapce is 60 mm. long when it begins to assume an elliptical outline.

Distribution. A fresh water form common in the low-country. It is very destructive to fish and at night wanders ashore in search of other food and, when captured, bites savagely and suddenly.

Jaffna (N.P.), Chilaw, Batuluoya, Kurunägala (N.W.P.), Anuradhapura, Rämbäve, Mädavachchiya (N.C.P.), Veyangoda, Colombo, Yakvala, Kelaniya, Kalutara (W.P.), Tissamaharama (S.P.), Trincomalee (E.P.).

This sub-species is peculiar to Ceylon.

1. As in Dermochelys, this superfamily shows reduced ossification as a result of a long aquatic existence. The early fossil Pseudotrionyx possessed a pygal and an almost complete set of marginals, whereas the modern Aspidonectes has lost both. The process of ossification in *Emyda granosa ceylonensis* is long delayed. The prenuchal is the second dermal bone formed and when the carapace is 87 mm. long, traces of the five anterior marginals appear.

Annandale stated that it "is closely allied to *vittata* from which it is distinguished by the greater relative size of the entoplastral callosity, by the facts that the xyphoplastral callosities are in contact for their whole length and that the marginal bones show a greater tendency towards fusion and by the extreme shortness in the adult of the median xyphoplastral process."

The flesh is eaten and resembles that of hare.

Dimensions : A large gravid female from Kalutara weighed 6,917 grammes. Length of carapace 370 mm., width 230 mm., length of plastron 350 mm., axilla to groin 130 mm., head length 125 mm.

Superfamily **CRYPTODIRA** Cope

Family **TESTUDINIDAE** Gray

Cryptodira with head and limbs completely retractile and with no temporal roofing to skull. Choanae located posteriorly, ear distinct. Corselet strongly ossified, plastron connected to carapace by osseous buttresses.[1] Limbs short, phalanges with condyles. Digits with never more than 2 phalanges each. Claws five on hand, four on foot. Reproduction by hard-shelled eggs. Habit terrestrial or amphibious. Two Ceylon genera.

Genus **Testudo** Linné

Head covered for the most part with small scales, tympanum exposed. Skull with temporal and postorbital arcades, alveolar surface with one or two median ridges in upper jaw. Choanae between eyes. Plastron sutured to carapace, its posterior lobe sometimes movable. Neural plates alternately tetragonal and octagonal, costals alternately narrower and wider. Supracaudal scute usually single. Five claws on each hand, four on each foot. Limbs rounded, digits bound together, covered with large scales or tubercles. Tail shorter than head. Terrestrial and herbivorous.

Testudo elegans Schoepff

The star tortoise

Testudo elegans Schoepff, Test. 1792.
Testudo stellata Schweigg, Prodr., 1814.
Testudo elegans Boulenger, Cat. Chel. 1889.

Maivara ibba, Tharuka ibba, Vetakaya ibba, Vairan ibba (S), *Kātu petti āmai, Kātu āmai* (T).

Scutes juxtaposed. Head usually with small flat scales. Limbs covered with granular or acutely conical scales.

1. The corselet of terrestrial forms becomes strongly ossified. In families which have taken to water the process is retarded.

Costals 4, vertebrals 5, nuchal absent, marginals 11, supracaudals azygos, intergular absent or present, pectorals very narrow, abdominals widest shields on plastron which is notched acutely anteriorly and obtusely posteriorly. Axillary and inguinal scutes small ; 3-4 marginals between groin and supracaudal. Five claws on hand, four on foot. Head scales small, numerous. In some specimens a single pair of large prefrontals present. Two or three preorbitals, two or three large postoculars, the posterior of which is usually the largest cephalic scale. Anterior surface of arms with strong, conical tubercles. Skin of neck with finely granular scales and also in inguinal and axillary cavities. These scales become larger, tuberculate and elongate distally along each limb.

Upper beak with three small triangular cusps, of which two are lateral, one median. Each maxillary margin has 15 serrations with a ridge of 10 serrations internally. Skull has a distinct wide pit on alveolar surface of premaxillaries into which the point of the lower beak fits. Premaxillo-maxillary suture emphasised by a groove. A well marked alveolar ridge on each maxillary bone. Nasal opening almost as large as orbit. Liver bilobate. No choanal papillae.

Colours. (1) Newly hatched young are bright orange with three longitudinal rows of more or less regular black spots on carapace. These later give out stellate processes while yellow areolar areas occupy the interspaces.

(2) (*Adult*). Yellow and black arranged in stellate patterns on corselet, and as spots and bands on head and limbs. 6-8 yellow radii on each carapace scute, 11 such on each plastral scute. In old specimens, these radii are broken into numerous blotches and spots. Beak black with yellow blotches, a black dot under each eye, two irregular black bands across top of head. Arm with black longitudinal stripe on external upper edge, and two or three spots on axilla with two or three wavy bands on anterior side of arm. Two black bands on outer side of leg. Tail with a median row of two elongate, black spots, with a row of two or three spots on each side of them.

Food. Vegetarian ; in captivity, grass, rice, fruit, coconut.

Reproduction. The male and female associate for a period of about six weeks. The irregularly round, hard-shelled eggs, about 2-4 in number are said to be hidden in grass tussocks or buried in the earth. The newly hatched young have a carapace almost circular in outline and very tectiform and smooth. Young were noticed at Mahaoya (N.W.P.), on December 27th, 1928, and at Trincomalee (E.P.), January 18th, 1928. Two eggs in the Colombo Museum measure 45 by 35 mm. and 46 by 37 mm.

Distribution. A forest dweller, found in the dry areas of the low-country. Although in captivity it drinks large quantities of fresh water daily, the animal abounds on islands and in localities where the only water supply available is brackish except during the monsoons. Karaduva Island, Puttalam, Venappuva, Maho (N.W.P.), Anuradhapura, Polonnaruva (N.C.P.).

Kuderamalai, Marichchukkadde, Elephant Pass, Mannar (N.P.), Trincomalee (E.P.).

Ceylon, India.[1]

Dimensions. Length of carapace (along curve) 340 mm. (in a straight line) 270 mm., width of plastron 180 mm., axilla to groin 130 mm. Head length 48 mm.

Genus **Geoemyda** Gray

Head invested in smooth skin, tympanum distinct, distal portions of limbs with scales. Skull with a bony temporal arch, no median alveolar ridge, choanae between eyes. Plastron sutured to carapace. Neural plates hexagonal or alternately tetragonal and octagonal. Five claws on hand, four on foot, digits distinct, with or without a short web. Limbs depressed distally. Tail somewhat shorter than head, as long in adult as in young. Habit amphibious or terrestrial.

Geoemyda trijuga thermalis (Lesson)

The terrapin

Emys thermalis Lesson, Cent. Zool., 1830.
Nicoria trijuga var *thermalis* Boulenger, Cat. Chel. 1889.

Gal ibba, Goo ibba, Thumba ibba (Young) (S), *Pi āmai, Kal āmai, Karuppen āmai* (T).

Scutes juxtaposed. Head covered in smooth, neck in finely granular, skin ; tympanum as large as eye, distal end of each limb with large scales ; gluteal region and tail with acutely conical scales, which blunten with age.

Carapace narrower anteriorly than posteriorly, moderately depressed with a supracaudal groove ventrally and with three longitudinal ridges which become less distinct with age when the costal ones become shorter proportionately. Nuchal scute small or absent, costals four, much wider than vertebrals of which there are five ; marginals twelve, the two supracaudals broadly contiguous and fused together in old

1. A single living specimen of the allied Madagascan form *T. radiata* Shaw, purchased. Locality unknown, probably introduced.

specimens. Plastron fully developed, its anterior lobe truncate or with a faint median projection in young; posterior lobe notched. Axillary and inguinal scutes present. Four marginals between groin and supra-caudal. Scutes of corselet with numerous rugae radiating from areolar centres, which disappear with age. Upper beak with a mesial notch anteriorly, alveolar surface smooth.

A scaly fold of skin along posterior margin of hind foot. Liver bilobate, right lobe the larger. No choanal papillae.

Colours (*Young*). Dark brown to black with yellow or deep orange spots and short bands on head, similar spots on neck. A yellow margin to plastron. Limbs, tail and interspaces slatey with darker scales.

(*Adult*). No yellow spots on head. Jaws a pale olive. Body colour a dark brown. Interspaces between limbs, tail and sheltered parts of limbs a pale yellow. Plastron with a dirty yellow outer margin which disappears almost completely in old age.

Food. Omnivorous. A very useful scavenger.

Reproduction. Four or five hard-shelled ellipsoid eggs with blunt, rounded ends, are buried in the earth at a depth of about 7 or 8 cm. They measured as follows :—

45 mm. long, 27 mm. wide.
44 mm. long, 27 mm. wide.
43 mm. long, 24 mm. wide.
43 mm. long, 26 mm. wide.
44 mm. long, 26 mm. wide.

Found November 2nd, 1928, in Colombo 300 metres from water.

Distribution. The young are decidedly aquatic but develop a more or less terrestrial habit with age. Adult specimens denote their aquatic existence by a luxuriant algal covering on the carapace. The young are markedly rheotropic and are found in numbers where drains and streams flow into the lake. It is no uncommon sight to find three or even four tortoises in order of size, perched on top of each other, basking in the sun. Found in still water ponds, swamps, lakes and dry land. Has been taken from the Hot Springs at Kanniya, E.P. Is found at as high an altitude as Kandy where it abounds in the lake.

Colombo, Yakvala, Veyangoda, Dehiwela, Panadura, Kalutara (W.P.), Anuradhapura (N.C.P.), Kurunegala, Chilaw, Puttalam (N.W.P.), Jaffna (N.P.), Tissamaharama, Galle (S.P.), Trincomalee, Kantalai, Kanniya (E.P.).

Ceylon, India. (Ramnad District). Chagos Archipelago, Maldive Islands.

Dimensions. Length of carapace (along curve) 270 mm. (in a straight line) 230 mm., width of plastron 175 mm., axilla to groin 77 mm. Head length 46 mm.

Family **CHELONIIDAE** Gray

Cryptodira with head and limbs incompletely retractile. Skull with temporal regions completely roofed over,[1] choanae open posteriorly under a line joining centres of orbits, ear hidden. Plastron with persistent fontanels and is connected to carapace by ligaments. Limbs paddle shaped, depressed, digits bound together; phalanges without condyles. Arms elongate. Claws one or two. Reproduction by numerous spherical soft-shelled eggs. Habit marine (littoral).

Key to genera of Cheloniidae

I. Costals 4 pairs, the first separate from nuchal; intergular present.
   (*a*) 1 pair prefrontals, 1 claw on flipper. ..... *Chelonia.*
   (*b*) 2 pairs prefrontals, 2 claws on flipper. ..... *Eretmochelys.*

II. Costals 5-9 pairs, the first touches nuchal; intergular absent ..... *Caretta.*

The Cheloniidae are marine forms and are usually found in shallow water, browsing on algal growth among fringing coral reefs at a depth of 3 to 10 metres. When young and active the diet is largely of a carnivorous nature, but old specimens feed mainly on algae[2] which they swallow without proper mastication and Scyphomedusae. In captivity all prefer fish. They spend nearly all their life in the water and it is only on uninhabited islands or reefs that they are known to come ashore[3] other than for the purpose of depositing their eggs. These latter are spherical and white, with soft shells and range from 90 to 180 in number and are buried together in a pit dug in the sand. It is thought that three such batches are laid annually and turtles captured after oviposition have the oviducts enlarged and vascular and the ovaries often have another batch of half developed eggs.

Incubation of eggs

All marine turtles lay soft-shelled white spherical eggs which consist of thick, viscid translucent albumen and a pale yolk. The egg case

1. Temporal roofing appears to be the condition of the primitive marsh dwelling ancestor. This has been partially or completely lost according to the duration of terrestrial life of a family prior to becoming aquatic.
2. *Caretta caretta* does not feed on algae.
3. Said to bask at midday on an uninhabited island in the Maldives, known to the people as Turtle mountain.

is covered with a mucilaginous coating, the function of which appears to be to absorb and retain moisture during the early stages of development, but after the eggs have been in the earth for a month this coating disappears. Contrary to general opinion turtle eggs bear transit tolerably well and develop almost as readily in ordinary earth as in sea sand. Examples were seen in the eggs of *Eretmochelys imbricata* which were transported in a mat bag from Bentota (S.P.) to Colombo (W.P.) by rail over a distance of 40 kilometres and buried 24 hours after they were laid. Eight young ones hatched out of about thirty eggs. (Similarly eggs of *Dermochelys coriacea* packed in straw in a wooden box made the same trip and were buried four days after they were laid. Out of about 50 eggs four embryos developed, one of which was destroyed by ants when almost ready to hatch). Eggs of *Caretta caretta* from Galkissa and Dehiwela (W.P.) also withstood transport to Colombo and yielded a good percentage of embryos which were killed by ants when nearly due to hatch. Eggs with month old embryos do not stand transport, as the least movement causes the embryos to break through the blastoderm, but ones more advanced can be shifted without danger to the embryos.

The process of incubation is of interest. The eggs when newly laid are readily dented on handling, but after ten days in the earth all the fertile eggs become turgid and spherical and do not retain depressions on handling, whereas the infertiles now show numerous dents. On holding the fertile eggs to the light they appear dark, whereas the infertile ones are transparent. The fertiles, if opened after thirty days, show a well formed embryo, while the viscid albumen has become a very mobile limpid fluid, probably due in some measure to the absorption of water from the soil.

A peculiarity of turtle eggs is that in spite of prolonged boiling the "white" does not harden. However, if the eggs are placed in salt water over night the yolk will be found to be in a solid state. Hence, in all probability, sea water is deleterious to turtle eggs and such nests as are within wave range are soon rendered sterile, although Schmidt imagines that the nest of *C. mydas* is dug within reach of the waves. Eggs should not be buried deeper than the length of the hind flipper of the adult turtle to which they belong, if sea sand is used, and if buried in ordinary earth the depth should be considerably less, to enable the sun light to permeate the denser layers of sand, otherwise after attaining to a certain stage the embryos find the warmth insufficient and die and it is not unusual even in a natural nest, to find the upper layers of eggs hatch out first while the bottom ones contain some dead embryos which in dry weather remain without disintegrating for nearly ten days after death. This is effected by the albumen next to the egg case hardening

to hermetically seal in the embryo. Infertile eggs usually remain fresh for fifty days after which their shells turn grey and assume a nodular fungus which is probably responsible for their musky smell which is peculiar to most reptile eggs during the early stages of putrefaction, and it is not until some time after the young hatch out that the strong odours of sulphuretted hydrogen and other gases emanate from the infertile eggs. However, under damp conditions this stage is reached before the young hatch out, often with disastrous results to the entire nest. This is doubtless due to the more retentive nature of ordinary earth, whereas sea sand would not hold excessive moisture, and bring about such a mishap. The period of incubation is 60 days and the newly hatched young have three longitudinal ridges on the carapace, *viz.*, a neural and two costals and two on the plastron; all species possess a white margin to the carapace and flippers, and are darker and more uniform in colour than the adult. The length of the carapace is equal to or one or two mm. longer than the diameter of the egg of the species in question.

The scutes are always slightly imbricate in the newly hatched but separate from each other in about three weeks, leaving dark interspaces. Meanwhile, as the animal grows the original scutes are pushed back and exist as areolae to disappear finally in about three months. After this occurrence the scutes grow to fill up these interspaces but remain juxtaposed throughout life except in *Eretmochelys imbricata* where the imbrication becomes very pronounced with adolescence and does not disappear until middle age. The newly hatched young have a skeleton markedly different from the adult. The internal skeleton, as well as the plastral and nuchal bones, are completely ossified, but those of the carapace form later as callous expansions originating from the ribs and vertebrae, which latter are at this stage incompletely fused with each other.

The Cheloniidae have numerous enemies at all stages of their existence and, in consequence, their numbers are decreasing in some localities. The eggs suffer most and are eagerly sought for by man and beast. Along uninhabited shores the egg collector watches wild pig or the lizard *Varanus salvator* locate the nest, when he drives them away and gathers the spoils. Mammals such as leopard, mongoose, civet cats, rats and dogs destroy many nests and, when one does escape to hatch out, the young have to "run the gauntlet" past birds and mammals to reach the sea where fishes and invertebrates, chief of which is the cuttle fish, further decimate their ranks. The young are very weak and their long delicate flippers are useless in struggling once seized by a cuttle fish as was seen by placing some in a tub containing loggerhead turtlets. The newly hatched young are rendered very buoyant by internal yolk material,

sufficient nutriment for two days and being very lethargic they appear to be dispersed by currents, while some are repeatedly cast ashore by the waves and die in consequence of the battering they thereby receive. Once past the infantile stage the turtle has fewer enemies. The adult, especially *E. imbricata*, is much troubled by parasitic Cirripedes which bore deep into the corselet and into the soft exposed parts, while sharks not infrequently amputate a limb and man takes his toll with net and harpoon.

An imperfect knowledge of the growth and development of the Cheloniidae had led to their generic differentiation hitherto being based on transitory characters common to all, which appear and disappear earlier or later during the life of every species. These common characteristics are :—

(1) Nuchal bone free in embryos, fused to carapace later in life.
(2) Nuchal bone, skeleton and plastral bones ossify before carapace plates develop.
(3) Period of incubation 60 days, carapace length of young nearly equals egg diameter.
(4) A carinate rostral ridge present for piercing egg case.
(5) Newly born have three longitudinal ridges on carapace and two on plastron, nares located dorsally.
(6) Scutes faintly imbricate in new born, later they become juxtaposed. This imbrication is negligible.
(7) Newly born are more or less uniformally pigmented and possess a light margin to carapace and flippers.
(8) Marginals of adolescents show prominent posterior carinae which disappear later.
(9) Parietal scales elongate with age.
(10) The lump-like dermal scales become flat and thin.
(11) Corselet scutes become thin and partially fuse with each other.
(12) Last vertebral scute widens.
(13) Pigment of carapace changes from streaks to spots.
(14) Skull of young possesses an intertrabecular cartilage.

Genus **Chelonia** Latreille [1]

Corselet scutes juxtaposed. Nuchal scute four sided and separate from costals, of which there are four pairs. Intergular and inframarginals present. A single pair of prefrontal scales. Lower beak strongly

1. *Chelonia* Brongniart 1800 is a *nomen nudum*.

dentate, upper one with rounded margin and with two alveolar ridges. A single claw on each flipper. Costoperipheral fontanels persist. Choanal papillae numerous.

Chelonia mydas (Linné).[1] Plates XI, XII

The green turtle

Testudo mydas Linné, Syst. Nat 1. ed. X. 1758.
Chelonia mydas Schweigger, Prodr. Mon. Chelon. 1814.
Chelonia virgata Ibid.
Chelone mydas Boulenger, Cat. Chel. Brit. Mus. 1889.

Batu käsbäva, (adolescent), [2]*Gal käsbäva*, *Velli käsbäva*, *Mas käsbäva* (S), *Perr amai* (T), *Pal amai* (E.P.), (T).

Corselet scutes juxtaposed. Costals 4, vertebrals 5, marginals 12. Nuchal separate from first costal, four sided, its posterior edge normally does not exceed 1·2 times its anterior edge. (Plate XI, fig. 1).

In old specimens the first and last vertebrals much wider than the intervening ones. Plastron with developed intergular scute. One claw on each flipper. Claws elongate and curved in old specimens.[3]

A single pair of long prefrontals, frontal smaller than the single frontoparietal from which it is usually distinct, parietals 1-3 pairs, occipital present or absent, preoculars inconspicuous, supraoculars 1, postoculars 2-4. (Plate XII, figs. 1, 1A). Scales from wrist to claw 12-13, from groin to claw 7-8. Well marked scales between cloaca and plastron ; they are blunt knobs in young but flatten out and tend to disappear with age. Tail of adult male extends beyond extremities of extended feet, while cloaca is slightly below level of a line joining their claws ; tail of female short and barely reaches beyond supracaudal marginals. Inguinal concavities of plastron shallower than in the other genera, posterior margin of plastron bluntly ellipsoid. Margin of upper beak feebly denticulate with grooved internal, edge, alveolar surface with two prominent ridges, on each side. Margin of lower beak strongly denticulate, especially in male. Skull roughly rectangular, has two strong internal ridges, one on each maxillary, each ending in a prominence near vomer. Mandibular symphysis

1. The most important Ceylon turtle economically and an extensive fishery is conducted in the Gulf of Mannar, the chief camps being on such Islands as Karaitivu, Pallimunai, and Illipanduva at the mouth of the Gulf of Kalpitiya. The captured turtles are kept in pens built in the sea and are removed at intervals to Jaffna and other towns for slaughter. The height of the fishery season is during the North-east monsoon from November to March and the men at Karaitivu compute that their catch each season is about 1,000 turtle.
An adult realises Rs. 40 to Rs. 70 in the Jaffna market where turtle flesh is largely used by the Hindu population who are averse to beef. The chief methods of capture are net and harpoon, which latter is not driven completely through the carapace as then the blade slips out of the wound, whereas otherwise the tissue contracts and secures the steel in a firm grip.
2. Commonly applied to *C.mydas*, rarely to *Caretta caretta*.
3. Young specimens are said to occasionally show two claws on the foot. (Not observed by the writer.)

is one-third length of orbit and has a distinct ridge along its posterior margin which is joined to the anterior one by a narrow raised isthmus. External premaxillary margin rounded and without any point. Prefrontal suture longer than nasal opening. Liver bilobate with right lobe long and the left very short. Choanal papillae numerous.

Chelonia mydas has an oval carapace and plastron which are proportionately longer than in the other Cheloniidae, and rather wider posteriorly than anteriorly. The process of ossification in carapace and plastron is also considerably slower than in the others, for even very old specimens have the costoperipheral fontanels of the carapace incompletely closed. When the carapace length is 65-77 cm. ossification is complete in the other two genera, whereas in this species the fontanels are still very large. Similarly the plastral elements develop and expand more slowly than in the other genera which have plastrons with deeper inguinal concavities. (Plate XI, fig. 2). The head of this species is rectangular in side view and the beak is short, broad and blunt without any pointed tip.

Colours vary with age. Head and limbs rust red to olive green, carapace rust red to pale yellow with black spots or dark red and brown streaks, plastron pale yellow to white.

(1) Newly hatched, dark olive brown with broad white margin to carapace and flippers. Neural ridge well defined, costal ridges indistinct.

(2) Carapace 420 mm. long, has head rust red, while the frontal scale is usually dark. Beak yellow with dark clouding on top and sides, eye with dark grey iris. Flippers olive in front, large posterior scales darker. Carapace scutes pale yellowish green, heavily marked with dark brown and rust red streaks radiating from a dark red distal areolar centre on each scute. Marginals rust red. Plastron, ventral surface of flippers and interspaces between scales, yellow.

(3) Carapaces 1,100 mm. long, show a preponderance of yellow which is more pronounced in females than in males. The dark brown streaks of the 420 mm. carapace are broken into small spots or bars which give the animal a very different appearance from the previous stage. Plastron pale yellow. Beak light yellow, with dark cloudings on top and sides, top of head loses its red and becomes a pale olive as do flippers and neck. Throat and pelvic regions become light yellow shaded with pink.

Food. Algae and in captivity fish and meat. The stomach contents are never in a finely divided condition and appear to be "bolted" entire. The retarding effect on the digestion of specimens removed

from water is noteworthy. Under normal conditions a turtle browses continuously in its algal pastures and digestion is rapid, but the stomachs of specimens slaughtered four days after removal from water are full of fresh algae. If these specimens are returned to a tub of sea water the stomach is emptied of its contents in about twelve hours, but such would not be the case if they were left on dry land for that period.

Reproduction. Although this form is as common as *Caretta caretta* no mature eggs have been examined by the writer. This rarity of eggs has been noted by Schmidt in the Seychelles where it is equally common. The explanation for this, according to fishermen in the Seychelles, is that unlike the others, this genus lays its eggs within reach of the waves which obliterate all traces of the nest. This is unlikely as salt water coagulates the yolk of turtle eggs.

The Australian observers, Musgrave and Whitley, who watched this turtle lay and obtained photographs of the process state that she comes ashore at dusk and proceeds inland to the margin of scrub. There after selecting a suitable spot she dispels the loose sand with her fore flippers and in the hollow thus created excavates the smaller nest hole with her hind flippers.

This hole is "eighteen inches across at the bottom, widening to about two feet at the top." Covering her tail with her hind flippers which are placed edge to edge she lays 105 to 153 eggs and after covering them with sand, returns to the sea. The breeding season in Australia lasts from the end of November to January. According to Indian observers the period of incubation is two months and the figure of an egg, as given by de Rooij, has a diameter of 48 mm. This turtle, in all probability, breeds in Ceylon or in the neighbouring Islands as young specimens with a carapace length of 300 mm. are frequently taken in the Gulf of Mannar where the fishermen affirm several males are often seen pursuing a female and add that when in copula a pair can be easily approached and captured. The male is readily distinguished from the female by its long lizard-like tail, the size of which may be ascertained from the table showing dimensions. After the breeding season the males show deeply concave plastrons consequent on their enfeebled condition. At Karativu Island a female was reported to have laid 140 eggs on July 5th, 1929. A female opened at Jaffna on July 7th, 1929, contained half mature eggs. According to fishermen the eggs of this species are rare and are smaller than those of Dermochelys but larger than those of Caretta. They state that the egg-laying season commences in September. Immature eggs have been noted in July and August in specimens slaughtered at Jaffna.

Distribution. Very common and found in shallow water between the shore and the fringing coral reef which extends down the coast. Rarely seen far from land or in water deeper than 25 metres.

Negombo, Colombo, Panadura, Kalutara (W.P.), Trincomalee, Batticaloa (E.P.), Jaffna, Mannar (N.P.), Karaitivu, Illipanduvá, (N.W.P), Ahangamá, Weligama, Tangallá, Palutupané (S.P.).

Tropical regions of Indian, Pacific and Atlantic Oceans.

Dimensions.

The following measurements expressed in millemetres were obtained from specimens as they lay on their backs in the Jaffna turtle sheds.

Axilla to Groin	*Head Length*	*Snout to tip of Tail*	*Length of Carapace*	*Length of Plastron*	*Width of Plastron*	*Arm*	*Tip of tail to Cloaca*	*Tip of tail to Plastron*	*Sex.*
		1,250		790	650	500	70	240	♀
		1,370		840	710	530	70	270	♀
		1,440		780	650	480	100	370	♂
		1,460		790	650	560	90	450	♂
		1,420		740	630	530	110	420	♂
		860		470	440	470		125	♀
			1,200	975					
		1,430	1,070			440			
			11,500		8,700				♀
560	210			880	810		85	305	♀
510	180			790	780		145	410	♂
510	180			770	760		120	500	♂
620	220			920	910		90	350	♀

Genus **Eretmochelys** Fitzinger

Corselet scutes imbricate until middle age, after which they are juxtaposed. Nuchal scute usually four sided, always separate from costals, of which there are four pairs. Intergular and inframarginals present. Two pairs of prefrontal scales. Lower beak finely denticulate, upper one with a pointed tip which bluntens with age, it carries a single alveolar ridge. Two claws on each flipper. Costoperipheral fontanels disappear with age. Choanal papillae one or two.

Eretmochelys imbricata (Linné) Plates XI, XII

The Hawksbill

Testudo imbricata Linné, Syst. Nat. 1. 1766.
Eretmochelys squamata, Agassiz, Contr. Nat. Hist. U. S. A. 1. 1857.
Chelone imbricata Boulenger, Fauna Brit. Ind. 1890.

Pothu käsbäva, Leli käsbäva, Pana käsbäva, Kukulu käsbäva (S.), *Aluk āmai, Alung āmai, Pankini āmai* (T).

Corselet scutes imbricate until middle age when they become juxtaposed,[1] costals 4, vertebrals 5, marginals 12. Nuchal four sided when scutes are juxtaposed (Plate XI, fig. 6); five sided when scutes are imbricate (Plate XI, fig. 5), its posterior edge is 1·5 to 2·5 times length of anterior edge. Nuchal separate from first costal. (Plate XI, figs. 5,6). In old specimens first and last vertebrals much wider than intervening ones. Plastron with intergular scute. Two claws on each flipper, the distal one short, broad and flat; both curved and elongate in old specimens.

Two pairs prefrontals, frontal smaller than the single frontoparietal which is at times partially bifurcated anteriorly. In females over 160 mm. in carapace length, frontal usually fused to frontoparietal, but is distinct in males throughout life. Parietals a single pair which elongate greatly with age. Occipital present or absent, temporals 2 on each side. Preoculars inconspicuous, supraoculars 1, postoculars 3-4. (Plate XII, figs. 2,2A). Scales from wrist to first claw 10, from groin to claw 9. Scales on limbs and neck short, acutely conical knobs in young, but flatten out after carapace exceeds 156 mm. in length. Tail of adult male elongated, in female short and barely reaches margin of carapace. Plastron with deep inguinal concavities and with an abruptly truncate posterior lobe in young adults but later becomes ellipsoid. Upper beak pointed and projects downward over lower one in adolescent turtle but bluntens with age. Margin of upper beak smooth, of lower one feebly dentate. A single, short, thick, alveolar ridge to upper beak, with a depression posterior to ridge to receive the posterior symphysial ridge of lower beak. Skull acutely triangular and bird-like with a faint, wide, alveolar ridge running along each maxillary and on to premaxillary. Mandibular symphysis equals two-thirds orbit length or equals height of orbit and has a well-defined prominence on its posterior edge. External premaxillary margin a pointed ellipse. Prefrontal suture equals nasal opening. In young specimens the interorbital area slopes down.

Costoperipheral fontanels disappear when carapace is 770 mm. long. Scutes thick in young adults and do not attain their maximum

1. This form possesses many characters of both Caretta and Chelonia and occupies an intermediate position.

imbricate development until the animal is eighteen months old. The three carapace ridges disappear after two years and in specimens of both sexes which have a carapace length of 770 mm. the scutes are thin and juxtaposed and even partially fused with each other. The sharp pointed marginals also become smooth and the carapace can only be distinguished from that of *Chelonia mydas* by the shape of the nuchal and by the reddish ground colour of the scutes, whereas in *C. mydas* it is a pale yellow. Liver with one large lobe and one small. Choanal papillae one or at most two, broadly flattened.

Colours. (1) (Newly hatched). Carapace light red or bay with a white external edge along marginals. Plastron black with ridges yellow. Scutes with black outlines. Top of head paler than carapace, frontal shield black. Beak and sides of head below eye level, lower jaw and throat, black. Neck yellowish dorsally, black ventrally, flippers black with a white margin posteriorly and as far as proximal claw anteriorly.

(2) (247 days old, carapace 185 mm. long).

Scales conical, carapace and plastral ridges faint. Carapace scutes with dark brown red, yellow and black streaks radiating from posterior corner of each. Marginals, dark brown dorsally, with a horn coloured margin. Plastron yellow with black tips to scutes. Arm black dorsally, with white margin, leg white at base, black distally. All four flippers white ventrally with black spots distally. Head scales light red with a preponderance of black. Frontal black, supraciliaries a dull yellow, Infraciliaries black. Postoculars whitish with large black centres. Upper beak with a black median line separated from a dark lateral blotch by a yellow line. Lower beak black with a yellow median line.

(3) Carapace 300 mm., scutes imbricate, scales flat. Carapace scutes have the streaks of colour broken up into small mottlings. Plastron yellow with diffuse black terminal marks to scutes. A black spot on intergular. Scales on top of head black, those on cheeks with wide yellow interspaces. Mandibular scales and those at angle of mouth with black centres. Flippers with black scales dorsally, yellow ventrally, with black spots distally. Upper beak with a black median line separated from two black lateral patches by a thin yellow band.

(4) Carapace 770 mm., scutes juxtaposed, middle aged adult female. All yellow replaced by a pale carrot red. The various tracts of brown and dark red of carapace are suffused and merge into each other. Plastron a uniform pale carrot colour. Scales of flippers and neck olive brown with a carrot red tinge. Beak as in previous stage, with a carrot red border. Median carrot red band of lower beak, very wide. Each mandibular scale and those at angle of mouth with a black mark. A somewhat larger male with juxtaposed scutes was similarly coloured.

It is said that the flesh of this turtle is rendered poisonous after it has fed on certain algae, and deaths are occasionally reported from eating it. The author was informed that sickness produced from eating this turtle at such times, is not uncommon, but is cured by the fishermen dosing the patients with soup made from the carapace and plastron of *Chelonia mydas*. Experienced fishermen seldom eat an Eretmochelys without first chopping up its raw liver and throwing it to the crows. If these discard the liver, the animal is poisonous. Among the Mannar-Kachcheri records is one mentioning the death of 12 persons at Karuppankudiyiruppu on June 27th, 1888, as the result of eating this turtle. Tennant, in his Natural History of Ceylon, mentions a case of turtle poisoning from Panadura (W.P.) in October, 1840, in which twenty-eight were affected, of whom eighteen died. The symptoms were sickness and coma. He does not mention the species of the turtle but remarks that, according to the survivors, the flesh was fatter than usual.

At Mandaitivu, Jaffna, twenty-four persons were poisoned in June, 1921, by eating this turtle. Seven died after two days and the rest recovered. It was said that the poisoning was due not to the species of turtle, which is still being eaten, but to the presence of poisonous weeds previously swallowed by the turtle.

The symptoms, according to the Medical Officer of Health, were inflammation of the mouth, vomiting, pains in the limbs, burning sensation in the stomach and scratches on the body.

At Vaddukoddai West, in the Northern Province, a mother and three children died in April, 1927, from eating this species of turtle.

The writer tasted the flesh of the large female taken at Bentota. It was almost without any flavour and soup made from the same animal was equally insipid, although quite as gelatinous as that made from *Chelonia mydas*.

Food. Algae, molluscs, crustacea, fish.

Reproduction. A female laid 115 eggs at Bentota (S.P.) on February 16th, 1928, at 7 p.m. These were removed to Colombo and buried in ordinary earth the following day. The young hatched out on April 16th, 1928, at 4.30 p.m. Period of incubation 60 days after oviposition or 59 days after the eggs were buried. The eggs were 38 to 41 mm. in diameter, while the last one was only 9 mm.

Embryos were obtained at intervals. The age and carapace lengths are :—

Age.	*L. of C.*	*Remarks.*
28 days.	15 mm.	Corselet scutes present, limbs and head scaleless.
38 days.	29 mm.	Lepidosis complete.
44 days.	35-37 mm.	Pigmentation complete.
60 days	40-42 mm.	Newly hatched

The embryo is doubled up over the yolk, the line of flexure being between the pectoral and ventral scutes. The arms covered the marginal scutes with their posterior edges, the legs were crossed and extended downward over the yolk.

Oviposition: A female turtle was noticed on the beach at Bentota (S.P.) at 7 p.m. on February 17th, 1928, at a distance of 80 metres from the sea. The animal was past middle age as testified by the juxtaposed and partially fused corselet scutes.

Its length from snout to tip of tail was 100 cm., axilla to groin 23·5 cm., width across plastron 52 cm. Weight was 3 qrs. 14 lbs. or 44,688 grammes. After selecting a suitable spot under the fringe of the screw-pine (Pandanus) brush wood, it commenced to dispel the loose sand with a few outward semicircular sweeps from all flippers, after which the animal began to dig methodically and slowly using its feet for the purpose. The sand was grasped by contraction of the under surface of one foot and gently set aside and the process repeated with the other. As the hole deepened a foot would be carefully lowered into the pit where, after a pause of a second or two, it caught up a flipperful of sand. The limb was then slowly withdrawn and the sand gently set aside. This would be followed by a short pause after which the other foot would be lowered. The same foot never dug twice consecutively. Finally, the bottom of the hole was enlarged so that the nest appeared goblet-shaped in section and was about 20 cm. in diameter and about 50 cm. deep. After finishing the nest, the depth of which equalled the length of the leg, the animal placed her feet on either side of the hole and commenced to oviposit. At this stage the sand was scooped by the writer from the side of the hole to obtain a better view, and it was observed that the cloaca was prolongated to a considerably lower level than the caudal appendage, but not everted. The turtle strained prior to the ejection of eggs which were shot out in simultaneous batches of 2, 3 or 4 between pauses of a few seconds' duration. Eggs were not observed to be deposited singly. The number of eggs ejected at each stricture was verified by receiving each discharge into a coconut shell and it was noticed that the batches of four appeared early in the process and lasted until oviposition was half finished. After this the eggs issued in threes and ultimately in twos. Along with each batch of eggs were also discharged a few drops of mucus.

The eggs were 115 in number and were white with skin coverings which were faintly calcareous. They were 38 to 41 mm. in diameter and thinly covered with a mucilaginous secretion which appeared to absorb water and was found to be moist 48 hours later, in the case of

eggs kept in a mat bag. The last two eggs deposited were abnormal. One was 38 mm. in diameter and had a small knob at one end, the other was diminutive, being only 9 mm. in diameter.

All the eggs were taken out of the nest through the side opening, but the turtle did not take any notice. After the last egg had been laid the animal strained for another three minutes, then after a few minutes' rest commenced to fill in the empty hole with great care. It grasped sand with a foot which was next lowered far into the hole prior to dropping the sand gently on the place where she imagined the eggs to be. The feet were worked alternately in this manner until the animal considered its eggs well covered. Now it worked faster and with less care shovelling in sand with alternate sweeps of its hind limbs. At last the nest was filled in and, placing her feet together edge to edge, she patted down the loose earth, at first gently, later rapidly and with increased force. All this time the animal had remained stationary and had not used its arms, but now it began to gyrate around the covered hole which it kept under its belly and scattered sand with strong sweeps from all four flippers. This gyration produced a small trench around the filled up nest, but in a short time this was obliterated and the animal began to move off seaward, when it was captured.

The process of digging occupied about three-quarters of an hour, oviposition about a quarter of an hour and filling in the nest about another three-quarters of an hour.

The turtle was in poor condition and had encrusting barnacles *Chelonobia caretta* on the shell and flippers and was badly infested with a cirripede which had bored into its flippers, carapace and plastron. Two days later the animal was killed and the oviducts and ovaries were found to be well developed, the former being 354 cm. long. The latter showed numerous Corpora lutea where the eggs had burst the follicles. There were also numerous immature ova in various stages of development. The largest one was 26 mm. in diameter, there was another of 24 mm., ten of 10 mm. and 450 others ranging from 3 mm. to 8 mm. The stomach was full of algal material and a few pieces of coral and small gastropods which were possibly ingested by accident.

Some features of note are the choice of a nesting place under the shelter of Pandanus which might keep predatory animals from off the eggs but give the young a great distance to travel before they reach water.

The care in not making the orifice of the hole large although the bottom was capacious was probably another safeguard against predatory

animals which would locate the eggs by following the loose sand in burrowing.[1] The care in filling up the nest was also remarkable and afforded a striking contrast to the indifference of the animal to animate sources of danger. The whole process of oviposition was watched by the writer and three others in the glare of a coconut leaf torch and a lantern kept scarce two feet away, while no attempt was made by any one at maintaining silence.

Behaviour of young. The eggs hatched out 60 days later. When dug out of the earth the young inhaled once or twice and commenced to move away. They were positively heliotropic and, when put in a dry basin and placed in the house, commenced scrambling towards the direction of light and in whatever direction the basin was turned they would at once orient themselves toward the light. This tropism disappeared after they had been in water for a few minutes. On emerging from the shell they showed extraordinary activity, scrambling tirelessly for two and a half hours against the sides of a dry basin. Occasionally they would all stop simultaneously for a rest of about ten seconds' duration and resume their efforts all together. A few minutes after they were placed in sea water they became very sluggish, and by keeping contact with each other by means of their flippers exposed a larger surface to the up-thrust of the water, remained afloat without any exertion, aided by the buoyancy of the yolk material which was found to be inside them. When placed on land the animals, which were so active ten minutes previously, refused to move.

The fore limbs were used mainly as balancing organs for the first day of existence, and swimming was chiefly by alternate strokes of the hind limbs. During the first ten minutes the turtlets were very jerky and unstable in their movements, while diving was impossible for several days owing to their buoyancy due to the presence of yolk material internally.[2] The animals had no conception of fear until they were over a month old and would make no effort to resist capture, floating lazily at the surface. However, they reacted to vibration caused by striking the basin and under this stimulus attempted to dive.

On the evening of the second day after hatching the turtlets commenced to bite at pieces of sea weed and were given chopped up fish. This was seized in the jaws and, if the piece were too large, it would be struck aside with the flippers leaving a portion in the animal's mouth. They were kept in a zinc bath filled with sea water and were very sus-

1. Similar to nest of *Caretta caretta*.
2. Compare with young Dermochelys

ceptible to impure water. Although the water was changed daily several died until it became necessary to change it twice daily. This is because the animals are constantly inhaling water through the nostrils and, if the water is foul, soon poison themselves by so doing and become extremely torpid. Their recovery when placed in clean water is very rapid and they become exceedingly active. Many died of starvation, for although the bath was well stocked with food the animals were unable to descend lower than 2 or 3 cm. below the surface without great difficulty and then they had little control over their movements when submerged and failed to get near their food. Later broods of turtles were raised with less mortality by feeding the youngsters with fish held in a pair of forceps.

This turtle is known to bite its captors and the habit has been recorded by early observers such as Bennett. It is greatly subject to attacks from Cirripedes and even young specimens of 290 mm. carapace length show signs of infection, whilst in old specimens the carapace and plastron are often badly damaged by these ecto-parasites.

The homing instinct of this turtle has also been remarked on and a specimen marked and released by a Dutch Governor was reported to have been taken thirty years later when it came ashore at the same place to oviposit on the south coast of Ceylon.

Distribution. The rarest and smallest of Ceylon Cheloniidae and also the most valuable owing to its ornamental scutes. Specimens or parts of dead specimens were examined from :—

Bentota (S.P.), Dehiwela, Negombo (W.P.), Karaduva Island in Gulf of Mannar, Jaffna (N.P.).

Ceylon, India, Singapore, Malay Archipelago, New Guinea, Samoa, Formosa, Seychelles, Arabia, Guiana, Tehuantepec, Gautamala, Bahamas, the Atlantic ocean.

Variation. The genus is not subject to much variation. As seen from the affixed table out of 29 young and embryos developed from a single nest, not one had the nuchal split as is so common in *Caretta caretta*. Three had 5 costals on the left side only. One had 4 vertebrals, while two had 6. Two had 13 marginals, on each side, while five had 13 on the right and three had 13 on the left. Two had 11 marginals on the left. The adults examined so far have not presented any extraordinary feature. There is a prevalent belief among the fishermen that the flesh of an Eretmochelys which has 14 large dorsal scutes is poisonous, whilst ones with 13 may be eaten with impunity unless they had previously fed on poisonous algae.

Eretmochelys imbricata

Embryos	*R.C.*	*V.*	*L.C.*	
	4	—	4	
	4	—	4	
	4	5	4	The 3rd vertebral split into two longitudinally.
	4	6	5	The 5th vertebral small.
	4	5	4	
	4	5	4	
	4	4	4	
	4	5	4	
	4	5	4	
	4	5	4	
	4	5	4	
	4	5	4	
	4	6	4	
	4	5	4	
	4	5	4	
	4	5	4	
	4	5	4	
	4	5	5	
	4	5	4	
	4	5	4	
Newly hatched	4	5	4	
	4	5	4	
	4	5	4	
	4	5	5	
	4	5	4	
	4	5	4	
	4	5	4	
	4	5	4	
	4	5	4	

Dimensions and growth.[1]

Age.	*L. of C.*	*W. of C.*	*L. of Head.*	*Ax to Gr.*	*Weight.*
Just hatched	39	29	18	17	
	39				
April 16th, 1928	40				
	40				
	42				
	42				
	42				
	42				
	42				
	42				
Died May 15th,	42·5	33	19	20	
28 days old	43	32	20	20	
Died May 29th.					
1 month, 12 days old	49	39	21	24	
	50	40	21	25	
	51	41	21	26	
	51·5	40	21·5	25	
August 10th, 1928.	93	71	31		
3 months, 26 days old	95	78	32		

1. Growth of specimens hatched on April 16th, 1928. Specimen A. had lost a costal scute.

Age.	*L. of C.*[1]	*W. of C.*	*L. of Head.*	*Ax to Gr.*	*Weight in Grs.*
Nov. 13th, 1928. 7 months old	156	120	46		481·93
Jany. 24th, 1929, 9 months, 12 days.	213	151	60		
March 9th, 1929. 10 months, 26 days	A.				1814·32
	B.				1899·37
March 22nd, 1929. 11 months, 19 days.	A. 265	193	70	110	
April 12th, 1929.	A. 290	210	72·5		2894·7
12 months, 10 days.	B 300	220	75		3036·45
April 26th, 1929.	A. 295	210	77		2736
12 months, 24 days	B. 300	230	78		2856
May 14th, 1929.	A. 303	220	76	148	2891·58
13 months, 14 days	B. 315	235	77	147	3061·68
May 28th, 1929.	A. 303	224	81	140	3061·68
13 months, 28 days	B. 315	240	83	150	3316·81
June 12th, 1929.	A. 320	227	82	145	3486·91
14 months, 13 days	B. 320	247	85	170	4053·89
June 28th, 1929.	A. 330	243	84	160	3543·61
15 months	B. 335	260	87	165	4053·89
July 18th, 1929.	A. 335	260	87	165	3968·84
15 months, 20 days	B. 350	280	89	165	4450·77
August 3rd, 1929	A. 355	265	91	166	4360
	B. 363	285	92	169	4987
Museum	152	121	46	72	
Specimens	360	285	95	165	
Karaduva ♀ March, 1929.	290	230	78	116	
Bentota ♀	770	520	192	235	44,688
Jaffna ♂	Slightly	larger	than	Bentota ♀	

Regeneration of scutes[2]

On October 29th, 1928, a young *Eretmochelys imbricata* lost the second left costal scute together with the upper halves of the 6th and 7th margi-

1. S. to T. = snout to tail, L. of C. = length of carapace, W. of C. = width of carapace, L. of P. = length of plastron. W. of P. = width of plastron. L. of Hd. = length of head, Arm = length to bend at wrist, Ax. to Gr. = axilla to groin.

2. The fishermen of Ceylon on capturing an Eretmochelys usually smear it with sesemum oil after which a lighted taper is held near each scute which thereupon softens and is easily detached. The oil prevents the occurrence of blisters and the turtle is returned to the sea still retaining the nuchal and first vertebral as the men affirm that their removal would result in its death. They also state that scutes removed from the dead turtle are opaque and lack the translucent lustre of those taken from the living animal which, according to them, betakes itself to a cranny in the coral reef until it regenerates a new set.

nals. The wound surface exposed was covered with soft, thick, spongy dermis which next day showed faint yellow risings which later became light brown and commenced to slough off as fibrous tufts. These grew darker daily. By November 11th when the carapace length was 156 mm. the yellowish crust which had formed over the wound had begun to peel exposing two ribs, while the rest of the wound was covered by a horny skin which had dark bands of pigment. By December 6th the scabs had fallen off the ribs which were now covered in skin which formed a depression. On December 10th the wound which had nearly healed appeared raw, probably as the result of a bite by the other turtle in the tank. January 24th, 1929, saw the lower uninjured portion of the marginals drop off as did the scab over the wound. Numerous thin overlapping slate-coloured corneous layers had formed over the seat of injury and by January 30th the scute had commenced to regenerate after the fashion of a broken nail, growing out posteriorly from the anterior margin of the scar. Growth continued and the corneous skin over the scar thickened until by May, 1929, the scute occupied two-thirds of the scar which was hollow, but slowly proceeded to fill up. By June 20th the scute was entirely regenerated, but there was a slight dent in the margin of the carapace denoting the site of injury.

Genus **Caretta** Rafinesque

Corselet scutes juxtaposed. Nuchal scute six sided and contiguous with first pair of costals. Costals 5 or more pairs. Intergular absent, inframarginals present. Two pairs of prefrontal scales. Beaks smooth edged, with pointed tips which blunten with age, the upper furnished with one or two alveolar ridges. Two claws on each flipper. A single choanal papilla or none. Costoperipheral fontanels disappear with age.

Caretta caretta (Linné) Plate XI, XII, XIII

The Loggerhead

Testudo caretta Linné, Syst. Nat. 1. Ed. X. 1758.
Chelonia olivacea Eschscholtz, Zoo. Atlas. Pt. 1. 1829.
Thalassochelys (*Colpochelys*) *kempii* Garman, Bull. Mus. Com. Zool. VI.1880.
Thalassochelys caretta Boulenger, Fauna Brit. Ind. 1890.
Caretta caretta Siebenrock, Zool. Jahrb. Suppl. X. 1909.

Olugeddi käsbäva, Mada käsbäva, Parai käsbäva, Gal käsbäva, Kanadi käsbäva, Batu käsbäva (*Young*), *Eramudu käsbäva* (S). *Perunthalai amai, Kili chondan amai, Nai amai, Kangil amai, Yethu pankini amai, Sith amai* (T).

Corselet scutes juxtaposed. Carapace heart-shaped, widest anteriorly with a prominent neural carina, while the posterior marginals form blunt points. Both these characters disappear after middle age and in old specimens, the last vertebral scute is much wider than its fellows. In this species a scute or scale is frequently formed by the partial or entire fusion of two or more such. Costals 5-9, vertebrals 5-8, marginals 13, occasionally

14. Nuchal scute contiguous with the first pair of costals, and is six sided with anterior and posterior edges of equal length (Plate XI, fig. 3.) This scute is frequently divided either into two marginals or two marginals and a small vertebral. No intergular scute on adult plastron. Cephalic scales are as follows: Two pairs prefrontals, frontal distinct and as long as frontoparietal but shorter in newly hatched specimens. Frontoparietal usually double in young, azygos in adult and contiguous posteriorly with one or two pairs of parietals which elongate with age. Preoculars 3-4, inconspicuous in adult, supraoculars 1-3, postoculars 3-4. (Plate XII, figs. 3. 3A.) Each limb with two claws, of which the distal one is broad and flat. Scales from wrist to first claw 10-12, from groin to claw 10-12. Tail elongate in adult male, very short in female and does not reach margin of carapace. Inguinal concavities of plastron deep, posterior margin of plastron truncate, until middle age. Upper and lower beaks with smooth edges and end in sharp points which blunten with age. Upper beak has a wavy edge and two strong alveolar ridges, of which the external is better developed than the internal.

Skull obtusely triangular and with a smooth palate devoid of alveolar ridges. A pronounced premaxillary pit present to receive tip of lower beak. External premaxillary margin ends in a sharp point. Prefrontal suture equals half nasal opening. Mandibular symphysis as long as length of orbit and has no posterior marginal ridge.

Complete ossification[1] of the corselet, except for traces of plastral fontanels, occurs in this genus prior to attaining middle age. Compare plastral bones with those of *Chelonia mydas* (Plate XI, fig. 4.) Choanal papillae single or absent. Liver bilobate, the right lobe somewhat larger than the left.

Colours. (1) 32-day old embryo with carapace 24 mm. long is bluish green dorsally, with distinct black margins to scutes. Plastron and ventral aspect white.

(2) 57-day embryo with carapace length 37 mm. A sooty black with a narrow white margin to carapace and posterior edge of flippers; plastron dusky with traces of white, throat black, base of neck dirty white ventrally. Angles of mouth dirty white.

(3) Newly hatched. Carapace olive brown with darker flippers. A faint white margin. Plastron light brown with traces of yellowish white. Throat dark, base of neck lighter. Angles of mouth dirty white.

(4) Adolescents dark olive dorsally, white ventrally.

(5) Adult, a drab olive, to a uniform dark reddish brown dorsally, pale reddish yellow to white ventrally. Beaks orange yellow, reddish brown clouding on sides.

1. In newly hatched Caretta traces of the first three or four marginal plates appear anteriorly in deeper layers of dermal carapace. Posterior ones develop later.

Food. A specimen taken in the Gulf of Mannar contained crabs, pieces of coral, several squilla and the smashed up shells of mollusca. The intestines were full of parasitic nematodes. It is also reported to feed extensively on the pearl oyster, *Margaritifera vulgaris* and *Scyphomedusae.* In captivity it thrives on meat, fish, cuttle fish, octopus and pearl oyster.

Reproduction. The nest is generally scooped out under shelter of the Pandanus scrub about 50 metres from the sea. The hole is about 30 cm. in depth and wider at the bottom than at the top. The eggs range from 38 to 43 mm. in diameter. The number in one nest is 90 to 135. The breeding season is said to be from September to January, and newly hatched young were obtained on the beach at Weligama (S.P.) on January 20th, 1929, and from Galkissa (W.P.) on January 29th and 1st February, 1929, December 26th, 1929, January 18th, 1930. Bentota (S.P.) on February 6th and October 20th, 1929.

The young hatch out in two months and for the first 24 hours are tirelessly active, later they become torpid. The rate of fertility may be gathered from the fact that in a nest examined at Weligama there were two dead embryos and three infertile eggs. The young turtles of this nest were first observed emerging from the sand at 2 p.m., January 19th, and according to the fishermen, continued to do so until 12 a.m., January 20th, 1929. The line of flexure of the embryo over the yolk sac lies between the pectoral and ventral divisions of the plastron. The carapace length of newly hatched young is 42-45 mm. and in common with other *Cheloniidae* they show three well marked dorsal and two ventral longitudinal ridges. At three weeks the carapace scutes appear faintly imbricate and when two months old the scutes separate from each other showing distinct black outlines, while the inner alveolar ridge of the upper beak does not appear until long after birth, a six-month old turtlet showing only the outer ridge. Eggs were obtained on the following dates in 1928—Dehiwela, September 11th, September 12th, October 25th, January 29th, 1929, Modera, September 24th, Karaitivu September 3rd, 1929 (contained mature embryos). The eggs were of the following dimensions :—

Diameter in mm.	*Weight in grs.*
43	38·05
40 by 39	35·37
42	38·32
41·5	41·3
42 by 40	36·99
38 by 39·5	33·96
41·5	39·54
39	37

Embryos.

Age.	*Length of Carapace.*	*Remarks.*
26 days.	17 mm.	Corselet scutes present.
32 days.	26-29 mm.	Lepidosis complete.
57 days.	37 mm.	Scutes thickened. Pigmentation complete.
60 days.	42-45 mm.	Date of hatching.

Distribution. The commonest marine turtle in Ceylon waters but seldom captured,[1] as its flesh is coarse and tasteless, however the eggs are brought to market more often than those of other genera.

Like the other Cheloniidae it is found in coastal waters near the fringing coral reefs.

Karativu (Gulf of Mannar), Illipanduva (Gulf of Kalpitiya), Negombo, Modera, Galkissa, Kalutara (W.P.), Bentota, Weligama (S.P.).

Tropical regions of Indian, Pacific and Atlantic oceans and Mediterranean.

Variation. The most variable of the order Testudinata and has been separated by some herpetologists such as Eschscholtz, Gray, Günther, Garman, Taylor and Stejneger into three separate species *Caretta caretta* (Linné), *Caretta olivacea* (Eschscholtz) and *Caretta kempii* (Garman). They have based their opinion after the examination of too few specimens and appear to consider that the first which is the Atlantic form always has five costal scutes on each side, whereas the second which they assign to the Indian and Pacific oceans has six to eight.[2] The Atlantic form which, as a rule, has five costals on each side, at times possesses as many as eight or nine, (see table), while embryos of the Ceylon form developed out of the same nest show that the 5/5 condition also exists but is uncommon. A nest of 26 Ceylon embryos showed three with the costals 5/5, while another nest of 80 embryos had none and out of 22 adult carapaces five were found to have this arrangement of costal scutes. One fact appears to be certain, that the usual condition in the Atlantic form is 5/5, whereas in the Indo-Pacific form it is from 6 to 8, but there is no means of separating an Atlantic specimen with 6/7 costals from an Indo-Pacific one with a similar number or an Indo-Pacific specimen with 5/5 costals from a common Atlantic individual. Plate XIII.

Possibly the diameter of the egg, and a few structural differences may cause the formation of two sub-species, but in the face of present knowledge this separation would not be justified. Apart from the various

1. This turtle bites savagely and its powerful jaws which enable it to crush mollusca and crustacea are capable of inflicting severe injuries. Its ferocity when captured has earned it the name "Nai amai" = Dog turtle. It remains vigorous and active on land, long after *Chelonia mydas*. This is because its respiration is not impeded by the collapse of the plastron against the lungs as the plastron and sides are more completely ossified.

2. Four adult Mediterranean specimens in the Monaco Aquarium showed no external difference from the Ceylon form. Mounted adults possessed two alveolar ridges in the upper beak. The 18 carapaces examined all showed the costals as 5/5.

combinations of 5, 6, 7, 8, 9 costals, the nuchal scute of Ceylon forms is not infrequently split into two marginals and at times into two marginals and a small vertebral. There is also a decided tendency for the carapace scutes to fuse to a certain extent with advancing years.[1]

The following information regarding Atlantic specimens in the Harvard Museum Collection was kindly supplied by Dr. Thomas Barbour :

Locality.	*Index No.*	*Number of specimens.*	*Costals.*
Key West.	1,408	10	5/5
,, ,,	1,409	2	5/6
Bahamas.	1,412	1	5/5
	4,017	2	5/5
Cuba.	12,609	1	5/5
Atlantic ?	12,612	1	8/7
	12,613	1	8/9
Florida.	13,416	1	5/5

In 12,612 and 12,613 "the 8ths and 9ths are very small split-offs. No doubt abnormalities."

The following is the result of an examination of some young spirit specimens of the Atlantic form which are preserved in the Muséum d'Histoire Naturelle in Paris.

Locality.	*Right Costals.*	*Left Costals.*
Concarneaux	5	5
,,	5	5
Gabon	6	7
,,	7	6
,,	6	6
Côte d'Ivoire	6	6
,,	6	6

Costal scutes of Ceylon specimens examined

Embryos from Dehivala

R.C.	*V.*	*L.C.*	*Remarks.*	*R.C.*	*V.*	*L.C.*	*Remarks.*
7.	7.	8.		5.	9.	6.	Split nuchal.
7.	6.	6.		6.	6.	5.	
5.	6.	6.		7.	7.	7.	
7.	7.	6.		6.	5.	7.	
6.	6.	6.		6.	6.	7.	Split nuchal.
6.	6.	6.		6.	6.	6.	
6.	5.	6.	Split nuchal.	6.	6+1.	6.	Split nuchal with vertebral.
7.	7.	7.	Split nuchal.				
7.	7.	7.		5.	6.	6.	
6.	7.	6.		7.	8.	7.	
5.	6.	5.	Split nuchal.	5.	5.	5.	Split nuchal.
7.	6.	7.		5.	6.	5.	Split nuchal.
6.	7.	7.	Split nuchal.	6.	6.	6.	Split nuchal.
6.	6.	7.					

1. This turtle has been divided into three species by some herpetologists. Two from the number of costal scutes, the third for possessing a single alveolar ridge to its upper beak. The writer has seen all three types alive and considers the division unjustified, as all three are merely variations of the same animal influenced by habitat.
(1) *Caretta caretta* var. *caretta*, (2) *Caretta caretta* var. *olivacea* (Esch.) Plate XIII (3) *Caretta caretta* var. *kempii* (Garman.)

Embryos from

Karativu, September 6th, 1929.

R.C.	*V.*	*L.C.*	*Remarks*
8.	7.	8.	
8.	6.	8.	
6.	6.	6.	
8.	7.	8.	
6.	5.	5.	
6.	6.	6.	
6.	6.	5.	
8.	6.	8.	
8.	7.	8.	Split nuchal.
5.	7.	7.	
6.	6.	6	
8.	7.	7.	Split nuchal.
8.	7.	8.	Nuchal fused to 1st vertebral.
8.	7.	8.	
6.	6.	6.	
8.	6.	8.	
7.	6.	7.	
6.	6.	5.	
6.	6.	6.	
6.	5.	5.	
9.	6.	9.	
5.	6.	6.	
6.	5.	5.	
8.	7.	8.	
6.	6.	6.	
8.	7.	8.	
8.	7.	8.	
7.	7.	8.	
8.	6.	8.	
6.	6.	6.	
6.	6.	6.	
9.	7.	8.	
8.	7.	8.	
8.	7.	8.	
8.	6.	8.	
8.	7.	8.	
8.	7.	8.	
8.	6.	8.	
7.	7+1	8.	Split nuchal with vertebral.
8.	7.	8.	
8.	7.	7.	
8.	6.	7.	
7.	7.	8.	
7.	7.	8.	
9.	7+1	8.	Split nuchal with vertebral.
8.	7.	8.	
7.	6.	7.	Split nuchal.
8.	7.	8.	
8.	6.	8.	Split nuchal.
8.	7.	8.	
8.	6.	7.	
8.	7.	7.	Split nuchal
8.	7.	8.	
8.	6.	8.	
8.	7.	8.	
8.	7.	7.	
8.	7.	8.	
7.	7+1	8.	Split nuchal with vertebral.
6.	6.	8.	
7.	7.	8.	Split nuchal.
7.	6.	8.	
7.	7+1	8.	Split nuchal with vertebral.
7.	7.	8.	
8.	6.	8.	
8.	7+1	8.	Split nuchal with vertebral.
8.	7.	8.	
6.	6.	6.	
8.	7.	8.	
8.	7+1	8.	Split nuchal with vertebral.
7.	5.	7.	
8.	6.	7.	
8.	6+1	7.	Split nuchal with vertebral.
7.	6.	8.	

Embryos in the Colombo Museum.

R.C.	*V.*	*L.C.*	*Remarks.*
5.	6.	6.	
7.	7.	7.	
6.	6.	6.	
6.	6.	5.	
6.	8.	7.	
6.	7.	6.	
6.	7.	7.	
8.	7.	7.	
7.	7.	7.	
6.	8.	6.	
7.	7.	7.	
7.	7.	7.	
7.	7.	8.	
7.	8.	8.	
6.	6.	6.	

Newly hatched

R.C.	V.	L.C.	Remarks	R.C.	V.	L.C.	Remarks.
7.	7+1	7.	Nuchal with small vertebral	6.	5.	6.	
				7.	7.	7.	split nuchal.
6.	7.	6.		6.	5.	6.	
7.	7.	7.		5.	5.	6.	

Young

R.C.	V.	L.C.	Remarks.	R.C.	V.	L.C.	Remarks.
6.	5.	6.		6.	5.	6.	
6.	5.	7.		7.	7.	6.	
7.	6.	6.					

Adults.

R.C.	V.	L.C.	Remarks.	R.C.	V.	L.C.	Remarks.
5.	5.	5.		7.	not counted	6.	
6.	7.	7.		6.	,,	6.	
7.	7+1	7.	split nuchal with vertebral.	7.	,,	6.	
6.	not counted	7.		8.	,,	6.	
7.	,,	7.		7.	,,	5.	
7.	,,	7.		7.	6.	6.	
				6.	7.	6.	

Adults. Jaffna turtle sheds.

R.C.	V.	L.C.	Remarks.	R.C.	V.	L.C.	Remarks.
8.	7.	7.		7.	6.	8.	
6.	6.	6.		5.	5.	5.	
5.	6.	6.		5.	5.	5.	
7.	5.	7.		5.	5.	5.	Nuchal split, marginals 24.
8.	7.	8.					

Dimensions. The usual length of an adult carapace is 650 mm., the width 57 mm. and it is completely ossified. The plastron is 51 mm. by 49 mm., the interspaces between the processes of the plastral bones being almost completely filled in with bone (Plate XI, fig. 4).

Ossification[1] occurs at an earlier age in this species than in the other two genera, while the plastron appears relatively shorter and the head larger. The dorsal scutes are also thinner and are continually desquamating in small flakes. Beak broad, triangular and both the upper and lower, end in points, which blunten with age. Upper one with a wavy edge. The shape of the beak has earned for it the Tamil name of "parrot beaked turtle."

1. Probably Eretmochelys and this genus have spent less time in water than Chelonia, hence the process of ossification is less retarded, and the claws are more numerous.

Dimensions and growth

The growth experiment was conducted with three turtlets, of which only one survived.

Age.	*L. of C.*	*W. of C.*	*L. of Hd.*	*Ax. to Gr.*	*Weight in Grs.*
Feby. 1st, 1929.	A. 43	36	19	—	—
Just hatched at	B. 42	36	19	—	—
Galkissa	C. 42	36	19	—	—
April 11th, 1929.	A. 57	50	22	-	36·96
2 months, 9 days	B. 54	49·5	22		34·5
	C. 51	47·5	21	-	25·15
April 26th, 1929.	A. 61	52	23	- -	38·5
2 months, 24 days	B. 57	49·5	22	—	35·7
May 14th, 1929.	A. 61	54	23·5	28	40·46
3 months, 12 days	B. 58	52	21	21	36·19
May 28th, 1929.	A. 62	55	24	28	39·42
3 months, 26 days	B. 60	52·5	23·5	21	37
June 12th, 1929.	A. 63	55	24	30	43·72
4 months, 11 days	B. 60	54	23·5	30	42·5
June 28th, 1929	A. 62	55	24	27	36·55
4 months, 27 days					
July 18th, 1929	A. 67	59	26	29·5	59·18
5 months, 17 days					
August 3rd, 1929	A. 74	62	27	34	75·46

Age.	*L. of C.*	*W. of C.*	*Ax. to Gr.*	*Hd. length.*	*Locality.*
Dead in nest	37 mm.	32	- -	19	Weligama
Newly hatched	42	35·5	—	19	Galkissa
	42	36	-	19	,,
	42	35	19	19	,,
	43	36	19	19	,,
Newly hatched	43·5	37	19	19	Bentota

Age.	*L. of C.*	*W. of C.*	*Ax. to Gr.*	*Hd. length.*	*Locality.*
Newly hatched					
	44	35	—	20·5	Bentota.
	45	36	—	20	Incubation
	45	38	—	20	August 28th to
	45	35	—	20	October 20th,
	44	35	—	20	1929.
	45	35	—	20	
	44	34	—	20	
	45	37	—	20	
	44	36	—	20	
	44	35	—	20	
	45	36	—	20	
	45	37	—	22	
	44	35	—	20	
	44	35	—	20	
	45	36	—	20	
	45	36	—	20	
Adolescents.	123	105	—	40	Galkissa, hatch-
	100	94	—	38	ed Jan. 18th, 1930, measured June 18th, 1930.
Adults	650	570	—	152	Gulf of
	662	587	—	—	Mannar
	712	675	—	—	
	900	720	—	225	
	830	690	—	—	
	790	680	320	185	
	670	620	—	—	

EXPLANATION OF PLATES

Plate VII. *Dermochelys coriacea*, sixty days embryo and cephalic scales × 1·5

Plate VIII. *Dermochelys coriacea*, adult female.

Plate IX. *Dermochelys coriacea*, plastron.

Plate X. *Emyda granosa ceylonensis* (young) × 1.5

Plate XI. Carapaces and plastra of Cheloniidae.

Front of carapaces of fig. 1. *Chelonia mydas.*

fig. 5. *Eretmochelys imbricata* (imbricate)

fig. 6. *Eretmochelys imbricata* (juxtaposed)

fig. 3. *Caretta caretta.*

N = nuchal, V = vertebral, C = costal scute.

Front of plastra of fig. 2. *Chelonia mydas.*

fig. 4. *Caretta caretta.*

1 G = intergular, G = gular, H. = humeral scute.

EP = entoplastral, EPP = epiplastral.

HOP = hyoplastral, HYP = hypoplastral.

XP = Xiphiplastral bone.

Plate XII. Heads of Cheloniidae.
fig. 1. *Chelonia mydas.* fig. 2. *Eretmochelys imbricata.*
fig. 3. *Caretta caretta.*
figs. 1A. 2A. 3A. are dorsal views of 1.2.3. respectively.
PF = prefrontal, F = frontal, FP = frontoparietal.
P = parietal, SO = supraoculars, T = temporals.
PO = postoculars.

Plate XIII. *Caretta caretta*, adult female.

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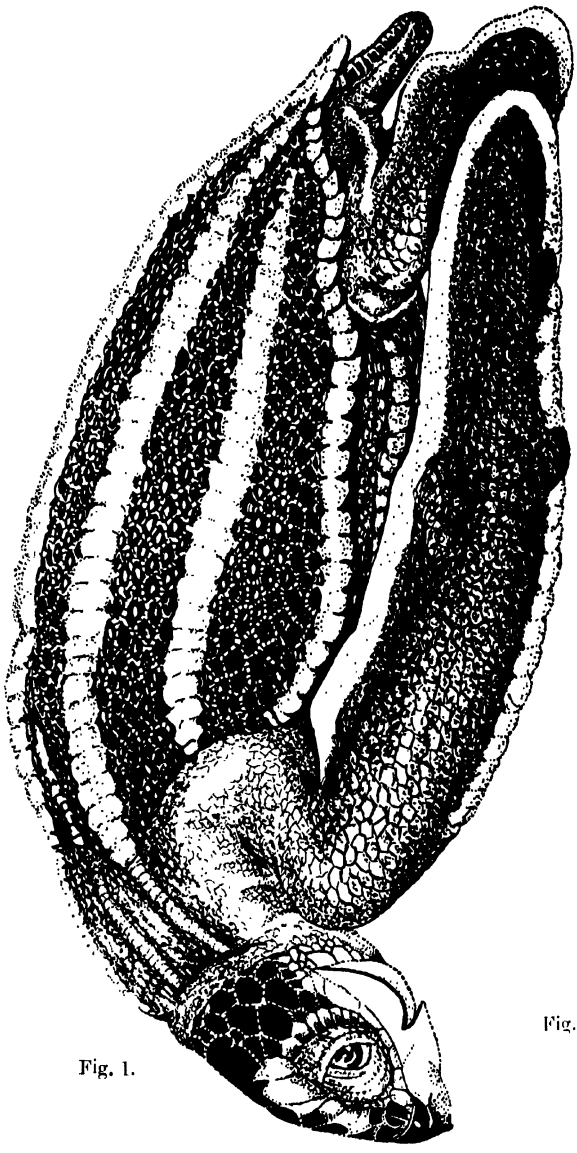

Fig. 1.

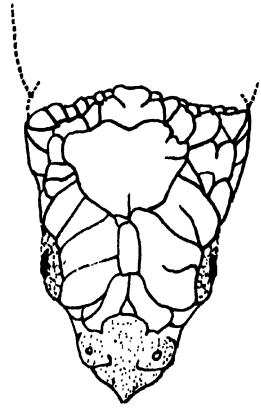

Fig. 2.

Fig. 1.—*Dermochelys coriacea*, 60 days embryo
Fig. 2.—Dorsal view of cephalic scales

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Dermochelys coriacea, adult female

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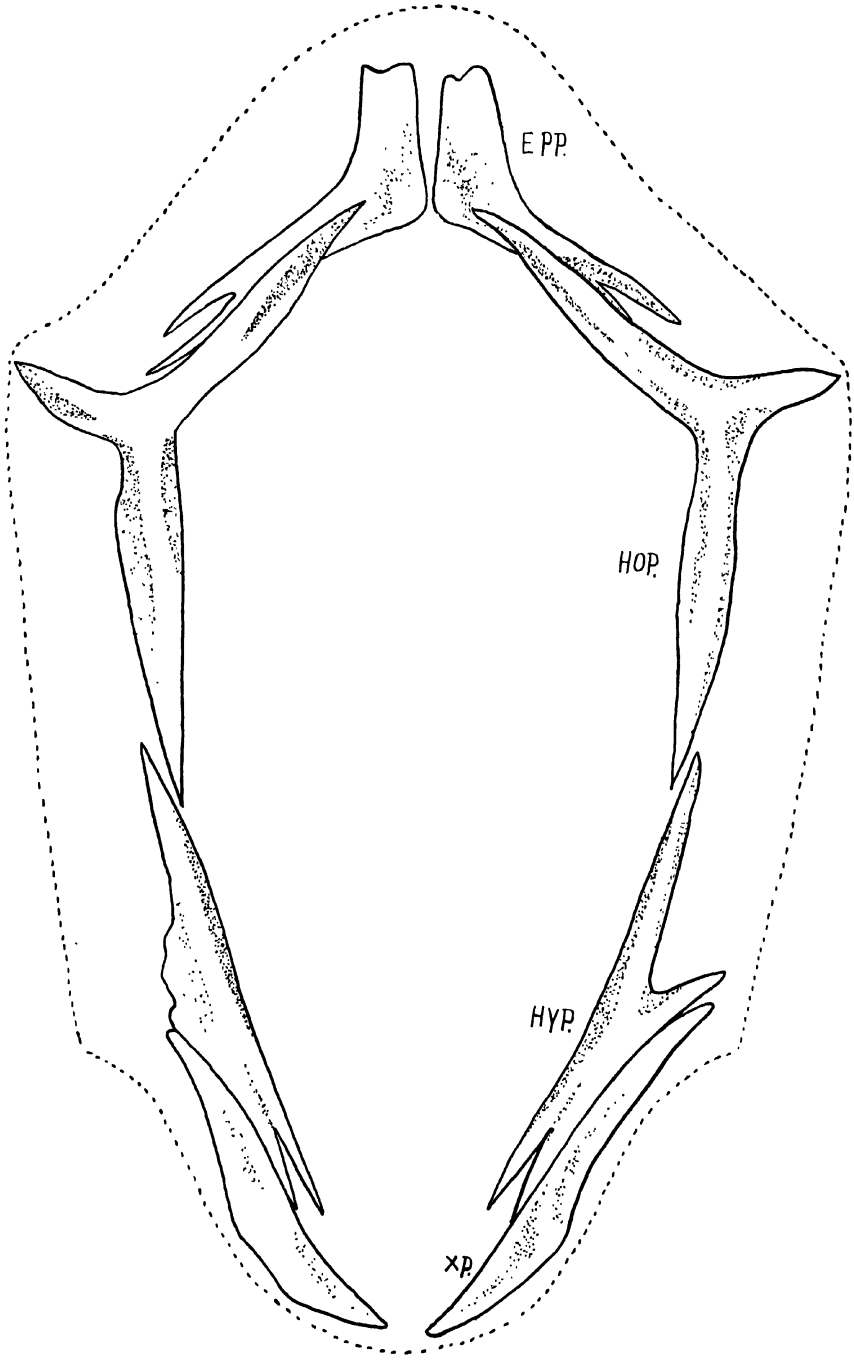

Dermochelys coriacea plastron

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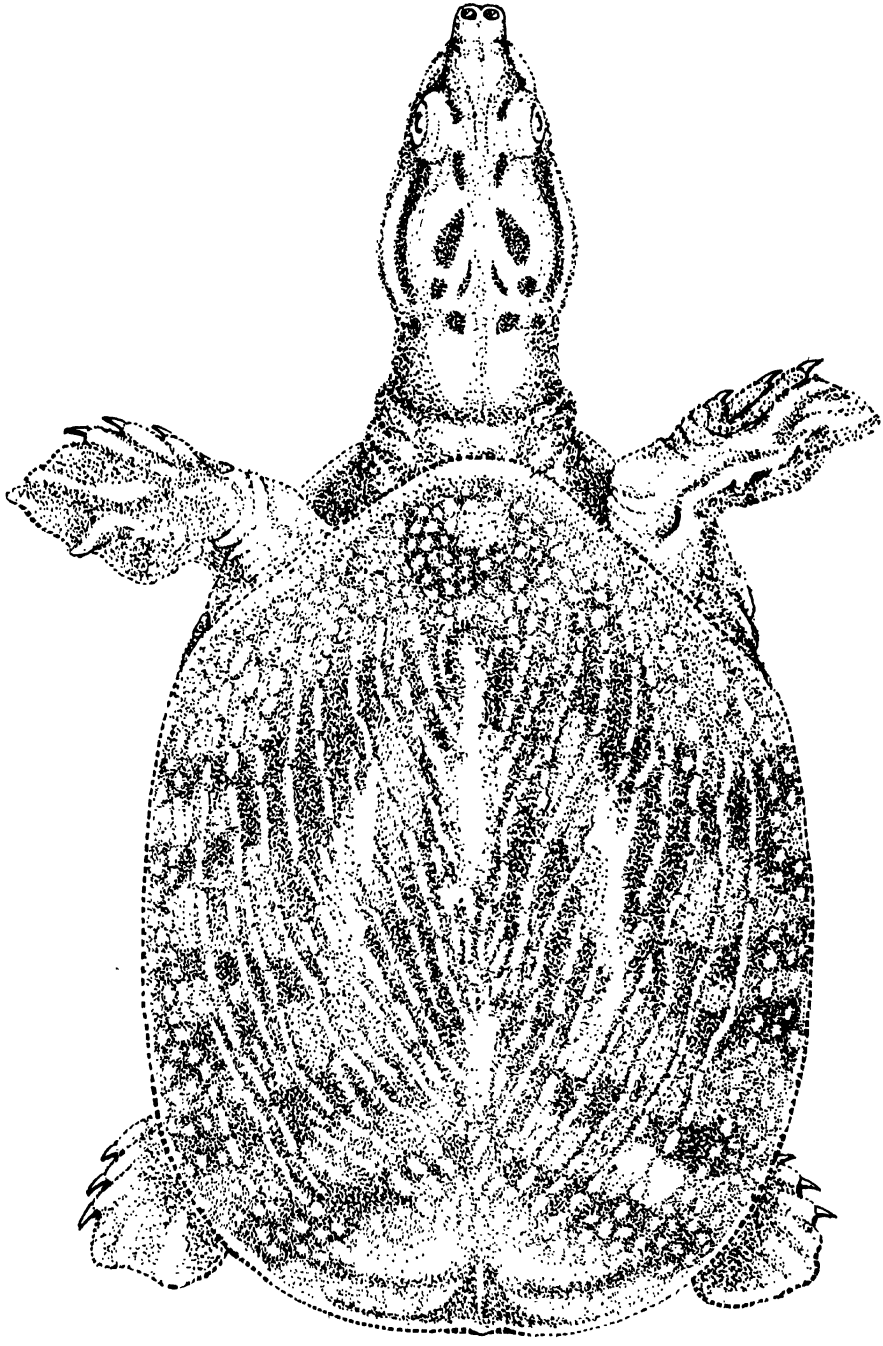

Emyda granosa ceylonensis, young

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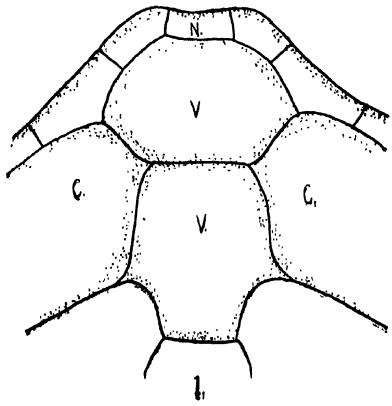

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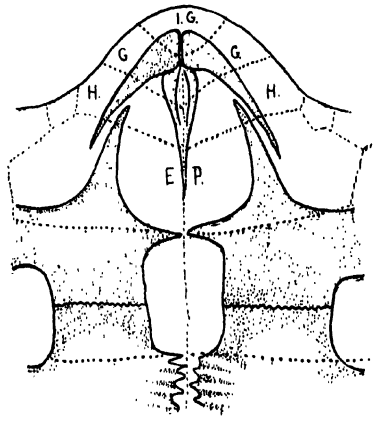

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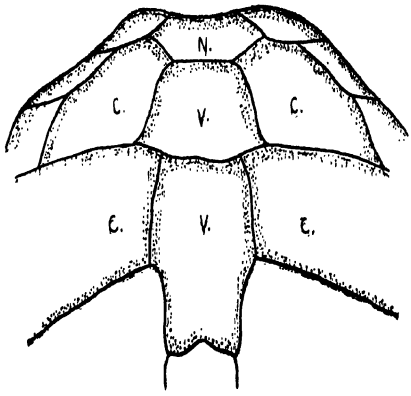

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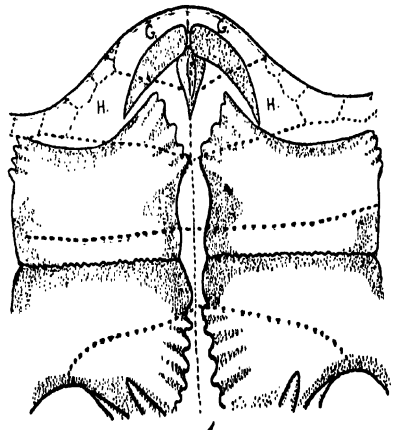

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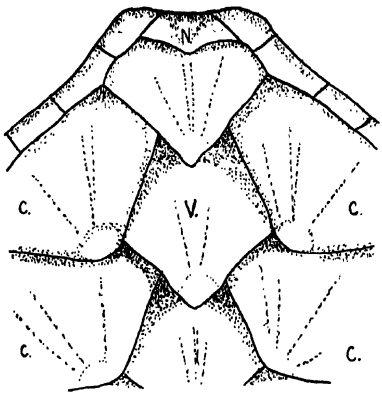

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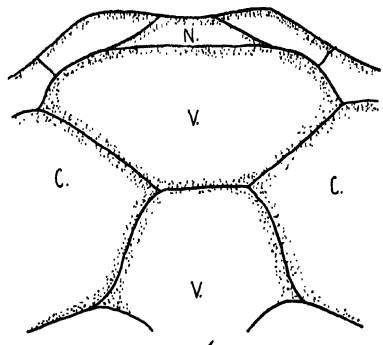

6.

Carapaces and plastra of *Cheloniidae*

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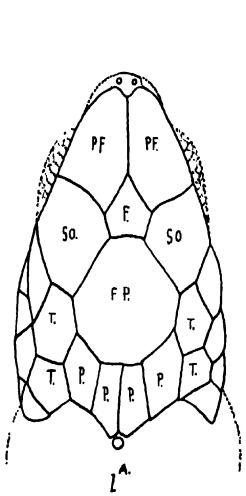

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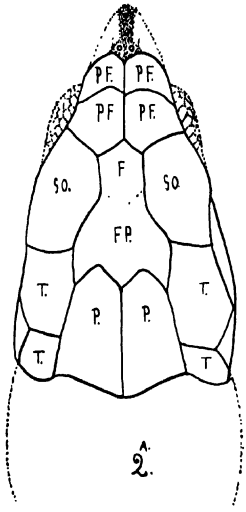

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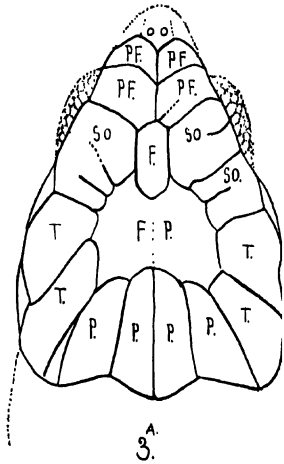

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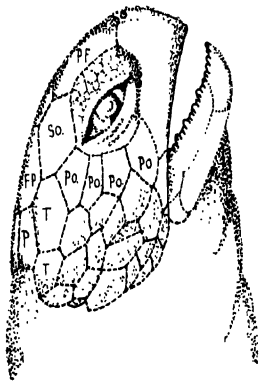

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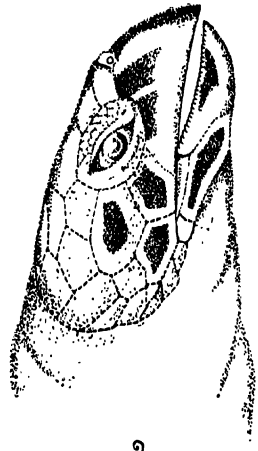

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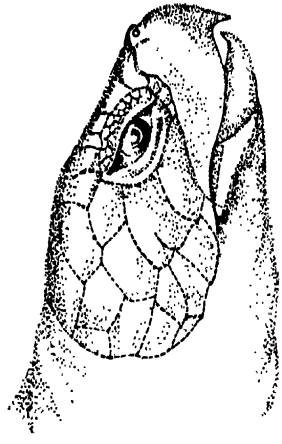

3.

Heads of *Cheloniidae*

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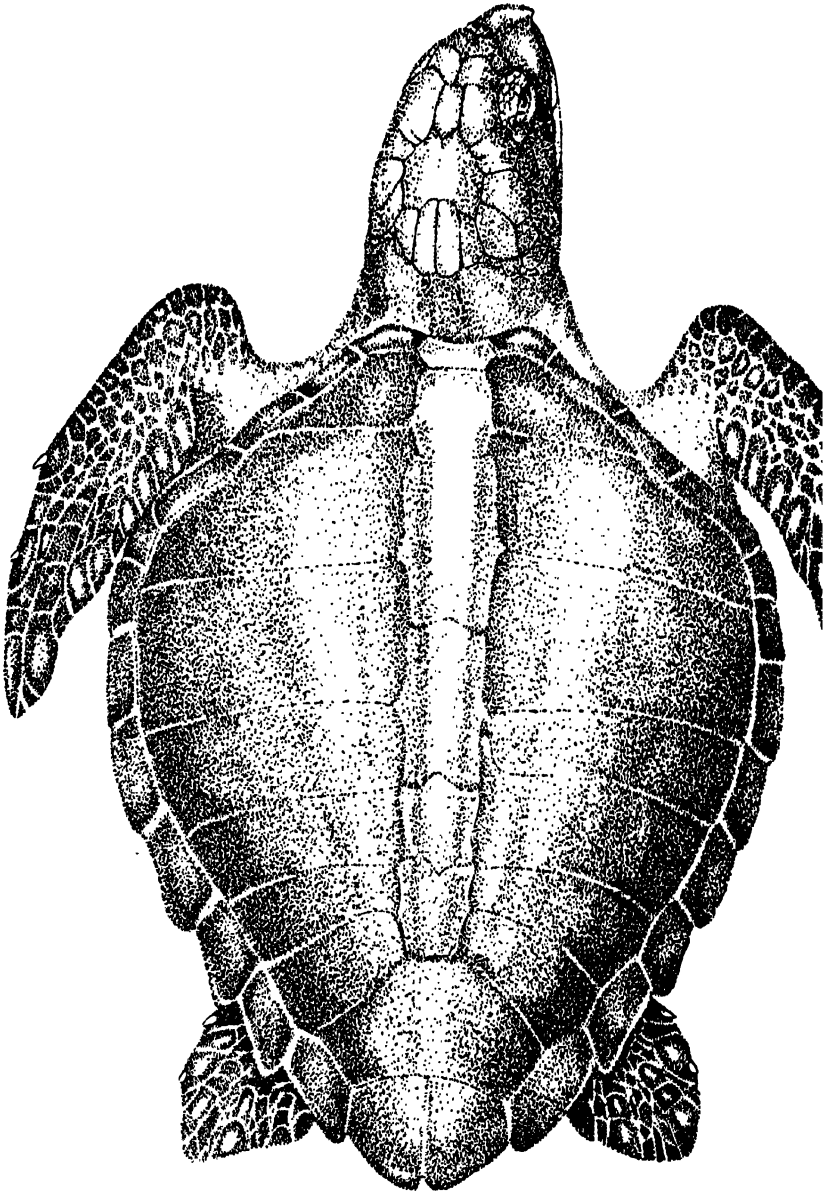

Caretta caretta, adult female

P. E. P. Deraniyagala del.

The Crocodiles of Ceylon

BY

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WITH TWO PLATES

There are two species of crocodile in Ceylon, the gregarious tank form *Crocodylus palustris* and the solitary estuarine form *Crocodylus porosus*. Both are essentially carnivorous but occasionally feed on kaolin clay, while pebbles are also ingested to titurate the food, for which purpose the stomachs of man eaters appear to retain the metal ornaments of their victims. During the heat of the day crocodiles lie in burrows which they excavate in a bank overlooking the water. The opening is under water but the passage is above and about four inches below the surface soil. Old specimens prefer to make lairs for themselves in reedy beds and, on capturing prey too large for immediate consumption, hide it near at hand. The popular belief that these reptiles aestivate under baked mud has probably arisen from the sight of them emerging from these burrows on the advent of rains which terminate the season of drought, and until this happens they may also be found in colonies under large rocks deep in the jungle. At night crocodiles emit a loud grunting bellow which is audible for a considerable distance. The eggs are oval and blunt-ended and have a thin, pitted, calcareous shell over a tough membrane Examination of nests of *C. palustris* from which the young have hatched out show that the shell falls off the membrane leaving the leathery egg cases which are only distinguishable from those of *Varanus salvator* Laurenti, by their blunter ends and the fragments of shell which the latter do not possess. Progression in the water is by means of the hind limbs and tail and the animal is able to disappear from the surface without causing a ripple by sinking backward, the snout being the last to be withdrawn. Crocodiles are taken in nets, kraals with a trap door, and with hook and line ; this last consists of numerous fine cords which the animal is unable to gnaw asunder with its widely placed conical teeth. The flesh is

occasionally eaten in a few places in Ceylon, such as at Bentota (S.P.), and there is an extensive trade in crocodile leather, the animals being netted in the "Kimbul dela" or shot from the bank.

In the preparation of this paper I am indebted for help in procuring specimens to Mudaliyars S. W. Illangakoon and E. Tillekeratne.

Family **CROCODYLIDAE** Gray

Dorsally an imperfectly developed carapace of juxtaposed ossified scales which are in a few isolated cases present ventrally as well. Pectoral girdle outside ribs. Abdominal ribs present. Cervical and dorsal ribs with two heads. Sternum and inter-clavicle present. A diaphragm between thorax and abdomen. Heart four chambered. Skull thecodont with two temporal arcades, quadrate bone fixed. Nostrils near tip of snout, with compressible valves, choanae open far back into throat. Pupil vertical. Ear with movable opercles. Bones of skull pitted. Teeth replacable when broken. Tongue adnate with a fleshy throat valve to occlude water. Fore limb with 5, hind one with 4 digits, of which only the three inner ones are clawed. Pubic bones loosely connected to pelvis. Tail strong, as long as head and body which it nearly equals in thickness at its base. Reproduction by numerous hard-shelled ova. Copulatory organ single. Habit aquatic.

Genus **Crocodylus**[1] Laurenti

Edge of upper jaw with 16-24 teeth, lower with 14-15 on each side. Fifth maxillary tooth the largest, 4th mandibular fits into a notch in upper jaw. Upper eyelid with a small bony plate. Musk glands on ventral surface of throat and in cloaca.

Key to Ceylon Species

1. Four large post occipital scales.
   A ventral collar of enlarged scales.
   .....*C. palustris.*

2. Two rudimentary post occipital scales or none.
   No ventral collar of enlarged scales.
   .....*C. porosus.*

1. *Crocodylus* is the original spelling by Laurenti in *Synop. Rept.* 1768.

Crocodylus palustris Lesson Plate XIV

Crocodilus palustris Lesson, Bélangéss Voy. Ind.-Or., Zool., 1834.
Crocodilus trigonops Gray, Cat. Tort. 1844.
Crocodilus bombifrons Gray, ibid.
Hella kimbula, Äla kimbula, Äli kimbula (S).

Width of snout 1·25-1·5 into length of snout. A short ridge at times extends from anterior angle of each eye along the snout as far as an orbit length or less. Snout and top of head rugose. (Plate XIV, fig. 1). Eye 3·5-7·5 in head. Width of occipital bone 1-2 into snout. Premaxillary teeth 5, rarely 4 in young, maxillary teeth 14-15, mandibulars 15-16 along each side. Four well developed, carinate, postoccipital scales always present. Nuchal scales in a cluster of four with a single external pair. No scales between nuchals and dorsals, which latter are strongly carinate and divided into a longitudinal series of 3/3 by a shallow vertebral groove. Scales on sides and limbs well formed and more or less carinate. An enlarged ventral collar of scales at base of neck. In this collar the two median scales are usually narrowly contiguous in the middle and partially separated by a small scale anteriorly and another posteriorly (Plate XIV, fig. 2). Premaxillo-maxillary suture a straight line. Liver bilobate, the right lobe larger and longer than the left.

Colour. Varying intensities of olive green dorsally, with four alternate black bands on body and nine to twelve on tail. Nuchals olive green, posterior pair tipped with black anteriorly. Ventrally white. (Variation). A dirty white with reddish brown dorsal scales and markings. The Äli kimbula a rare form.

Food. The chief food consists of frogs, crabs and fishes. When in quest of the last named the crocodile lies with jaws wide open until a fish swims close by, when with a quick snap it is seized, then raising its jaws above water the victim is swallowed. This animal varies considerably in temperament. Specimens in one tank may be ferocious "man eaters," whereas those of the neighbouring ones will permit men to bathe or fish in their abode with impunity.

Reproduction. Six to twelve eggs similar to those of *C. porosus* are laid in a hole about 10 inches deep dug in the sand close to the lair of the mother. The parent remains in the vicinity of the nest until the young hatch out, during which process the calcareous shell falls off from each egg leaving the leathery cases in the vacated nest. Young were obtained emerging from the egg at Timbiriyaya, Maho (N.W.P.), on May 12th, 1928. Veyangoda (W.P.). August 20th, 1929. Egg cases were observed in the vacated nests at Batuluoya (N.W.P.) 20th June, 1929. Veyangoda (W.P) April 19th, 1929.

Distribution. A gregarious swamp dweller, found in salt lagoons of Mullaittivu (N.P.) and the Southern Province and in most of the inland tanks and streams. Kelaart, writing in 1852, says that it was common on the peninsula of Jaffna where today it is exceedingly rare. During the dry season this form aestivates in burrows in the bank or under large rocks in the forest.

Specimens have been noted from :

Jaffna, Elephant Pass, Mullaittivu (N.P.), Puttalam, Murungan, Yodhaveva, Batuluoya, Kurunegala (N.W.P.), Anuradhapura, Minneriya, Rambeva (N.C.P.), Kumana, Batticaloa (E.P.), Tissamaharama, Bentota, Southern Game Sanctuary Lagoons (S.P), Veyangoda, Gampaha, Kalutara (W.P.)

Ceylon, India.

Dimensions :

Newly born (Puttalam, June, 1911).

Head.	*Axilla to groin.*	*Tail.*	*Snout to hip.*
44 mm.	52 mm.	142 mm.	126 mm.
45	50	143	128
45	50	142	127
45	50	148	130
45	53	142	128
45	51	137	128

Skull of Adult.	Total length	61 cm.	Width of occiput	25·5 · cm.
	Gape.	57 cm.	Width of snout	29·5 ·
	Length of snout	40 cm.		
	Orbit length	6 cm.		

A skeleton obtained from Minneriya tank, N.C.P., had the following dimensions :—

Head 66 cm., gape 57 cm., length of snout 35 cm., width of snout 23 cm., width of occiput 14 cm., length of eye 7 cm., axilla to groin 74 cm., hind limb 65 cm., total length 332 cm.

Crocodylus porosus Schneider Plate XV

Crocodilus porosus Schneid, Hist. Amph. 1799-1801.
Oopholis pondicherianus Gray, A. M. N. H. (3) X. 1862.
Gätta kimbula, Pittagätteya (S).

Width of snout 1·6-2·25 into length of snout. A strong osseous ridge runs from anterior corner of each orbit and converges near the nares with a similar ridge from the opposite eye. (Plate XV, fig. 1). In old specimens the snout becomes almost as wide as in *C. palustris,* while the ridges which are very prominent in specimens 2 metres long, grow indistinct. Eye 4·2-9 in head. Width of occipital bone 2–2·45 in

snout. Premaxillary teeth in adult 4, frequently 5 in young, maxillary teeth 14-19, mandibulars 13-15, along each side. Two rudimentary post-occipital scales present or absent. Nuchal scales in a cluster of four with one or two external ones on each side. The anterior pair of nuchals larger than the posterior ones. A few small scales between the nuchals and dorsals which are divided into a longitudinal series of 3/3 by a shallow median vertebral groove which extends from neck to anterior third of tail. Scales on sides and limbs small and smooth. Foliaceous flattenings on posterior edges of limbs and on tail. No enlarged ventral collar of scales at base of neck. (Plate XV, fig. 2). Skull with a "W"-shaped premaxillo-maxillary suture. Liver bilobate, the right lobe larger than the left.

Colour. Reddish olive dorsally with four or five alternate rows of oval black spots on body ; tail with ten or twelve black bands which alternate anteriorly. External nuchal scales black. Ventrally a pale yellow or white. The animal becomes much darker with age and the olive colouration is nearly absent in old specimens which have the snout broadened.

Reproduction. About 20-40 eggs are laid in from May to August and vary in length from 75-79 mm., but are constant in width which is 51 mm. Each egg has a calcareous zonary thickening of the shell at its short axis, and this band shows distinctly and is about 35 mm. wide. The egg shells are thin and pitted. The period of incubation appears to be about two months. The female deposits her eggs in a mound of decaying vegetation which she heaps up near the water's edge. The eggs are completely hidden from view and the mound is about 450 mm. high. The parent mounts guard in a shallow trench which she scoops out near the nest.

Distribution. This crocodile appears to have decreased since Kelaart's time (1852) where it is mentioned as the only species found near Colombo. Probably this is due to the increased use of fire arms and the easy detection of its eggs as the nests are conspicuous.

Unlike *C. palustris* it is a solitary animal. It is a river dweller and its burrow is usually under the roots of a tree overhanging the water. This species is usually fiercer than *C. palustris* and is never found far inland. It appears to spend more time in the water than the other species. On account of its estuarine habit it is frequently washed to sea during floods where, buffeted by the waves, it falls a victim to fishermen.

Several specimens 2-3 metres in length have been taken within the last two years from the sea off Kalutara, Panadura, Moratuwa (W.P.)

In all probability it was this reptile which was so petted by the Portuguese soldiery at Malvana, Colombo, Kalutara and other river forts, and Kayman's Gate in Colombo perpetuates the memory of their former abundance. These animals were so accustomed to the living Sinhalese captives hurled to them that they would crowd round with gaping, expectant jaws on hearing a whistle.[1]

To this day they are a serious menace to human life in the southern rivers, chief of which are the Bentota ganga, Gin ganga, Nilvala ganga. It is a cautious animal and does not float for long at the surface and only comes ashore to bask in some secluded spot. This renders shooting it difficult, so the most effective means of destroying it is by traps or baited hooks. The trap is an enclosure of stakes in the river bed, the entrance is through a trap door and the bait is a live dog in a cage on a platform beyond the reach of the crocodile.

Chilaw, Puttalam (N.W.P.), Colombo, Panadura, Bolgoda, Kalutara (W.P.), Bentota, Gintota, Vakwella, Matara, Hāthagalla near Tangalla (S.P.), Trincomalee (E.P.).

Ceylon, India, Malay Peninsula, N. Australia, Solomon Islands, Fiji Islands, Philippines, Burma, Singapore, Siam, S. China.

Dimensions.

Newly born. Puttalam (N.W.P.), June, 1911.

Head.	*Axilla to groin.*	*Tail.*	*Snout to hip.*
47 mm.	55 mm.	152 mm.	135 mm.
44·5	55	147	132
46	51	150	134
46	51·5	149	129
45	52	147	127

Young. Matara (S. P.) hatched December, 1927, died 13th December, 1928.

Head	71 mm.	Width of occiput	21 mm.
Gape	53 mm.	Axilla to groin	84 mm.
Length of snout	36 mm.	Snout to hips	185 mm.
Width of snout	22·5 mm.	tail	205 mm.

Man eater Adult. Bentota (S. P.)

Length of skull	37·5 cm.	Width of occiput	10 cm.
gape	35·12 cm.	Orbit	6·25 cm.
Length of snout	24·5 cm.	Width of snout	15 cm.
Snout to hips	125 cm.		
tail	115 cm.		

Adult. (Skull only). Matara.

Total length	73·75 cm.	Width of occiput	16·9.
Length of snout	37·5 cm.	Width of snout	37·5.
Orbit length	7·5 cm.		

1. (See Faria y Souza Bk. III, P. 321, also de Queiroz's *Conquista de Ceilão.*)

Boljoda (*W.P.*)		A.	B.	C.
Gape	..	31 cm.		12·6 cm.
Head	..	41	57 cm.	15·4
Length of snout	..	24·5	35	9·0
Width of snout	..	12·5	22	4·7
Width of occiput	..	9	14	3·8
Length of eye	..	3·5	5	2·6
Axilla to groin	..	47	93	18·0
Hind limb	..	44	—	19·0
Total length	..	249	359	99

EXPLANATION OF PLATES

Plate XIV. *Crocodylus palustris* (young) × 0·5

Fig. 1. Dorsal view
Fig. 2. Ventral view

(Arrow shows enlarged collar of scales.)

Plate XV. *Crocodylus porosus* (young) × 1.

Fig. 1. Dorsal view
Fig. 2. Ventral view

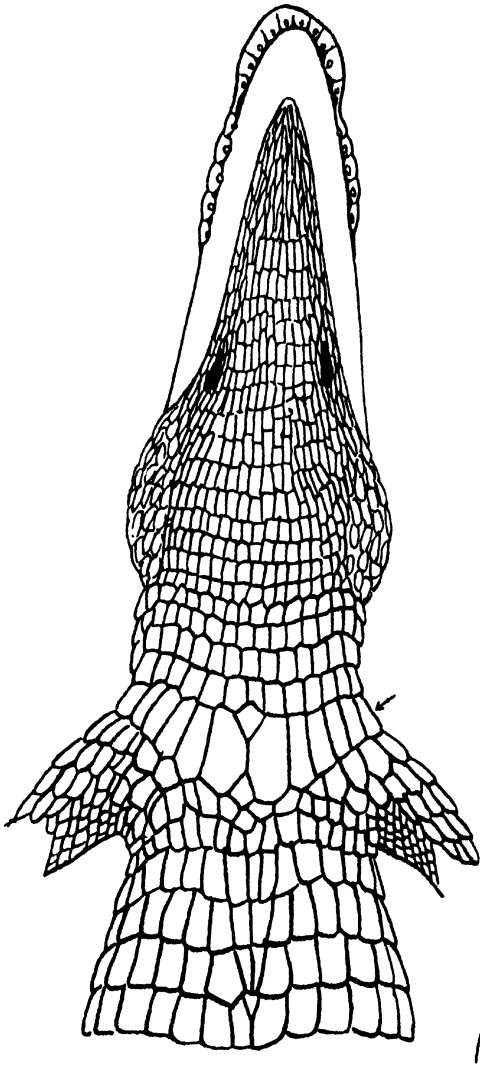

Fig. 2

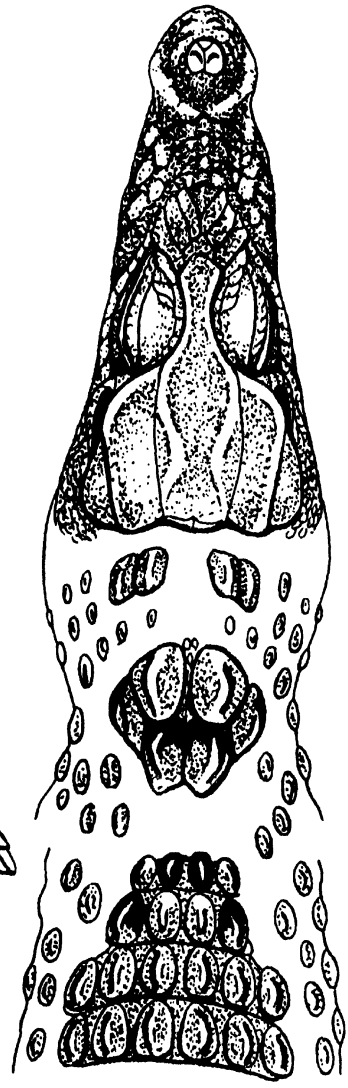

Fig. 1

P. E. P. Deraniyagala del.

Crocodylus palustris, young.

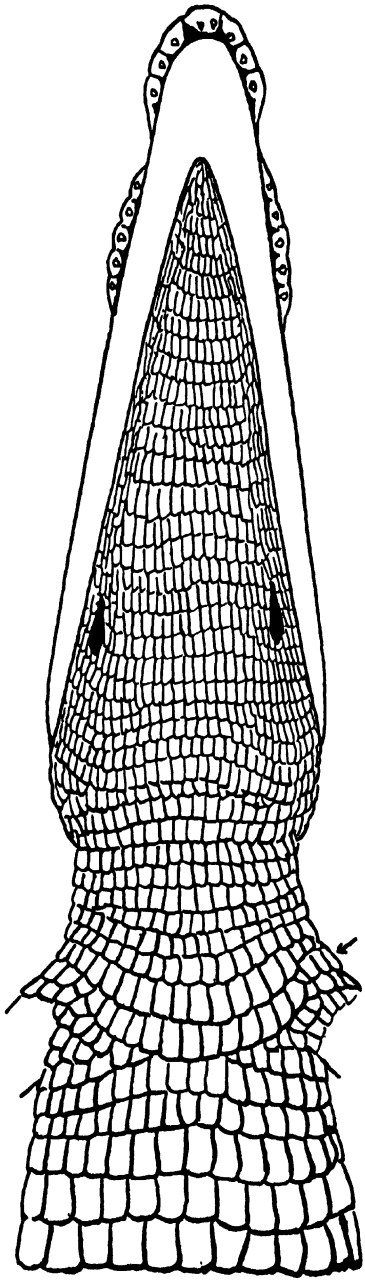

Fig. 2

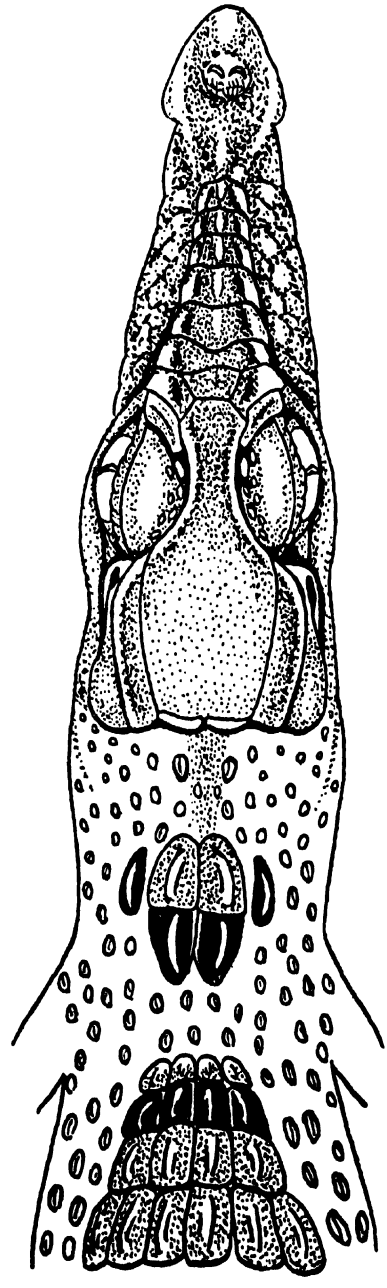

Fig. 1

Crocodylus porosus, young.

P. E. P. Deraniyagala del.

Variations in the Distribution of the Spermatic and Ilio-lumbar Veins in Rattus rattus kandianus Kelaart

BY

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WITH NINE PLATES

INTRODUCTION

The blood system of the common rat varies considerably in different specimens of the same species. In the practical classes at University College the courses of the ilio-lumbar and spermatic veins were seen to be particularly variable, and Mr. D. R. R. Burt, Lecturer in Zoology, suggested that I examine a large number of specimens to determine the extent and the nature of the variations. My thanks are due to him for his guidance in the carrying out of his work.

Different varieties of *Rattus rattus* are found in Colombo, but the most common variety *Rattus rattus kandianus* Kelaart (Phillips, 1926), the Common Ceylon House Rat can be readily obtained and it was used exclusively for this work.

The veins under consideration were in some cases so small that they were either identified with difficulty, or destroyed in an ordinary dissection. This difficulty was overcome by using a Rubber Latex Injection Mass (Burt, 1928). The advantages in this method of injection are many. Firstly, the injection is done at ordinary temperatures, without the use of heat. In this way a large number of animals can be injected without any fear of the solution hardening up. Secondly, once the latex has coagulated inside the vein, the rubber being elastic, the vein can be stretched without any fear of its breaking and even though the wall of the vein is removed the solid rubber core remains and indicates the original course of the vein. Thirdly, the specimens injected about a year ago still retain the original condition in spite of the fact that they

were all placed together and subjected to constant rough handling. The injections were done through the femoral vein, otherwise the technique is the same as that used by Mr. Burt.

The diagrams are confined only to the spermatic veins and the ilio-lumbar veins in the main types, although a large number of minor variations are found. As the variations found on the two sides of the body differ in kind, it is impossible to arrange the cases in any definite order.

DESCRIPTIONS OF THE CASES

Case 1

The left spermatic vein joins the left common iliac vein below the union of the two common iliac veins. From the left spermatic vein a small branch courses anteriorly running parallel to, and a short distance from, the inferior vena cava to meet the left renal vein midway between the hilus of the kidney and the union of the renal vein with the inferior vena cava. As this condition is found in several specimens it is constantly referred to below. The right spermatic vein joins the inferior vena cava opposite the junction of the left renal vein and the inferior vena cava.

The ilio-lumbar veins (Hunt, 1924) are normal in position, joining the inferior vena cava opposite one another in the lumbar region. Their point of union is posterior to the left renal vein by about a third of the distance between the left renal vein and the union of the common iliac veins. As this condition is most commonly seen it is regarded as typical for the ilio-lumbar veins.

Case 2

The left spermatic vein follows the same course as in case 1. The right spermatic vein opens into the right common iliac vein being in this respect similar to the left spermatic vein, but it lacks the small anterior branch to the renal vein.

The position of the ilio-lumbar veins is slightly anterior to that found in case 1, while the left ilio-lumbar vein joins the inferior vena cava in front of the right.

Case 3

This case is similar to the last, with the exception of the position and form of the ilio-lumbar veins. The position of the left ilio-lumbar vein is the same as in case 1, while the right joins the inferior vena cava midway between the left ilio-lumbar vein and the left renal vein. These veins are formed from two main trunks which do not unite until close to the inferior vena cava.

Case 4

Each spermatic vein enters the common iliac vein of its own side. There is no branch on the left side to the left renal vein.

The right ilio-lumbar vein is typical, while the left courses anteriorly dorsal to the kidney, and enters the left renal vein.

Case 5

This case differs from case 2 in the fact that the right spermatic vein gives off a small branch before its union with the right common iliac vein. This branch follows a course similar to that on the left side. In the region of the ilio-lumbar vein it turns medially to join the inferior vena cava midway between the left renal vein and the two ilio-lumbar veins.

Case 6

Three veins of equal size issue from the left spermatic plexus. Two of these unite to form one of the spermatic veins which enters the inferior vena cava, while the third vessel unites with the branch joining the spermatic vein and the left renal vein. On the right side there are two spermatic veins of approximately equal size. They run together for a short course when one leads directly into the right common iliac vein, and the other courses forwards to join the inferior vena cava at a point corresponding to that in case 5. An additional vein connects these two vessels.

The left ilio-lumbar vein joins the inferior vena cava in front of the typical position, while the right is typical.

Case 7

In this case the left spermatic vein has the same course as in case 1. The right spermatic vein, however, breaks up into two branches, both of which run into the right common iliac vein. From each of these a small vein arises which runs parallel to the inferior vena cava and each one joins the inferior vena cava independently in front of the ilio-lumbar vein.

The left ilio-lumbar vein joins the inferior vena cava as a single vein, but it is formed from two main stems which unite immediately before its junction with the inferior vena cava. The right ilio-lumbar vein, a single vein, bifurcates before entering the inferior vena cava.

Case 8

The main part of the left spermatic vein unites with the left common iliac vein as in the first five cases. It sends out, however, two small veins which run anteriorly to unite with the left renal vein following courses parallel to the inferior vena cava. One of the spermatic veins, the narrower of the two, arises very close to the junction of the left

common iliac vein and inferior vena cava, while the other, arising further from the junction, is slightly larger. Their courses being parallel they have separate junctions with the left renal vein. The right spermatic vein unites with the inferior vena cava close to the junction of the left renal vein and the inferior vena cava. There is a small connecting vein between it and the right common iliac vein, while it gives off another small branch which courses towards the kidney near which it is lost.

The ilio-lumbar veins are normal in position.

Case 9

The left spermatic vein bifurcates before uniting with the left common iliac vein. From the anterior division of this vein a small branch is given off which follows a course approximately parallel to the inferior vena cava as in case 1, but which enters the left renal vein close to the hilus. The right spermatic vein unites with the right common iliac vein at a point corresponding to the junction of the anterior division of the corresponding vein on the other side. The right spermatic vein gives off a small vein in the same manner as on the left side, which vein disappears in the region of the kidney anteriorly. This division, running parallel to the inferior vena cava, is connected to it about the middle of the length of the latter by a small connecting vein.

The ilio-lumbar veins are normal in their course but are situated slightly posterior to the normal position.

Case 10

On the left side the spermatic vein arises from the spermatic plexus as three veins of approximately equal dimensions which do not unite. One of these enters the left common iliac vein as in case 1 ; the second unites with the inferior vena cava close to its origin from the two common iliac veins ; while the third vein runs parallel to the inferior vena cava and unites with the left renal vein. Three spermatic veins are also seen on the right side, but two of these unite before entering the right common iliac vein, while the third runs forward to join the inferior vena cava.

The right ilio-lumbar vein is normal in size and position. The left is formed from two main veins which unite for a short distance before entering the left renal vein at a point between the junction of the anterior left spermatic vein and the hilus of the kidney.

Case 11

A further variation of the arrangement of the left spermatic veins is seen in this case. Three spermatic veins leave the left spermatic plexus. Two of these unite to form a single vein which enters the left common iliac vein in the same position as in case 1, and from this vein

another branch is given off which joins the left renal vein close to the hilus of the kidney. The third spermatic vein runs for a short distance beside the other two, but without uniting with them, and courses anteriorly to unite with the left renal vein close to its junction with the inferior vena cava. The right spermatic veins show a very slight variation on the arrangement seen in case 10. The spermatic plexus forms a single vein which bifurcates to form two equally large vessels. The anterior of these joins the inferior vena cava opposite the left ilio-lumbar vein, while the posterior branch enters the right common iliac vein in a position similar to that of the other side.

The right ilio-lumbar vein is normal in position, but the left is situated slightly posterior to it. They are both single veins.

Case 12

The left spermatic vein in this case unites with the left renal vein, but it sends off one branch to the posterior region of the inferior vena cava and receives the ilio-lumbar vein close to its union with the left renal vein. There is, therefore, no direct connection between the left ilio-lumbar vein and the inferior vena cava. On the right side the spermatic vein also bifurcates : the anterior branch unites with the inferior vena cava between the junction of the left renal vein and the right ilio-lumbar vein, while the equally large posterior branch joins the inferior vena cava posterior to the right ilio-lumbar vein.

The right ilio-lumbar vein is normal in position ; the left, which joins the anterior division of the spermatic vein, has been described above.

Case 13

The veins on the left side have the same distribution as in the previous case (case 12). The only difference on the right side lies in the fact that the right spermatic vein does not bifurcate, but enters the inferior vena cava in the position of the posterior division of the veins described in case 12.

The ilio-lumbar veins are similar to those in case 12.

Case 14

There is a similarity in the distributions of the veins on the left side in this case, to that seen in two previous cases (cases 12 and 13). The difference lies in the fact that a branch from the left spermatic vein unites with the left common iliac vein. On the right side the spermatic vein bifurcates sending an anterior division to the middle region of the inferior vena cava and a posterior division to the right common iliac vein.

The ilio-lumbar veins are similar to those of the two previous cases (cases 12 and 13), the difference being that the left ilio-lumbar vein

is double, both divisions uniting at their junction with the left spermatic vein.

Case 15

The veins of the left side differ from those of case 14 in the lack of the connecting veins between the left spermatic vein and the inferior vena cava. The difference in the right side lies in the position of the union of the anterior division of the right spermatic vein which is anterior to the right ilio-lumbar vein.

The ilio-lumbar veins are similar to those seen in cases 12 and 13.

Case 16

The type and branching of the left spermatic vein is the same as that seen in case 9, but the distribution of the branches differs. The left spermatic vein divides, the anterior division uniting with the posterior region of the inferior vena cava, and the posterior division uniting with the left common iliac vein. From the posterior division of this vessel a vein arises which runs parallel to the inferior vena cava to unite with the left renal vein, and between it and the anterior division of the spermatic vein are two short connecting veins. The right spermatic vein is a single vessel uniting with the right common iliac vein.

The ilio-lumbar veins lie in front of the position seen in case 1, the right vein being slightly anterior to the left.

Case 17

The spermatic veins are small in size. On the left side two veins arise from the spermatic plexus, one of which unites with the renal vein close to its union with the inferior vena cava, and the other unites with the inferior vena cava midway between the left renal vein and the left ilio-lumbar vein. A small branch from this vein is given off to the anterior division of the left ilio-lumbar vein, described below. The right spermatic vein runs directly to the inferior vena cava which it joins opposite the junction of the left renal vein.

The ilio-lumbar veins are double on either side. On the left side the two veins unite before entering the inferior vena cava in the normal position, while on the right the position is posterior to the normal one and both veins enter close together.

DISCUSSION

The courses of the spermatic veins in the cat and in man differ from that seen in any rat yet dissected. In man the spermatic veins are single, the left joins the left renal vein, while the right enters the inferior vena cava in the region anterior to the first lumbar veins. In man there is an ilio-lumbar vein, and also four lumbar veins, which latter enter the

inferior vena cava between the renal veins and the common iliac veins. In man also the renal veins lie opposite one another (Buchanan, '21).

In the rat the spermatic veins arise from a plexus of blood vessels which shows many variations in size, but in most cases three principal veins arise from this plexus to form the spermatic vein. This vein may continue as a single vessel, or else it may divide again. In only one case (case 10) do these vessels not unite, and this case gives us a clue to the interpretation of the other cases.

Those cases described where it continues as a single vessel on the right side are cases 1, 2, 3, 4, 13, 16 and 17, while in case 4 only the vessel is single on the left side joining the common iliac vein. In cases 2, 3, 4 and 16 the right spermatic vein joins the right common iliac vein, while in 1 and 13 it unites with the inferior vena cava.

The single spermatic vein, formed from the three principal veins arising from the spermatic plexus, may sub-divide again into three divisions and practically every possible variation in the distribution of these three vessels may be found. For instance, on the left side, one division may enter the renal vein, the second may enter the inferior vena cava, with the third joining the common iliac vein as in case 9 ; or again, as in case 8, the first two divisions may enter the renal vein and the third division the common iliac vein. Obviously all possible variations have not been realised in the specimens studied.

Where the spermatic vein bifurcates, the most common arrangement on the left side is for the anterior division to go to the renal vein, and the posterior division to go to the left common iliac vein, and in these cases the division going to the renal vein is generally smaller than that joining the common iliac vein. This is seen in cases 2, 3, 5, 7 and 15. The other alternative is seen where the posterior division of the spermatic vein joins the inferior vena cava and not the left common iliac vein as in cases 12 and 13. On the right side this condition is varied, in that the anterior division enters the inferior vena cava and the posterior division enters the right common iliac vein as in cases 5, 8, 9, 11, 14 and 15. The condition where both vessels enter the inferior vena cava is seen in case 12. No case studied shows any division of the right spermatic vein entering the right renal vein, and in this respect the rats studied resemble the other mammals. It is probable that in these cases one division may represent two of the three main vessels found in the plexus, and this interpretation is supported by the fact that one vessel is usually much smaller than the other which is presumably double in origin. It may be that the smaller division tends to disappear, for in two cases it was so small that it was not injected throughout its entire length, and could not be traced to its insertion.

Another possibility is seen where the three veins arising from the spermatic plexus do not unite at the same point. In this case one of the vessels may never unite with the other as in case 11 ; or again, the vessel with the double origin may subsequently bifurcate and the third vessel arising from the plexus may join either of the sub-divisions.

The hypothesis that the spermatic vein is three-fold in origin is borne out by practically every case, the only exception being seen in case 7 on the right side. Here the single spermatic vein divides into two, which two divisions enter the right common iliac vein, but before doing so, give off a small vein which runs forward to the inferior vena cava. One can conclude from this instance that here the spermatic vein is at least three-fold in origin or else that the spermatic vein has divided, which division is not connected with the three-fold origin.

The ilio-lumbar veins also show very interesting variations. Normally they lie opposite one another about a third of the distance from the left renal vein and the union of the common iliac veins. In many cases the ilio-lumbar veins tend to lie posterior to the normal position. The tributaries from the lumbar region usually unite to form the single ilio-lumbar vein, but in some cases this union takes place nearer the inferior vena cava, so that in cases 3, 7, 10, 14 and 17 two main veins unite to form the single ilio-lumbar vein. Or, as in case 17 on the right side, there are two ilio-lumbar veins entering the inferior vena cava. Instead of joining the inferior vena cava the ilio-lumbar vein of the left side may join the renal vein, as in cases 4, 10, 12, 13, 14, and 15, and in many cases the ilio-lumbar vein unites with the spermatic vein and the combined vessel joins the inferior vena cava as in cases 12, 13, 14, and 15.

It may be that a developmental stage in the rat is a condition where the three spermatic vessels exist and that one or the other has been suppressed at a later stage, and there are many instances in embryology where veins which function in the earlier stages of development are lost before birth. Colour is lent to this view by the fact that two main conditions of the left ilio-lumbar veins are found; in one it enters that division of the spermatic vein which joins the renal vein, in the other, after flowing towards the inferior vena cava it turns abruptly forward to join the renal vein, no trace of a spermatic vein associated with it being seen. These may be two aspects of one and the same condition. If one supposes that at an early developmental stage the ilio-lumbar vein united with a division of the spermatic vein going to the renal vein, it would follow that the subsequent degeneration of that part of the spermatic vein posterior to the junction with the ilio-lumbar vein would account for this unusual condition. The ilio-lumbar vein showing a

supply to the anterior division of the spermatic vein is seen in cases 12, 13, 14, and 15, while in case 4 the ilio-lumbar vein enters the renal vein. It is suggested that the condition seen in case 4 has arisen by degeneration of part of an anterior division of the spermatic vein which flowed into the renal vein, and which, at an early stage, united with the ilio-lumbar vein. The same interpretation would apply equally to case 10, but here it appears that the ilio-lumbar vein has been deflected from its course by the anterior division of the spermatic vein, and that in the adult stage both vessels persist.

In conclusion, the many variations are seen to be of one order, and within the limits described, from that of a single spermatic vein to that of three separate spermatic veins there are many possibilities. In this respect the arrangement is plastic and from the most generalised condition one may derive the arrangement found in different mammals, *e.g.* the rabbit or man. A study of the developmental stages of these veins in the rat will alone give a satisfactory verdict regarding the origin of the modifications.

SUMMARY

(1) The spermatic vein is at least three-fold in origin, arising as three main vessels in the spermatic plexus.

(2) The subsequent fate of these three vessels varies in the following way :—

(*a*) The three main vessels may unite to form a single spermatic vein. The single vein may enter the common iliac vein on the side on which it arises, or, on the right side, it may enter the inferior vena cava. There are indications that the divisions formed when the single spermatic vein subsequently branches represent, and are homologous with, the original three main vessels.

(*b*) The three main vessels may remain separate. In this case one is found entering the renal vein, the second entering the inferior vena cava, and the third entering the common iliac vein. All the possible variations in the distribution of these veins have not been realised.

(*c*) Two of the three main vessels may unite, the third remaining separate or uniting more distally ; or, the third main vessel may unite subsequently with a division of the vessel with the double origin.

(3) Those cases where the left ilio-lumbar vein enters the left renal vein indicate that there is an early developmental condition where three separate spermatic veins are found, but that in development atrophy may take place.

(4) The arrangement of the veins of the spermatic and ilio-lumbar regions is variable, the rat exhibiting a great plasticity in this respect.

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EXPLANATION OF THE PLATES

The figures, with the exception of Fig. 18, correspond to the cases bearing similar numbers which are described in the text. Fig. 18 represents the condition of the spermatic and associated veins in man.

Abbreviations used in fig. 1 :—

c.i.—common iliac vein.
i.l.—ilio-lumbar vein.
i.v.c.—inferior vena cava
k.—kidney.
r.—renal vein.
s.p.—spermatic plexus.
s.—spermatic vein.

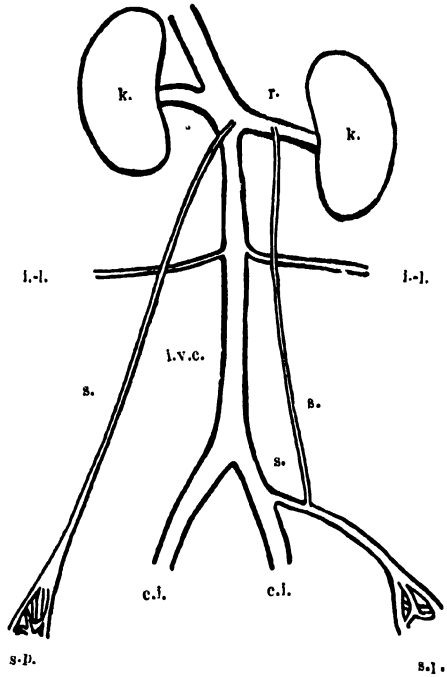


Fig. 1

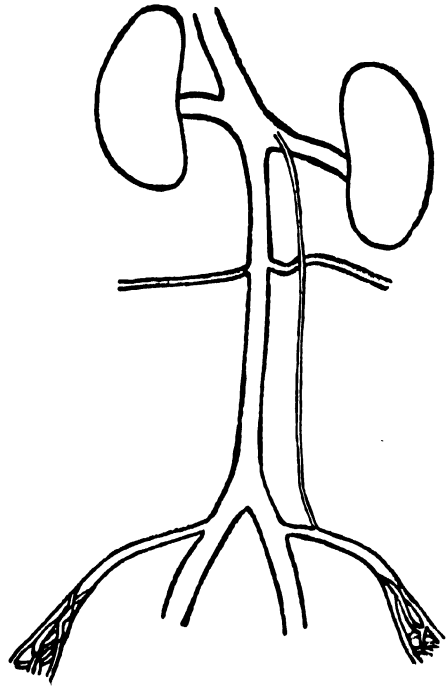


Fig. 2.

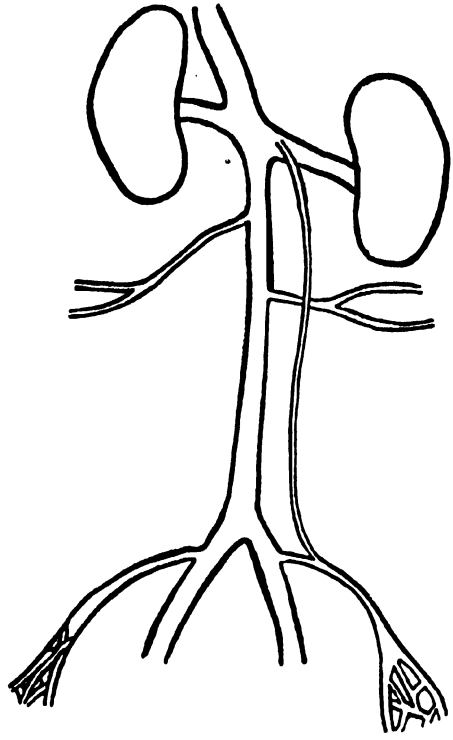


Fig. 3

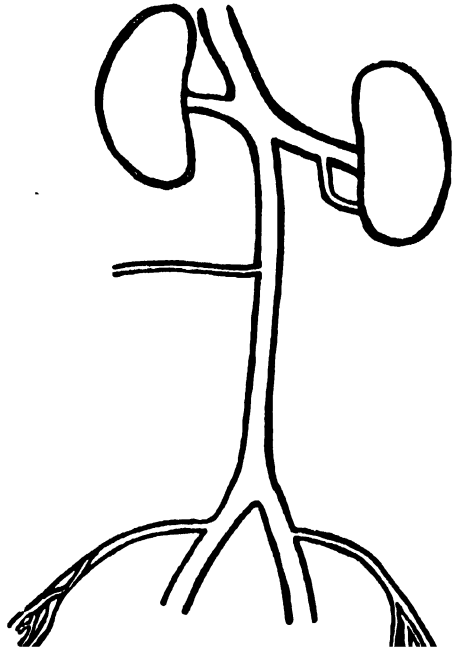


Fig. 4

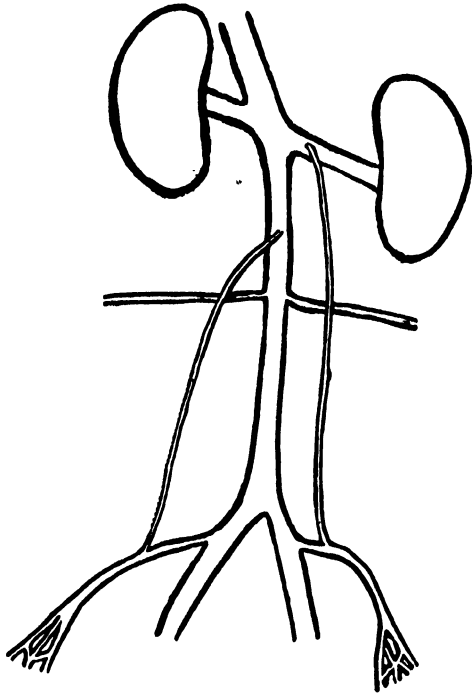


Fig. 5

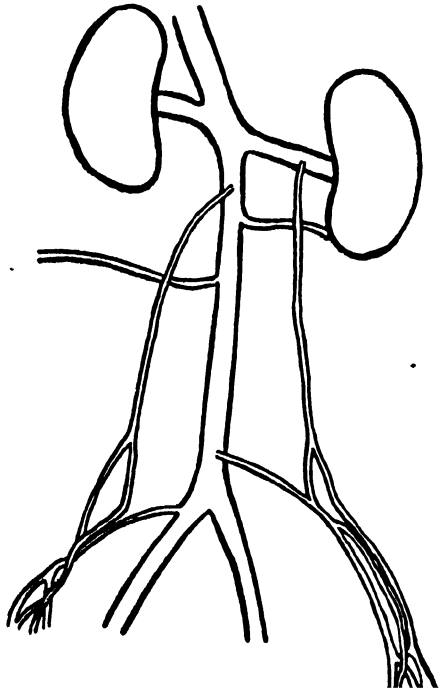


Fig. 6

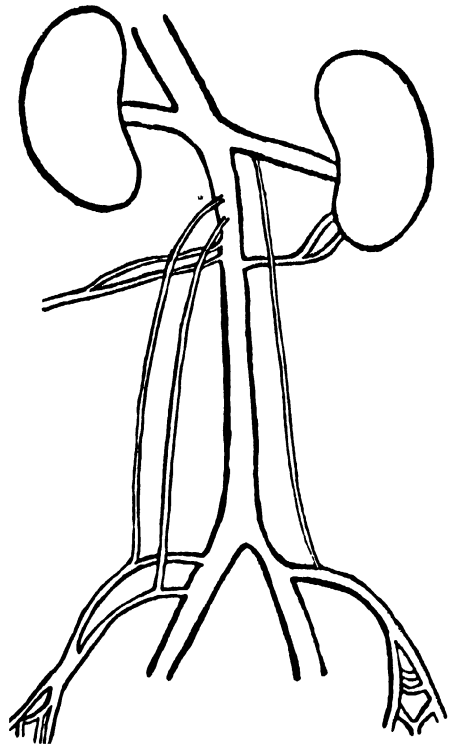


Fig. 7

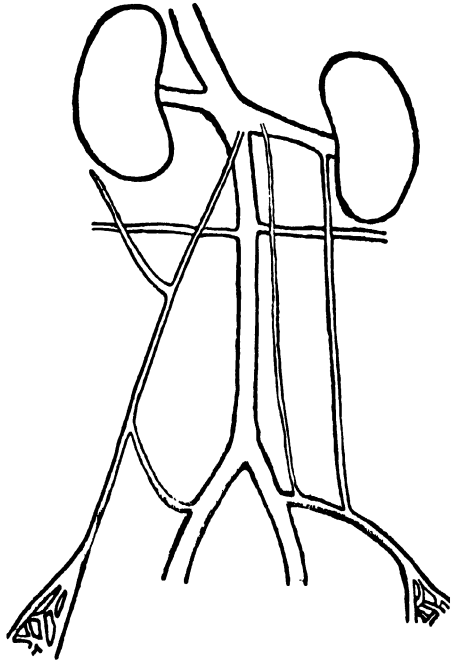


Fig. 8

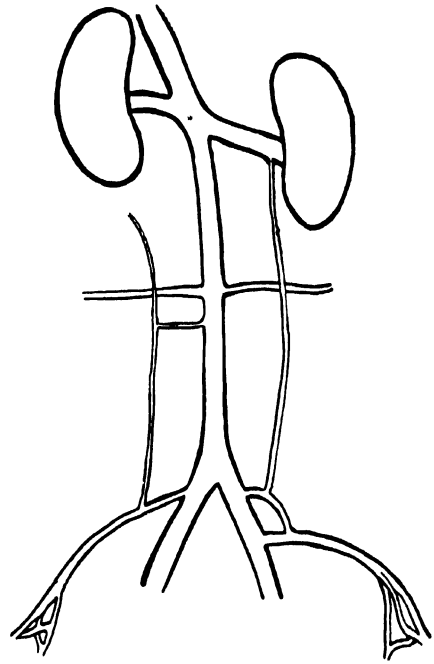


Fig 9.

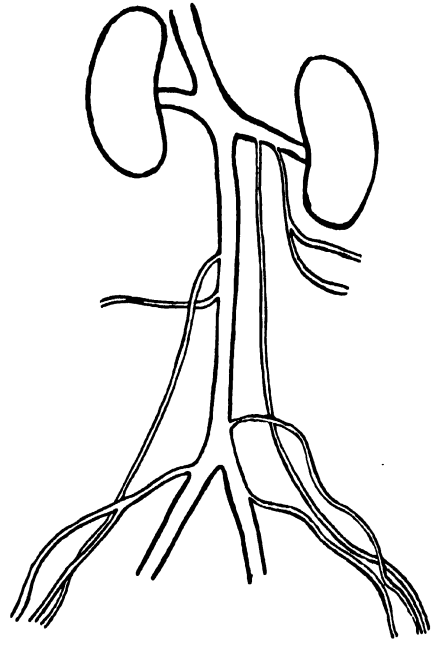


Fig. 10

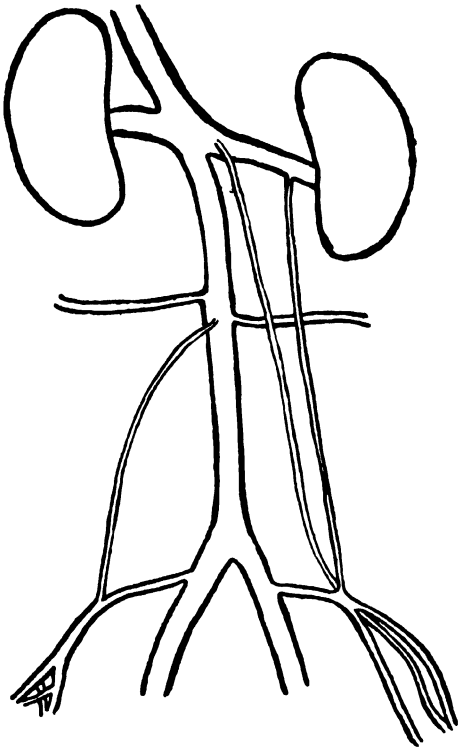


Fig. 11

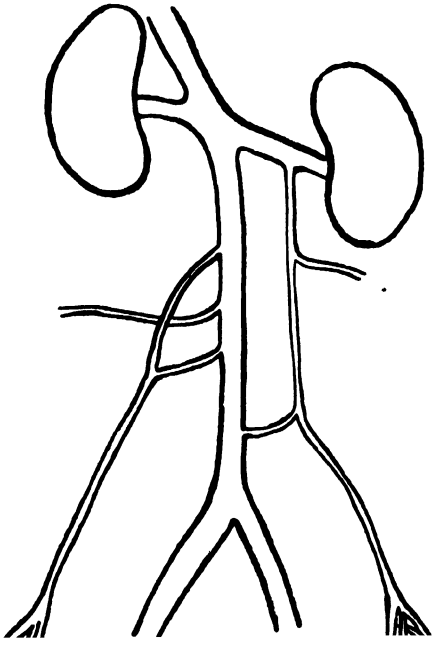


Fig. 12

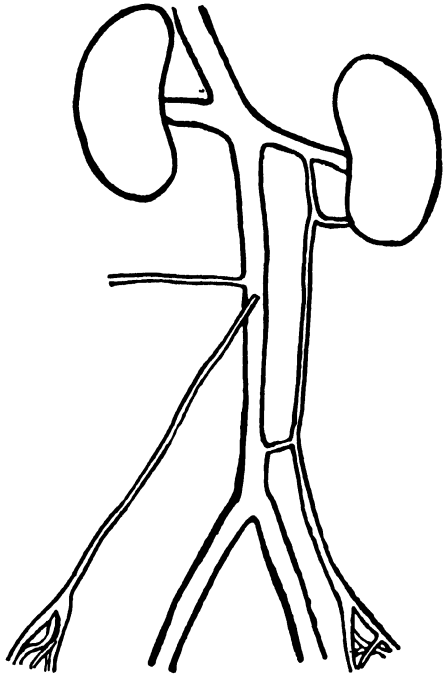


Fig. 13

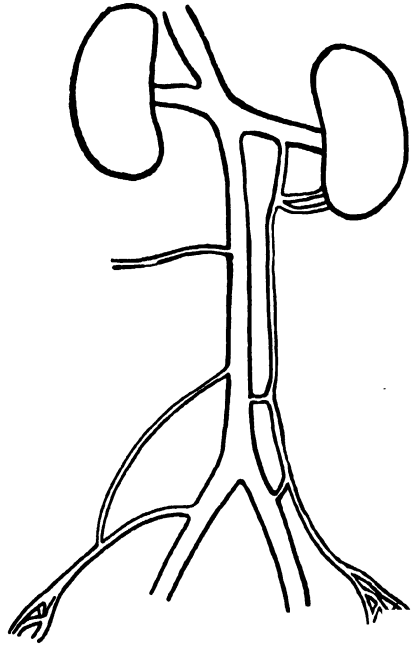


Fig. 14

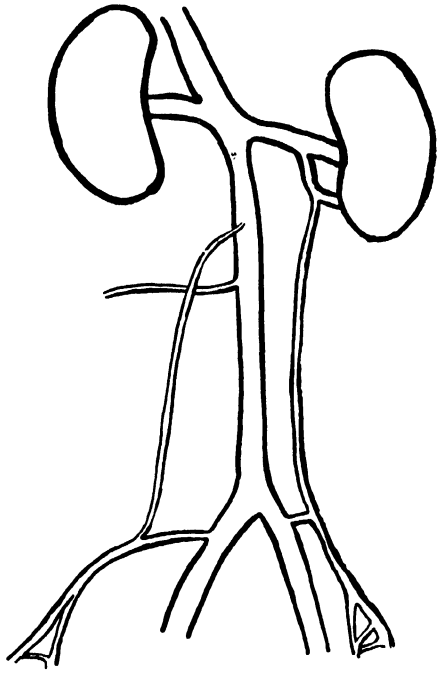


Fig. 15

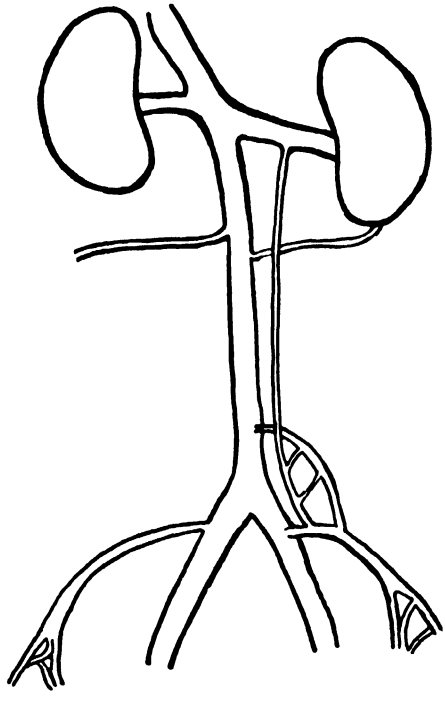


Fig. 16

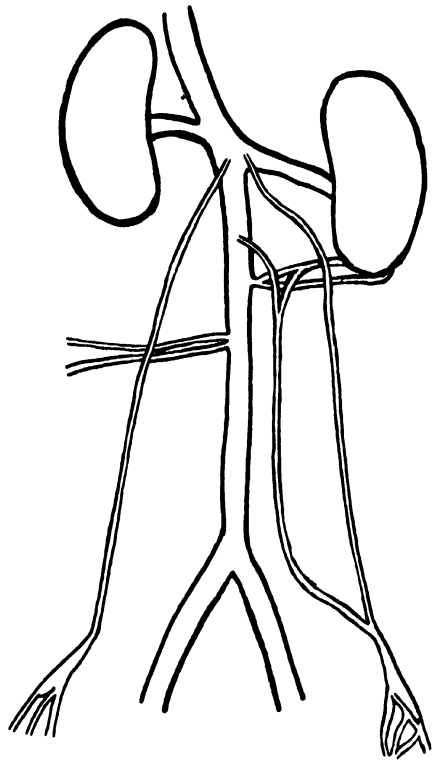


Fig. 17

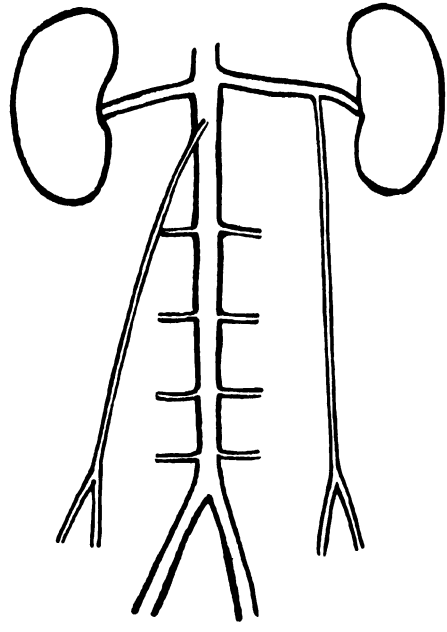


Fig. 18

Notes on the breeding habit of the eel Leiuranus semicinctus

BY

P. E. P. Deraniyagala, M.A. (Cantab), A. M. (Harvard)

Second Assistant Marine Biologist, Fisheries Department

As our knowledge of the breeding habits of apodal fishes is very limited this short note may not be without interest to ichthyologists. Three specimens of the eel *Leiuranus semicinctus* (Lay and Bennett) were taken from the surface at 8.45 p.m. on February 25th, 1929, when the Fisheries research vessel "Nautilus" lay at anchor on the Pearl banks in Lat. 8° 40′ N. Long. 79° 42·7′ E. in 18 metres of water above a sandy bottom which appeared to abound in Amphioxus. When placed in a basin of sea water one of the eels soon attached itself dorsally to the head of another at a position slightly in advance of the gill opening and remained thus in spite of its tail being struck several times with a glass rod and considerable force was necessary to break this hold which would be at once resumed, always on the head of the same specimen, which continued to swim actively. The third specimen which was of no interest was liberated. These two eels remained attached to each other until 10 a.m. next day when they were further examined. Both appeared rather exhausted, probably owing to the water not having been changed overnight. The male, when torn asunder, renewed his grip by seizing the female near the middle of her length with his snout under her belly and retained this position belly upward for one hour until he was grasped in the hand, whereupon he emitted a cloud of sperm and thereafter lost all interest in the female. The female showed no injuries from the prolonged hold of the male, except for a few faint scratches caused by the minute teeth which are present only in the upper jaw of this species. Mature ova were extruded on squeezing the female ; these were white in colour and showed no oil globule under the microscope. The dimensions of the two specimens, each of which had twenty-seven black body bands, were as follows :—

		MALE	FEMALE
Length	..	263 mm.	343 mm.
Head length	..	22 mm.	22 mm.
Tail length	..	142 mm.	165 mm.
Depth of body	..	4·5 mm.	5·5 mm.

PROCEEDINGS OF THE CEYLON NATURAL HISTORY SOCIETY

Seventeenth Annual Meeting

The Seventeenth Annual General Meeting of the Society was held in the Colombo Museum Reading Room on the 12th March, 1929, at 5.30 p.m.

Professor N. G. Ball presided and there were 16 members present. The minutes of the last General Meeting were read and confirmed.

The Secretary's and Treasurer's reports and the Balance Sheet were read and adopted.

The following office-bearers were elected to serve for 1929-30 :—

Patron :	H. E. Sir Herbert Stanley, K.C.M.G.
Vice-Patron :	Hon. Mr. A. G. M. Fletcher, C.M.G., C.B.E.
President :	C. T. Symons, Esq.
Vice-Presidents :	Sir Solomon Dias Bandaranaike, K.C.M.G. Dr. Andreas Nell. Very Rev. Fr. M. J. Le Goc. Hon. Mr. W. E. Wait. Dr. J. Pearson.
Honorary Secretary :	G. M. Henry, Esq.
Honorary Treasurer :	A. H. Malpas, Esq.
Council :	W. W. A. Phillips, Esq. Prof. N. G. Ball, D. R. R. Burt, Esq. Dr. S. E. Fernando. Dr. R. L. Spittel. E. C. T. Holsinger, Esq.

Mr. W. W. A. Phillips proposed a hearty vote of thanks to the retiring Secretary, Mr. E. C. T. Holsinger, for the splendid work he has put in during the past 4 years. This was seconded by the Hon. Mr. George Brown and carried with acclamation.

Mr. A. R. Hughes was elected an ordinary Member of the Society.

A letter from the Acting Director, Colombo Museum, was read informing the Society that Government has sanctioned the sale of sections A and B of the Ceylon Journal of Science at half published rates to members of the Society.

Mr. E. C. T. Holsinger then gave a lecture on "Some Aspects of the Natural History of the Galle Sea-shore." He illustrated his remarks by numerous well-preserved specimens of the animals and plants collected on the reef fringing the Galle Fort by a party of students under his supervision. Among the more interesting creatures met with were the following :—

Holothurians (*Holothuria atra* and *Colochirus quadrangularis*) Sea-Urchins, Star-fish, Snake or Brittle Star-fish, various Alcyonarians and Corals. Amongst the plants, Caulerpas and other sea-weeds were interestingly described and the sand-binding faculty of the curious marine flowering plant *Cymodocaea serrulata* was commented upon.

A short discussion took place after which the Chairman referred to the value of the collections and observations made by Mr. Holsinger, particularly in respect of the sea-weeds, which are very little known,

The meeting terminated with a vote of thanks to the lecturer and members were given an opportunity of examining the specimens more closely.

Eighty-third General Meeting

The Eighty-third General Meeting of the Society was held in the Colombo Museum Reading Room on June 11th, 1929, at 5.30 p.m.

Mr. C. T. Symons, President, occupied the chair, and there were 25 members and visitors present.

The minutes of the Seventeenth Annual General Meeting of the Society were read and confirmed.

Mr. I. B, H. Cameron was elected an Ordinary Member of the Society.

The Secretary read a letter from Mr. C. H. Dedman, England desiring to be put in touch with persons who would collect land and fresh-water shells for him.

The President drew the attention of members to the Journal of the Society for the Preservation of the Fauna of the Empire, part IX, which had come to hand.

Mr. G. M. Henry exhibited a number of insects collected on recent tours at Ohiya, C. 6,000 ft. and Rakwana , C. 1,800 ft. and illustrated his remarks with diagrams.

Dr. Pearson exhibited examples of the several classes of the Echinodermata and described the salient characteristics of the Phylum, viz., the radial symmetry, the internal (dermal) calcareous skeleton, and the water-vascular system. He also exhibited living examples of the Giant Tortoise from the Seychelles, the Ceylon Starred Tortoise, the hard and soft-shelled water tortoises and the Logger-head and Hawksbill Turtles. The latter were of particular interest as they had been reared in the Museum from the egg.

The President then demonstrated and explained a Wood's Light (Ultra Violet Ray) Lamp and pointed out its usefulness to the Analyst in enabling him to discriminate between apparently similar substances and so to detect frauds, etc. Amongst other things the following articles were tested:—Sticks of sealing wax, indistinguishable in ordinary light, which appeared very distinct under the rays. A number of sheets of white paper, which appeared of different colours and shades when placed under the lamp. Pieces of broken glass, which took on different colours. Quinine titration, etc. The action of the rays in revealing obliterated ink marks in document and stamps was also interestingly demonstrated.

The meeting terminated with a vote of thanks to those who took part.

Eighty-fourth General Meeting

The Eighty-fourth General Meeting of the Society was held in the Colombo Museum Reading Room on July 9th, 1929, at 5.30 p.m. By invitation the members of the Geographical Association were also present.

Mr. C. T. Symons, the President, occupied the chair and there were 38 members and 18 visitors present.

The Chairman announced that, in order to allow more time for the lecturer, the reading of the minutes of the last meeting would be deferred until the next meeting of the Society.

The following were then elected Ordinary members of the Society :—

F. E. Mackwood, Esq., Hon. Mr.T.L. Villiers, Roderick Dobson, Esq., Mrs. A. H. Malpas. Wilfred Fernando, Esq., Brig. A. C. Girdwood and Mrs. Girdwood.

Dr. Pearson delivered a lecture on the Geographical Distribution of Animals, illustrating his remarks with maps and specimens. The lecturer commenced by drawing attention to the discontinuous distribution of most forms of animal life, and showed that climatic considerations alone were inadequate to explain this. He then dwelt upon the effect of various checks and barriers to general distribution such as seas, mountain ranges, deserts, climatic conditions and diseases. He pointed out that such barriers are much less effective in the case of certain animals, such as birds and for this reason the true facts of distribution can be better ascertained from the study of such a group as the Mammalia, the distribution of which is more controlled. For this reason, he practically confined his observations to the Mammalia.

The lecturer then showed diagrams of the probable changes in the land surfaces of the Earth during the Jurassic, Cretaceous, and Tertiary epochs and pointed out that only on the assumption of some such changes of land surface could the anomalous distribution of animals be explained. Some interesting facts were then stated, *e.g.*, the presence of Tapirs in South America and Malaya only, the discontinuous dis-

tribution of the present day Marsupials, Elephants, Camelidae, Chevrotains, Lemurs and Rhinoceroses; and showed how fossils indicated that these animals were at one time very widely distributed throughout the Earth. The total distinctness of the fauna of Madagascar from that of Africa was shown to be due to the fact that the present fauna of Africa is not the original one but an immigrant fauna from Central Asia. Prior to this immigration, Madagascar was undoubtedly united with Africa and partook of the same fauna, but after its severance the original African fauna was largely wiped out by the immigrant fauna, so that the fauna of Madagascar really represents the last relic of it. Similarly the presence in Ceylon and South India of certain elements of Madagascar such as the Loris and the Chamaeleon and in Madagascar of the Flying-fox (which is absent in Africa) are almost certainly due to a former land connection between the two regions, which was broken sometime after the connection between Madagascar and Africa.

It was pointed out that the total absence of Mammalia in New Zealand in spite of its obvious former connection with Australia could be explained on the assumption that when this connection existed, Australia was divided into two sections by a broad belt of sea and that the western portion was connected with South East Africa, from which it was colonised by its present marsupial fauna. Then the connection with New Zealand became broken and the two halves of Australia were united by an upheaval of land. Lastly, Dr. Pearson pointed out the main features of the present Zoogeographical regions of the Earth.

At the close of the lecture questions were asked by Mr. Wicebloom, Mrs. Platts and Brigadier A. C. Girdwood. Dr. Pearson replied, and the proceedings were then terminated with a hearty vote of thanks to the lecturer proposed by the Rev. D. J. Nicholas Perera.

Eighty-fifth General Meeting

The Eighty-fifth General Meeting of the Society was held in the Colombo Museum Reading Room on Tuesday, September 10th, at 5.30 p.m.

Dr. J. Pearson occupied the chair and there were 39 members and visitors present.

The minutes of the last two General Meetings were read and confirmed.

The following new members were elected Ordinary Members of the Society :— Allan Bowie, Esq., L. Blichfeldt, Esq., and Mrs. A. B. Jayasuriya.

Mr. G. M. Henry exhibited living specimens of a mantis *Deiphobe infumata* collected at Hakgala, and remarked on their habits and cryptic colouration. He also exhibited living examples of the large black millipede from Hakgala.

Dr. Pearson exhibited skulls of the Lincolnshire Killer Whale, *Pseudorca crassidens*, a large school of which was washed ashore at Kayts in August, 1929. He mentioned the peculiar distribution of this species, which was first discovered in fossil form in the fens of Lincolnshire and was next taken alive at New Zealand. It has visited Ceylon waters on at least one previous occasion, as the Museum possesses the skeleton of a specimen which was washed ashore in 1891. The ferocious, predatory nature of this whale was mentioned.

The Chairman then called upon Dr. S. E. Fernando to deliver his lecture on "Some Inhabitants of Man." Dr. Fernando, in opening his lecture, emphasised the importance of the study of Zoology as an essential background for the proper study of Human kind. He then discussed the nature of parasitism, and classified parasites for practical purposes into internal and external. Another grouping is into temporary and permanent parasites. The lecturer indicated certain characteristics common to all parasites, such as: (1) Reduction of Organs of locomotion, organs of special sense and nervous system. (2) Formation of organs for attachment, for piercing the host and for suction of blood. (3) Prolific reproduction, distributive stage and often parthenogenesis. Whereas external parasites are subject to the same conditions of life as their host, internal parasites have a medium of their own in body fluids or tissues of the host. Dealing first with internal parasites, the lecturer distinguished between those which inhabit the hollows of the body and those which live in the tissues, and showed the three modes whereby internal parasites obtain their nutriment: (1) By devouring other inhabitants of the gut of their host. (2) By swallowing undigested food particles. (3) By absorbing substances digested by the host. He pointed out that the organisation of internal parasites

is, as a rule, more degenerate than that of external parasites, and their life-history is more complicated having two phases—multiplicative and distributive. They harm their hosts either by absorption of blood and destruction of tissues or by the production of toxins, and the host fights the intruder either by (1) enclosing it in a cyst, (2) by attacking it through the leucocytes, or (3) by the secretion of counter-poisons (anti-toxins). Dr. Fernando next proceeded to deal with examples of each of the Human parasites, commencing with the Protozoa, exemplified by *Entamoeba hystolytica*, Trypanosomes, Spirochaetes, and the Malarial parasites. He then discussed the Tape-worms, Liver-flukes, Round-worms and Hook-worm, etc., and gave details of the life-histories and of methods of infection. Specimens of most of these parasites were exhibited. The external parasites, exemplified by several forms of lice, the flea and the bed-bug were then described, and the lecturer concluded by pointing out that our knowledge of all these creatures was a result of Zoological research.

The discussion that followed the lecture was taken part in by Mrs. Platts, Mr. Wicebloom, Mr. D. C. Gunawardana and Mr. E. C. T. Holsinger.

In bringing the meeting to a close with a hearty vote of thanks to the lecturer, the Chairman expressed his gratification at the increasing interest in Zoology in Ceylon.

Eighty-sixth General Meeting

The Eighty-sixth General Meeting of the Ceylon Natural History Society was held in the Colombo Museum Reading Room on Tuesday, October 22nd, 1929, at 5.30 p.m.

Dr. J. Pearson occupied the chair and there were 22 members and visitors present.

The minutes of the last general meeting were read and confirmed.

Messrs. L. H. C. Waldock and A. E. Purves were elected ordinary members of the Society.

The Chairman called upon Mr. A. H. Malpas to read his paper on the Aims and Functions of a Fisheries Department.

The Lecturer opened his subject by drawing attention to the absolute necessity for scientific research for the progress of any modern industry. He then gave an idea of the extensive area available for fishing in Ceylon waters and the abundance of food fishes, and contrasted these facts with the inadequate local supply of fish, which necessitates the importation of Rs. 12,000,000 worth of fish goods annually. This state of affairs he attributed to the obsolete craft and methods in use and to the steady decline of the fishing community. The Fisheries Department was formed to investigate the whole question of Fisheries and see what could be done to place the industry on a proper footing. The work of the Department fell under two divisions—Scientific work and Economic work. With regard to the former the first thing to be done was for the available fishing grounds to be accurately surveyed and charted and for the nature of the bottom and the quantities and kinds of fish to be ascertained. This work had largely been carried out by means of the trawl and dredge, and it had been found that, whereas the bulk of the inshore waters were unsuitable for trawling owing to the presence of rocks and corals, etc., two extensive areas, the Pedro and Wadge banks, together able to accommodate 20-30 trawlers working continuously, had been located and were being surveyed as fast as circumstances permit. Both these banks lay outside the range of the inshore fisherman so that there exists a natural barrier between his sphere of action and that of the trawler. In addition to the location and surveying of suitable trawling grounds, the Department is engaged in a faunistic survey of Ceylon waters, the object of which is to investigate the identity, distribution and relative abundance of the various food fishes, Molluscs, Crustaceans, etc. This is a slow process depending on the accumulation of statistics and facts gleaned over many years, but upon its thoroughness depends the ultimate understanding of the conditions governing the future progress of the industry. He indicated that in Eastern waters generally, next to nothing is known of the movements, breeding seasons, feeding habits, etc., of even a single species of fish, and in temperate waters, in spite of the army of investigators at work, up to the present the Plaice is the only fish that has been at all exhaustively worked out. Dealing with economic questions, it was indicated

that the activities of the Department were directed towards an investigation of the economic conditions governing the present fishing industry and an enquiry as to how such conditions can be improved and brought up to date. The principal methods of fishing at present in vogue are (1) Line fishing, (2) Drift-net fishing, (3) Seine-net fishing. The first two are mostly carried out from catamarans or outrigger canoes, and the third is worked from the shore by the aid of large punt-like boats. None of these methods as carried out by the local fishermen is really efficient owing to the small type of boats and nets employed and the small scale on which operations are carried out. The lecturer then described the existing types of organisation with regard to boats and nets, sale of fish, and refrigeration during transport, and showed that in the interests of the health of the general community, the later item calls for close examination and improvement. The question of the introduction of new methods suited to the local conditions was then dealt with, and it was shown that further development in the local industry is absolutely dependant on the adoption of a type of craft offering much greater accommodation for the working of modern appliances than the outrigger canoe. The problem is a difficult one, for such craft could not be beached like the outrigger canoe and would have to be worked from definite fishing bases offering shelter from inclement weather. The question of suitable craft had been under investigation and it seemed possible that a solution of the difficulty might be found in the adoption of small moderate-powered motor craft such as have been coming into extended use of late in European waters. From such craft, methods of fishing such as deep-sea seining, drift-net fishing and long-lining can be worked, and the lecturer indicated that the future of the Ceylon fishing industry might lie in the use of some such craft and methods, and it is hoped to experiment along these lines. In conclusion reference was made to the work of the International Council for the exploration of the sea, which was created in 1902 and has done useful work in co-ordinating the scientific work of the various bodies interested in Fisheries in European waters, and he foreshadowed a similar organisation to co-ordinate the work of the Madras and Ceylon Fisheries Departments.

A number of excellent lantern slides illustrating various phases of the work of the Department were then shown.

The Chairman, in thanking Mr. Malpas for his able lecture, pointed out that the purpose of the Fisheries Department did not end as many supposed, with the mere survey of suitable trawling areas. That was but one item of the main problem, which was the establishing of the Fisheries of Ceylon on a sound basis of development, and the major portion of the problem still lay ahead. When the Fisheries Department was first created they suffered from the limitations of an inadequate staff and equipment, and instead of plunging at once into commercial trawling which in the absence of sufficient knowledge of local condition would only have ended in disaster, they had confined themselves to investigating the Fisheries in a less spectacular way, always bearing in mind that the real problem ultimately was the building up of an efficient local industry that would not merely supply local requirements but be able to export fish goods to other countries.

The meeting terminated with a hearty vote of thanks to Mr. Malpas.

New Ceylonese Rhynchota

BY

G. M. Henry

Assistant in Systematic Entomology, Colombo Museum

WITH THREE PLATES

The three species described in this paper were amongst a collection taken to the British Museum (Natural History) for identification, in 1930. I am much indebted to Mr. W. E. China of that institution for help and advice and for naming a number of species.

Family **Coreidae**

Notobitus bambusae sp. nov. (Plate XXV)

Superficially resembling *N. mundus* Dist., but narrower and differently coloured. *General colour* black, dorsally strongly glossed with metallic green and purple iridescence. Ventral surface of head and pro-sternum dull orange; rostrum, two anterior pairs of legs, and posterior trochanters ferruginous, posterior femora and tibiae (except the distal extremities, which, with the tarsi, are dull orange) shiny black.

Head ferruginous above, orange below, with the following black marks: a minute spot at extreme apex, just above base of rostrum, parts of antennal tubercles, a large discal spot, strongly green-glossed, on vertex between eyes; the inter-ocellar area, a dorsal demi-collar and the posterior margins of the orbits. *Eyes* dark brown, *ocelli* red. *Antennae*: First and third joints equal in length, each about 5/6ths of the second, fourth longer than the second and third together. Fourth joint opaque dark brown, with fine pilosity, the rest shiny black with coarser pubescence.

The *rostrum* reaching nearly to the posterior margin of the meso-sternum; its first segment longest, second and fourth nearly equal and a little shorter than the third. The second segment is somewhat compressed and dorso-ventrally expanded.

Pro-thorax strongly punctured above and on the sides, anterior and posterior angles forming slight tubercles. *Scutellum* irregularly rugulose, slightly concave discally, its lateral margins ridged and the base slightly gibbous. Its apex is flavescent. *Hemelytra* : Corium and clavus strongly punctured, dark brown with strong green iridescence, the costal margin flavescent. Membrane brown glossed with metallic green, extending well beyond the abdominal apex in both sexes. *Meta-thoracic wings* pale brownish hyaline, with purple iridescence and with brown nervures.

Fore and mid legs ferruginous throughout, darker along extensor surface of fore femora. Each with an irregular double row of small spines on the flexor side of the femora. *Posterior legs* ♂. Femora with an irregular row of stout tubercles on dorsal surface, smaller tubercles irregularly scattered on dorso-internal surface. A discontinuous row of spines on flexor margin. Of these, the one nearest the middle of the femur is the largest, stout and curved. There are two or three small spines proximal to it and two stout, curved spines, followed by one or two small ones, towards the femoro-tibial joint. The ♂ tibia is strongly bowed outwards in its proximal half, then almost straight to the end. It is triangular in section and slightly expanded on the flexor side in the middle, at which point there is a pair of strong spines, followed by a series of smaller spines and tubercles to the end. In the ♀, the femora are much slighter than in the ♂ and the tibiae are nearly straight and less expanded medially. The same spines are present, but feebly developed. It is evident from the series before me that the degree of development of incrassation, spines, etc., in the males varies within rather wide limits, for in one male the hind femora and tibiae are but little more developed than in the females.

The *abdomen* is black dorsally, with three large, more or less confluent, dirty yellowish (pale green in life) spots on the mid-dorsal line. The connexivum is narrow, stramineous or brown, and the postero-lateral angles of segments 2, 3, 4 and 5 bear small black tubercles. Ventrally the abdomen is dark brown with an indefinite dirty yellowish band on each side.

Measurements

	♂ mm.	♀ mm.
Length of body (including membrane) ..	15·5 - 17·0	16·5 - 18·2
Width of head	2·2 - 2·3	2·3 - 2·5
Greatest width of pronotum	3·5 - 4·0	4·0 - 4·5
Length of posterior femora	8·0 - 10·0	8·0 - 9·0

Material examined :

Type and another male, and 4 females taken at Labugama Reservoir on 10.IX.26.

1 female taken at Kitulgala 13.IV.27.

1 male, 1 female taken at Labugama 22.I.30.

At both Labugama and Kitulgala the specimens were captured on wild bamboo which is probably their food-plant.

Type ♂ and *para-type* ♀ will be deposited in the British Museum (Natural History). The remaining para-types are in the collection of the Colombo Museum.

Family. Capsidae (Miridae)

Thaumaturgus pulcher sp. nov. (Plate XXVI)

Form, rather stout. *Colour*, dark castaneous, shining except for the basal 2/3rds of the corium and the clavus, which are opaque and of a slightly lighter shade than the rest of the insect. The tarsi (except tips) and third, and basal half of fourth, antennal joints are pale stramineous. The following spots of silvery white pubescence are present : one on mes-epimeron, a short oblique line on sides of basal abdominal sternites, one at basal third of costal area of corium and one close to it in clavus, a transverse row across hemelytron at posterior third of corium, forming a boundary between the lighter, opaque, and the darker, shiny portions ; one on each side of scutellum. Traces of similar silvery spots are found also near the apex of scutellum and at the extreme base of the clavus. (N.B.—The scutellar and mes-epimeral spots are present also in *T. typicus* Distant although not mentioned by him). Membrane fuliginous.

Head sparsely covered with pale pilosity, and with a row of setae along the posterior margin. *Rostrum* reaching the base of the posterior coxae. *Antennae* shortly pubescent, and the first joint with a few setae mostly on its inner side. First joint shortest, second distinctly club-shaped, third and fourth slender and together shorter than the second. *Pronotum* very sparsely pilose, bearing a strong seta on each side, anteriorly. The *femora* have a few setae towards their distal ends, and the *tibiae* bear several rows of fairly strong setae. *Abdomen* beneath pilose.

The sexes are closely similar in form, size and colour.

Measurements :

	mm.
Length	2·75
Width of head	0·75
Length of second antennal joint ..	0·8
Length of posterior tibia	0·75

This species is closely allied to *T. typicus* Distant, from which it differs in being slightly shorter and stouter, with much shorter and stouter legs and second antennal joint. The colour is not so dark and the corium is almost entirely devoid of the light golden pubescence found in *T. typicus*, which, moreover, lacks the silvery spot in the middle of the clavus.

Material examined : Five specimens (4 ♀, 1 ♂) taken in Colombo, 11.VIII.24, on the leaves of a bean plant which they were puncturing. There is a specimen of this species (coll. by E. E. Green, V. 1911) in the British Museum collection included with the series of *T. typicus* Dist. *Type* ♂ will be deposited in the British Museum (Natural History). The remaining para-types are in the Colombo Museum collection.

Family Cicadidae

Pomponia polei sp. nov. (Plate XXVII)

Colouration : Green, sullied with dark brown on head and sides of pronotal disc. Anterior area of mesonotum brownish ochraceous. The following dull black marks are present. On head, a patch which includes the ocelli and extends backwards to the pronotal margin ; on pronotum, a concave-sided, longitudinal mark which encloses a pale greenish medial streak ; and one or two oblique, oblong spots on lateral areas of posterior margin ; on mesonotum, a medial streak, expanded in the middle, extending from anterior margin to cruciform elevation. On each side of this, a stouter streak, branching inwardly, extends nearly parallel with it from the anterior end of mesonotum to about its middle ; still laterad, a pair of shorter streaks and a spot just internal to each anterior angle ; posterior to the latter, and more or less confluent with them, there is a pair of stout, oblong blotches, extending convergently backwards to the postero-lateral angles. Immediately anterior to the upper limbs of the cruciform elevation there is a round spot surrounded by a ring of golden pubescence. All these markings vary considerably in different individuals and have a strong tendency to unite with each other in various directions as appears from the small series before me. In general arrangement, they follow lines very commonly met with in the genera *Pomponia*, *Terpnosia* and their allies.

The ventral side of head and thorax is dirty green, rostrum ochraceous with a dark brown tip, opercula pale green with a narrow dark-brown edge which is darker and more pronounced on the lateral margins. *Legs* : The femora are, in general, greenish, varied with brownish lines. The two anterior pairs of tibiae are dull greenish brown, lighter on

flexor side and terminating distally in a dull orange spot. Their tarsi are dark brown. The posterior tibiae are dull orange except the proximal fifth which is dark brown, and their tarsi are dull orange. The *tegmina* are hyaline with a yellow suffusion of the membrane along the veins: basal cell orange yellow; veins orange yellow except at cross-veins, corial fold and in the neighbourhood of forkings, where they are dark brown. The costal margin is brownish green, with a bright orange-yellow spot at the median anastomosis. There are the usual brown markings found in this genus, viz., a sub-marginal row of seven spots, fasciae at each of the cross-veins, and wherever a vein passes the corial fold.

In the *hind wings*, which are less yellow than the tegmina, the veins are mainly dark brown with the exception of their proximal ends, which are greenish. The following portions are bright orange (best seen by holding the specimen over a dark background): nearly the whole of Cu, and Cu 1 b, a short length of R 4+5 proximal to the cross-veins, short lengths, distal to the cross-veins, of R 4+5, M 1, M 2+3, M 4 and Cu 1 a. There is a narrow brownish-yellow suffusion on each side of M as far as the cross-veins and a brownish lining along Cu 2 and along the 2nd and 3rd Anals. The anal lobe is traversed by seven very faint yellow vestigial veins. (N.B.—The nomenclature used is that of Comstock and Needham as modified by Tillyard).

Abdomen: Dorsally dark brown, with large, somewhat oblique, green fasciae on each side of segments 3, 4, 5 and 6. The tympanal covers and area behind them on second segment are green and there is a pale triangular mark in the postero-lateral angle of each of the 4 succeeding segments. Ventrally the abdomen is almost colourless hyaline, with the posterior margins of the sternites feebly brown-pigmented and the 7th (apparent 6th) sternite nearly black.

Vestiture. Head: Scattered, sparse, golden pile on vertex and genae: longer, more silvery pubescence behind and below eyes. Fine white pubescence on margins of frons below. Pronotum: A fringe of golden pile along anterior collar and boundaries of the pronotal lobes. Mesonotum: Silvery and golden pile lining lateral margins: golden pubescence occupying the depressions anterior and lateral to the cruciform elevation. Lateral margins of scutellum fringed with long silvery pubescence. Abdomen: The posterior margin of 1st tergite lined with silvery pile: segments 2-7 with rich golden pile, especially developed on brown-pigmented areas, *i.e.*, on anterior and posterior segmental margins. A broken band of beautiful silvery pile can be seen in profile on the dorso-lateral areas of segments 3, 4, 5, 6 and 7, and there are small patches of similar silvery pile on the postero-lateral angles of the same segments

and also on segment 2 just internal to the tympanal covers. The 2 posterior segments are more or less covered with white powdery wax.

Structural details: Head (including eyes) narrower than the mesonotum; rostrum slightly passing posterior coxae; pronotum with a distinct, small "tooth" on each lateral margin; tympanal covers broader than long, covering the tympana almost completely anteriorly and internally, but leaving them exposed laterally; opercula rounded-triangular, their inner angles overlapping markedly in one specimen, slightly in another and merely meeting in a third. Their posterior margin extending just to the margin of the 2nd sternite (apparent 1st).

The above description applies to the male. In the main it applies also to the female, which is, however, smaller in body than the male (although her wings are ,if anything, larger), and the orange-yellow in the tegmina is replaced by a sickly green (? due to fading). The vestiture is nearly the same in colour and distribution; the female specimens available, are however, too old and mouldy for satisfactory description, in spite of which, I have little doubt that they are conspecific with the males. In one of the females, the forking of M 1 and M 2 in the tegmina occurs about the level of the cross-veins instead of much proximal to this point as in all the other specimens, but this I attribute to "individual variation."

Measurements:

	♂ mm.	♀ mm.
Length of body	39 - 40	27 - 28
Width of head	9	8
Width of pronotum	10 - 11	10
Length of tegmina	44 - 45	44 - 46
Breadth of tegmina	14	13·5
Width of tympanal covers	4·75	-
Length of tympanal covers	3·75	-

Material examined: 3 males taken in jungle at Morningside Estate, Rakwana, on 8.V.29, 2 females collected in Maskeliya, "April" and "May" (no year given) by the late Mr. John Pole. The *type* ♂ and a *para-type* ♀ will be deposited in the British Museum. The remaining para-types are in the Colombo Museum.

I owe the direction of my earliest incursions into the field of Entomology to the late Mr. John Pole, whose enthusiasm as a moth collector and naturalist have seldom been rivalled, and it therefore gives me peculiar pleasure to dedicate to his esteemed memory this handsome cicada, of which he was the actual discoverer.

EXPLANATION OF PLATES

PLATE XXV

Notobitus bambusae sp. nov.

Fig. 1 ♂ × 4
Fig. 2 ♂ head and thorax in profile × 4⅓
Fig. 3 ♀ hind leg × 4
Fig. 4 ♀ dorsum of abdomen × 7

PLATE XXVI

Thaumaturgus pulcher sp. nov.

Fig. 1 ♂ × 25
Fig. 2 ♂ in profile × 25

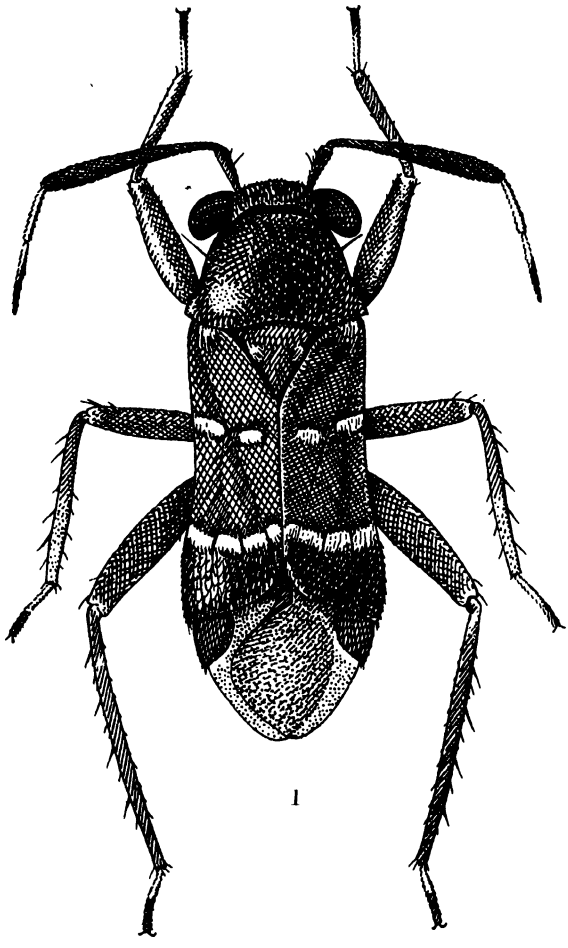
PLATE XXVII

Pomponia polei sp. nov.

Fig. 1 ♂ × 1 3/5
Fig. 2 ♂ head, ventral view × 2 2/5
Fig. 3 ♂ abdomen, ventral view × 1 3/5
Fig. 4 ♂ in profile × 1 3/5

Votobius bambusae sp. nov.

G. M. Henry del.



1

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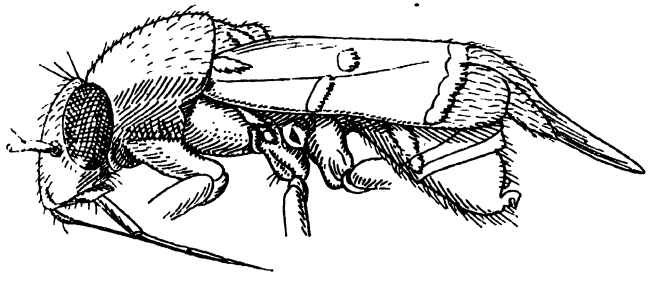


Thaumaturgus pulcher sp. nov.

G. M. Henry del.

2

3

4

1

Pomponia polei sp. nov.

G. M. Henry del

New Ceylonese Mantidae[1]

BY

G. M. Henry

Assistant in Systematic Entomology, Colombo Museum

WITH TWO PLATES

Family MANTIDAE

Sub-family IRIDOPTERYGINAE

Muscimantis[2] gen. nov.

Body very small, comparatively stout, micropterous. *Head* somewhat as in *Micromantis* but with the eyes much more prominent and sculpturing far more pronounced. A flattened (♂) or concave (♀) scutellum on vertex, bounded antero-laterally by the large ocellar tubercles and posteriorly by an obtusely angulated carina which continues beyond its limits to the eyes. On each side of vertex and posterior to the lateral angles of this scutellum there is a large tubercle set in a somewhat depressed area and the median space between these tubercles is gibbous, the gibbosity being medially slightly sulcate. The lateral sulci of the occiput are well developed, and in addition there is a pair of shallower sulci mesad to them. The ocelli are very small in both sexes and are arranged as in *Micromantis*. The frontal scutellum is transverse, with its dorsal margin slightly arched, its height a little more than 1/3 of its width. Antennae with proximal joints somewhat moniliform.

Pronotum somewhat like that of *Hapalopezella*; margins smooth, transverse sulcus very deep—especially laterally; supra-coxal expansion pronounced; prozona about 2/3 length of metazona. Middle of disc

1. I am indebted to Dr. B. P. Uvarov of the Imperial Institute of Entomology, with whom I have recently had the privilege of working, for assistance in determining the two species described in this paper.
2. Muscus (L) = moss.

of prozona strongly gibbous, as is also the middle of posterior end of metazona ; both these gibbosities slightly medially sulcate. No trace of a median carina, but instead, a slight, shallow, longitudinal sulcus.

Anterior coxae about as long as pronotum, unarmed. Anterior femora robust, their dorsal margin strongly sinuous, and, viewed from above, both sides are also irregularly sinuous. Discoidal spines three, of which the middle one is much the largest (N.B.—Some specimens have a minute, additional, proximal spine). External spines 5, averaging in length about half the depth of the femur ; internal spines (including a small apical one) 11 to 13, of which the second and the penultimate are slightly the largest, the first very small. Proximal half of interspinal disc set with small tubercles. *Anterior tibiae* with 8 external, 11 internal spines (not counting the terminal hook).

Meso- and *meta-nota* medially carinate. Tegmina very small, somewhat elongate-oval. Wings similar, but shorter and narrower. Meso- and meta-thoracic femora bearing a spine on dorso-internal side of apex ; tibiae with two apical, posterior spines and an anterior, scale-like point (as in *Micromantis*, *Hapalopezella*, etc.).

Abdomen with three rows of tuberculate processes—at the lateral and median margins of the tergites, the median series almost forming a broken carina in the proximal half of the abdomen. Supra-anal plate triangular, its apex forming almost a right angle. Cerci stout and conical, 8-jointed, not projecting beyond the sub-genital lamina in either sex.

The new genus has apparently no very near relatives, but may be placed near *Hapalopezella* Gigl.-Tos, with which its pronotal characters seem to ally it.

Muscimantis montanus sp. nov. (Plate XXVIII)

♂ Ground-colour, in life, dull green, in dried specimens dull greenish brown. The pattern is so complicated and varies so much in different specimens (due, most likely, to their respective degrees of tenerality as well as to state of preservation) that colour is rather an unsafe guide to specific determination, but the following features seem fairly characteristic of a well-coloured individual. Head, dark brown, with the following pale greenish marks : Two large blotches on clypeus ; three on facial scutellum ; blotches on ventral surface of eyes ; a broken band extending across fronts of eyes, anterior margin of facial scutellum and bases of antennae. Inner margins of eyes, occipital sulci, and the two short carinulae connecting the inner margin of the eyes with the scutellum on vertex ; blotches on juxta-ocular lobes and on occiput.

Pronotum mainly dark brown with a broad, mottled, median, greenish fascia. Fore coxae, femora and tibiae much marbled with large, bronzy-brown blotches and semi-tuberculate spots. Bronzy-brown spots on each side of meso- and meta-nota. The meso- and meta-thoracic legs are rather irregularly banded with brown in the manner shown in the figure.

The greater part of the 1st abdominal tergite is occupied by a large shiny black blotch divided by a pale line. The second and third tergites have merely small streaks and spots, but tergites 4-10 bear large triangular medial blotches of shiny, bronzy-black, each basally divided by a pale, longitudinal line, and in addition, the sides of the tergites are spotted with the same colour. Ventrally, the abdomen is greenish brown with a series of large, median, shiny-black blotches on sternites 1-7.

The head, body and limbs are very sparsely clothed with minute setae. The integument on prothorax, limbs and lateral areas of tergites is microscopically rugulose except on most of the bronzy-black marks where it is smooth and shining. The anterior femora bear 6 large, and 5 to 7 small internal spines, but the difference between major and minor spines is not very pronounced. In some specimens the number of minor spines is different in the two femora.

The female resembles the male but seems to be lighter coloured in most cases.

Measurements :

	♂ mm.	♀ mm.
Length of body, about	11·5	13·5 - 16·0
Width of head	2·75- 3·0	3·4
Length of pronotum	2·8 - 3·0	3·2 - 3·5
Width of pronotum	1·5 - 1·8	1·9 - 2·0
Length of tegmina	1·1	1·2 - 1·4
Width of tegmina	0·5	0·6
Length of wings	0·9	1·0 - 1·2
Width of wings	0·3	0·4
Length of fore femur	3·3 - 3·8	4·2 - 4·3
Length of hind femur	4·3 - 4·5	5·0 - 5·2

Material examined : 1 ♂ Pidurutalagala 20-IV-14 ; 1 ♂ Nuwara Eliya, 6-V-27 ; 1 ♂ (*Type*) Ohiya 6,800 feet, 20-IV-28 ; 1 ♀ Ohiya 6,500 feet, -IV-28 (preserved in spirit ; poor condition) ; 1 ♂ , 1 ♀ taken *in cop.* Ohiya 6,500 feet, -IV-28 (preserved in spirit) ; 2 ♀♀ Hakgala 15 and 29-VIII-29 ; 1 young larva (? ♀) Hakgala 3-IX-29 (badly shrivelled). The *type* ♂ and a *para-type* ♀ will be deposited in the British Museum (Natural History). The remaining para-types are in the Colombo Museum,

The specimens were all taken in dense mountain jungle above 5,500 feet. Most of them were captured on the masses of green moss which festoons many of the tree trunks in the montane forests, and their colouring in life assimilated very closely to the sombre green of the moss. It is probable that, as in the case of *Pezomantis* (see Uvarov, Spolia Zeylanica XIV, p.87) this species has been overlooked by collectors owing to its larviform appearance. In fact the first specimen taken by me was for years believed to be a larva, and it was only when a pair was taken *in cop.* in 1928 that they were recognised as adults.

Sub-family CALIRIDINAE

Group **Leptomantes**

Aetaella pluvisilvae[1] sp. nov. (Plate XXIX)

This species agrees in the main with the description of *A. bakeri* Hebard (Proc. Acad. Nat. Sci. Philad. LXXII, 1920, p. 45), with a para-type of which, in the British Museum, I have compared the type series. It differs, however, in measurements and in certain details of structure.

♂ *Head* as in *A. bakeri*. Eyes very large and prominent, ocelli very large, oval and set in an almost equilateral triangle. The anterior ocellus only about 2/3 the size of the lateral ones. Clypeus rather gibbous.

Pronotum slender, evenly rounded in front, very slightly emarginate at posterior border. Its edges minutely tuberculate, each tubercle bearing a small seta. The supra-coxal expansion slight, transverse sulcus fairly deep, a very slight medial carinula extending along metazona. Prozona about 1/3 length of metazona. Anterior coxae as long as metazona. Anterior femora very minutely denticulate along dorsal carina, and minutely tuberculose along the ventral carina proximal to the first discal spine. Discal spines four, of which the third is longest and about equal in length to the greatest depth of the femur. Ventro-internal spine formula rather variable as no two specimens agree exactly, and in three out of the four of both sexes before me the formula differs in the two femora; probably the normal formula is as follows: 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1; but the number of the small distal spines varies from 3 to 5, and in one specimen some of the other spines are also missing. The external spines are 5 (including a small apical one), and between the first two there is a slight depression for the reception

1. *Pluvia* (L.) = rain, *silva* (L.) = forest.

of the sixth external tibial when the limb is flexed. As in *A. bakeri*, there is a cluster of minute spinules on the ventral surface opposite to the second external.

The external tibial spines agree exactly with the description of those of *A. bakeri*. The internal tibials number 12 to 13 (not counting the terminal hook).

Meso- and *meta-nota* medially carinulate. Closed tegmina extending just beyond apex of abdomen, wings extending 2 mm. or so beyond the tegmina. Greatest width of tegmina at about 3/4 of their length from the base. Meso- and meta-thoracic legs very slender, posterior meta-tarsi about half as long again as the remaining tarsal joints together.

Cerci tapering, projecting beyond the styles by half their length, their joints almost parallel-sided.

Vestiture: The body is covered with sparse, pale pubescence, which is particularly developed along the middle line of pro-sternum, meso- and meta-sterna, meso- and meta-coxae and the posterior abdominal sternites. The tegmina and wings are minutely pubescent. The cerci and styles are rather thickly covered with brown setae.

The female resembles the male in most respects, but as in *A. bakeri*, the ocelli are much reduced and arranged in a triangle much wider than high. She is much less hirsute and lacks the fine pubescence on tegmina and wings.

The colour of both sexes in life is a delicate, bright green with none of the milky appearance noticeable in species of *Leptomantis*. The tegmina are greenish hyaline with the veins slightly darker green; wings paler except at the tips.

Measurements:

	♂♂		♀♀	
	mm.		mm.	
Length of body ..	26·0,	28·0	31·0,	31·0
Width of head ..	3·5,	3·4	3·9,	3·8
Length of pronotum ..	8·0,	8·0	10·0,	10·0
Greatest width of pronotum	1·6,	1·6	2·0,	2·0
Length of tegmen ..	17·4,	18·0	18·0,	19·5
Width of tegmen ..	—	—	4·5,	—
Length of anterior femur ..	6·9,	7·0	8·5,	8·3
Length of posterior femur..	7·8,	7·8	8·8,	8·8

Material examined[1]: 1 ♂ Ratnapura 16-IX-29 (*Type*); 1 ♀ Rakwana -V-29; 1 ♂, 1 ♀ Labugama 22-I-30. All the specimens were taken in

1. Since the above was written, three further specimens have come to hand, *viz.*, an adult ♀ and larval ♂ collected at Kitulgala in March, 1931, and kindly presented to the Colombo Museum by Mr. D. R. R. Burt; and a ♂ larva collected at Labugama on 9-3-31. Both larvae have been reared to maturity in the Laboratory, but the Labugama one is somewhat dwarfed and deformed.

jungle in the high-rainfall area to the S.W. of Ceylon's main mountain mass. The *type* will be deposited in the British Museum (Natural History). The para-types are in the Colombo Museum.

The type specimen was captured as a larva and reared to maturity in the laboratory and the Rakwana female was also kept alive for some time. While at rest the head was normally carried porrect, extended in the same plane as the prothorax, with the antennae laid flat along the back. The neck was noted to be very mobile and the insect was able to turn its head laterally until the broad axis lay parallel with the longitudinal axis of the pronotum. In this position the insect presented a singular appearance, as if its head had been attached to the side of the prothorax instead of to its end. They showed a strong predilection for resting on the under side of leaves, etc. In common with other mantises, they had a habit when excited of gently swaying from side to side.

EXPLANATION OF PLATES

Plate xxviii

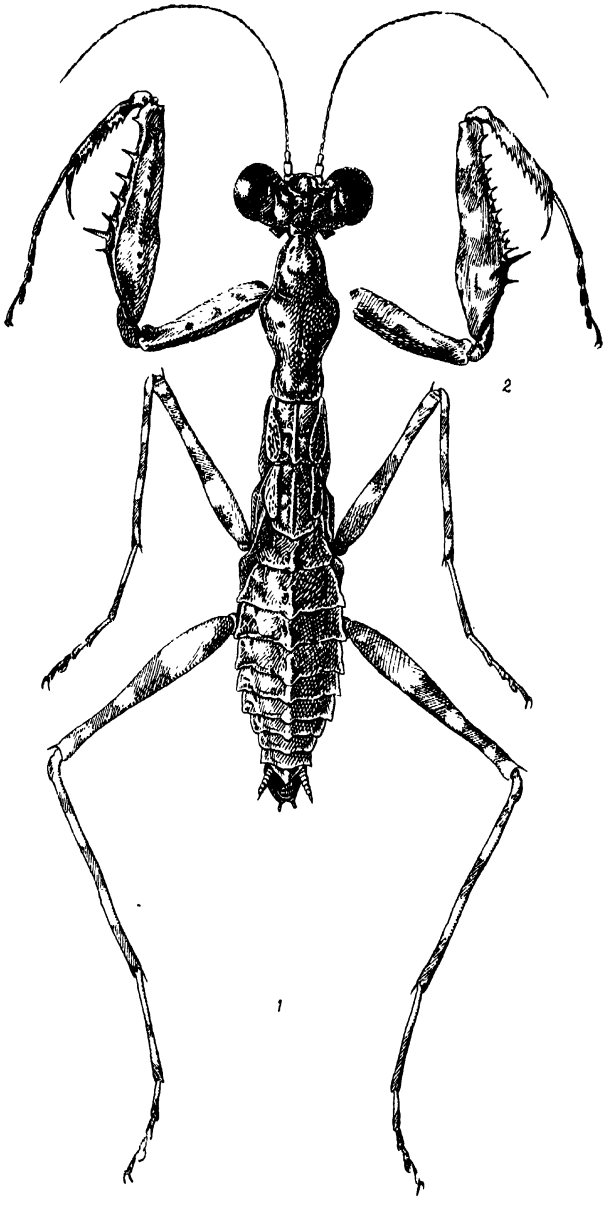
Muscimantis montanus sp. nov.

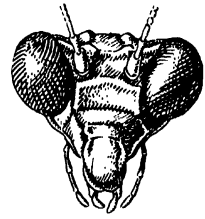
Fig. 1 ♂ × 7
Fig. 2 ♂ left fore-leg, inner aspect × 7
Fig. 3 ♀ face × 9
Fig. 4 ♂ in profile × 7

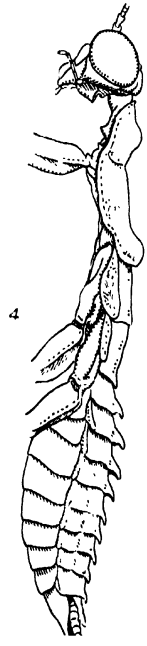
Plate xxix

Aetaella pluvisilvae sp. nov.

Fig. 1 ♀ × 3½
Fig. 2 ♀ face × 7
Fig. 3 ♂ face × 7
Fig. 4 ♀ left fore-femur, inner aspect × 7







Muscimantis montanus sp. nov.

G. M. Henry del

2A

Aetaella pluvisilvae sp. nov.

G. M. Henry del

Note on an Isopod (Mesanthura maculata) new to the Fauna of Ceylon

BY

P. Kirtisinghe, B. Sc.

WITH ONE PLATE

At the beginning of last February Mr. C. Abeyasinghe of the Botany Department of the Ceylon University College brought to the laboratory a collection of marine algae from the coral reef off Mount Lavinia. While searching for various Polychaets and Crustacea that are invariably found in such a collection I was struck by the appearance of an unsual Isopod with prominent patches of black pigment along its dorsal surface.

On examination under the binocular the characteristic nature of its tail-fan revealed that the animal belonged to the family Anthuridae. The Anthuridae are exclusively marine, living in shallow water. They do not reach a very great size, the largest recorded being 45·5 mm. in length. Body linear, cylindrical, with mouth parts in some cases modified for piercing. The exopodites of the first pair of pleopods form an operculum containing the remaining four pairs which act as gills. The uropods form a tail-fan with the telson.

With the help of an excellent key to this family by Barnard (1925) the specimen was further identified as a male *Mesanthura maculata* (Haswell). According to this key there are five species belonging to the well-defined genus *Mesanthura* Barnard. The structural differences separating the species are so slight that it is possible further investigation will show that some of the so-called species are only varieties. However, the five species recognized at present are said to be characterized by distinctive pigment patterns. In *M. maculata* the pigment in each segment conforms roughly to the shape of its tergum and there are no central unpigmented regions as in the other four species.

M. maculata has so far been recorded from New South Wales and New Zealand occurring at a depth of 0—52 fathoms. It was first described by Haswell (1881) from New South Wales. Two years later

Chilton (1883) described it from New Zealand but called it *Anthura affinis*. Except for a form described as *Paranthura miersi* by Haswell (1885) which, according to Barnard, is identical with *M. maculata*, there are no other references to this species.

Very little is known of the habits of the species, as is also true of most other species in the family. When the material in which the specimen was found was examined by me it had already been preserved in formalin. But the fact that it was gathered together with algae would confirm Chilton's opinion that it dwells in the shelter afforded by these plants.

Length of specimen 5 mm.

LITERATURE

BARNARD, K.H. (1925). "A revision of the family Anthuridae, with remarks on certain morphological peculiarities." *Journ. Linn. Soc. Vol. XXXVI, p. 109.*

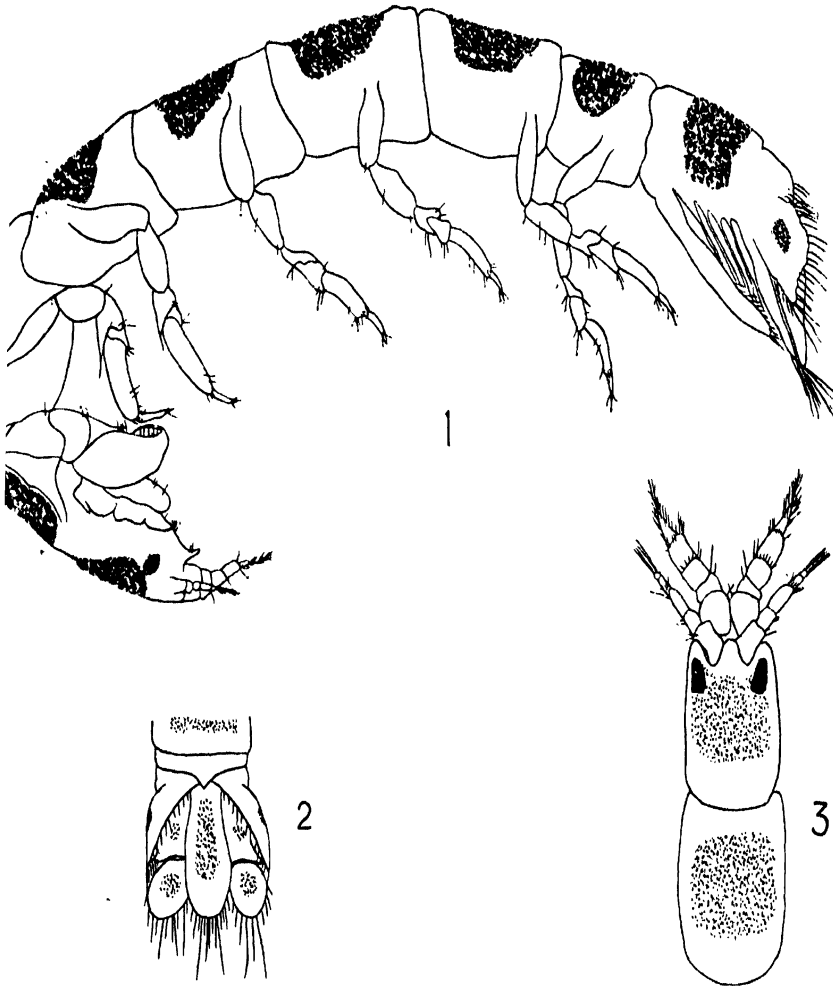
CHILTON, C. (1883). "Further additions to our knowledge of the New Zealand Crustacea." *Trans. N. Z. Inst. Vol. 15, p. 72.*

HASWELL, W.A. (1881). "On some new Australian marine Isopoda." *Proc. Linn. Soc. N.S.W. Vol. V. p. 476.*

(1885). "A revision of the Australian Isopoda." *Proc. Linn. Soc. N.S.W. Vol. IX. p. 1011.*

EXPLANATION OF PLATE XXX

Fig. 1. *Mesanthura maculata* (Haswell) (side view). × about 40.
Fig. 2. Tail-fan. × about 25.
Fig. 3. Head and antennae, with first thoracic segment (dorsal view) × about 50.



Mesanthura maculata

Further Notes on the Anguilliform Fishes of Ceylon

BY

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Second Assistant Marine Biologist, Department of Fisheries

WITH TWO PLATES

I. A NEW GENUS OF MURAENIDAE (Plate XXXI)

The family Muraenidae appear to have diverged furthest from the original Apodal stock having lost their pectorals, while in some even the single fins are vestigial.

In a previous paper[1] the writer described the presence of sub-dermal bony scutes in the eel *Echidna zebra* (Shaw) of which three specimens were examined. On further consideration it is proposed to establish a new genus intermediate between *Echidna* Forster and *Uropterygius* Ruppel, for this species.

As the Fisheries collection contained only *Echidna nebulosa* (Ahl) and *Echidna delicatula* (Kaup) for comparison, Mr. J. R. Norman of the British Museum was consulted and the following opinion was very kindly given by him :—

" With regard to the Echidna species, I quite agree that *E. zebra* is worthy of subgeneric or even generic rank. I have examined examples of *E. catenata*, *E. delicatula*, *E. polyzona*, *E. nebulosa*, and *E. xanthospila*, but do not find the osseous plates in any of them."

Apart from this important feature *Echidna zebra* is the only member of the genus which has the head and body twice as long as the tail or longer. In none of the other species does it exceed 1·3 times the tail length. The fins of this form are low and thick being somewhat akin to the condition in the genus *Uropterygius* Ruppell, in the other species the fins are prominent. In *Echidna zebra* the posterior nostrils are tubate and all the teeth are flat and button-like, whereas in the others the posterior nostrils are simple holes and some teeth are usually conical.

1 P. E. P. Deraniyagala—" Some Anguilliform fishes of Ceylon, " Ceylon J. Sc. (Sect. B), Vol. XV, Pt. 1.

In view of these five salient differences it is proposed to place this form in a new genus for which the name Arndha[1] is proposed.

The characters of the new genus are as follows :—

Arndha gen. nov.

Head and body twice as long as tail or longer. Head thick and blunt. Body elongate, sub-cylindrical, tail strongly compressed with bluntly rounded outline. Skin thick. Anterior nostrils tubes on top of snout, posterior ones also tubate[2] but shorter and above front of eye. Gape extends far behind eye which is small and sub-cutaneous. Fins very low and thick, best developed on tail, pectorals absent. Origin of dorsal ahead of gill opening, the fin rays very short anteriorly, longer posteriorly, all thickly invested in connective tissue. Teeth all flat and button-like, arranged in pavement formation, feeble on maxillaries, strong on intermaxillary plate and vomerines, both these groups being broadly united. Two interfitting rows of sub-dermal, lateral, osseous scutes. One row above lateral line, the other below and best developed on tail. *Vide* Plate XXXI, fig. 1 dissection of tail, fig. 2, internal view of scute. Type *Arndha zebra* (Shaw)

2. THE GENUS CALLECHELYS

This is a genus of Ophichthidae with posterior nostrils as slits in upper lip, tail somewhat longer or shorter than head and trunk, origin of dorsal in front of gill opening and with the pectorals absent or as vestigial filaments.

In 1901 Jordan and Snyder formed the new genus *Chlevastes*, in Apodal fishes of Japan—Proceedings United States National Museum, Volume 23—to receive the forms with vestigial pectorals and defined *Callechelys* as " Pectoral fin wanting." It is now seen that the absence of the pectoral is not a constant feature. While generally absent in some cases a vestigial filament may be present on one side in individuals of the same species, as was seen on examining *Callechelys longipinnis* (Kner et Steindachner).

Hitherto *Callechelys* does not appear to have been reported from Ceylon or Indian waters. Three specimens sent to the British Museum appear to be *Callechelys kirki* (Günther), *C. longipinnis* (Kner et Steindachner) and *C. marmoratus* (Bleeker).

1 *Arndha* (Sinhalese)—eel.
2 See Ceylon J. Sc. (Sect. B), Volume XV, Plate III, fig. 3.

Callechelys longipinnis (Kner et Steindachner)

Sphagebranchus longipinnis (Kner & Steindachner) Sitzgsber. Ak. Wiss. Wien. 1867.

Jaws overshot, snout conical with three large pores on each side dorsally. Gape small, reaches just behind eye. A blunt protuberance between anterior nostril which is a short tube and posterior nostril which is a slit in upper lip ending under front margin of orbit. Origin of dorsal midway between anterior edge of eye and gill cleft which is wide, lateral and vertical; pectorals usually absent. In one specimen left gill cleft with a small fleshy papilla on its upper hind edge probably a vestigial pectoral fin. This would denote that the genus *Chlevastes* Jordan and Snyder, is covered by the definition of *Callechelys*. Dorsal and anal fins rather low.

Colour : Olive brown dorsally, yellow ventrally.

Measurements : Snout 1·8 times eye, eye 16·4 in head. Gape 5·4 in head, dorsal fin on head is 2·2 in head. Head 11·36 in head and body and 10·3 in tail, depth 55·56 in entire length. Head 41 mm., trunk 425 mm., tail 423 mm., vestigial pectoral papilla 0·5 mm.

Teeth : Uniserial on jaws and palate. None on intermaxillary plate.

Distribution : An estuarine form. From the mouth of the Kelaniganga, Colombo, and from the Tamblegam Lagoon at Neerodumunai in the Eastern Province.

Ceylon, Samoan Islands.

Callechelys kirki (Günther)

Ophichthys kirkii Günther, Cat. Fish. Brit. Mus. Vol. VIII, 1870

Jaws overshot, snout conical with two or three large pores on each side dorsally; gape moderate, the small eye located over its middle. Anterior nostrils tubate, posterior ones slits in upper lip ending under mid eye. Origin of dorsal midway between angle of mouth and gill opening which is of medium size and lateral. Dorsal and anal fins rather low extending almost to tip of tail.

Colour : Brownish olive dorsally, pale yellow sides and belly.

Measurements : Snout 3 times eye, eye 19 in head, gape 4 in head, dorsal fin on head is 3·4 in head length. Head 9·8 in head and body and 10·3 in tail, depth 64 in entire length. Head 35 mm., trunk 308 mm., tail 375 mm.

Teeth : Uniserial on jaws and palate, a cluster of three or four on intermaxillary plate between the tubate anterior nostrils.

Distribution : One specimen taken on Pedro Banks 7.1.1926, deposited in British Museum.

Ceylon, Rovuma Bay (East Africa).

3. FIN CHANGES IN MORINGUA MACROCHIR (Plate XXXII)

In the family Moringuidae the low dorsal and anal fins are restricted to the tail, and interrupted in the middle where there are no visible fin rays. It is now discovered that the loss of these mesial rays as seen in *Moringua macrochir* Bleeker is due to age, the fins being normally developed and continuous in the young. The adult of this species is about 200 mm. long and is essentially estuarine, being common in the Negombo Lagoon, but appears to spawn in the ocean, as seen from the three young specimens obtained on Wadge Bank (Lat. 8 °20′ N, Long. 78 °12·3 E.) at a distance of 9·3 miles from land. The specimens were taken at night, October 23, 1927, in a dip net as they swam at the surface of the sea which was 13 fathoms deep.

The descriptions and measurements of specimens are as follows :—

(1) The youngest (Plate XXXII, fig. 1) was proportionately finer in body depth and with a smaller pectoral fin than the other two. The anterior nostril was one and a half orbits in advance of the posterior. The origin of anal was two-thirds of a head length behind cloaca. The dorsal and anal were of moderate height and continuous along tail and confluent with caudal which was large and rounded. Teeth uniserial. Head 13 mm., pectoral 0·9 mm., snout to cloaca 93 mm., tail 41 mm., depth 2·8 mm.

(2) The next stage (Plate XXXII, fig. 2) was thicker in body depth and with a larger pectoral fin. The anterior nostril was half an orbit in advance of the posterior. The origin of anal was half a head length behind cloaca. The dorsal and anal had well developed rays anteriorly and very short median rays ; the fins were very low mesially. The caudal fin was truncate. Teeth uniserial. Head 15·9 mm., pectoral 2·8 mm., snout to cloaca 94 mm., tail 43 mm., depth 3·8 mm.

(3) The oldest stage (Plate XXXII, fig. 3) resembled the previous one in depth, location of nostrils and origin of anal. The dorsal and anal fins had lost their median rays while that portion of each fin was vestigial until near the caudal where the rays persisted unchanged. The caudal was gently emarginate. Teeth uniserial. Head 16·5 mm., pectoral 2·9 mm., snout to cloaca 94 mm., tail 45 mm., depth 3·9 mm.

Thus it would appear that in *Moringua macrochir* Bleeker, the pectorals increase slightly in size. The dorsal and anal lose their mesial rays while the anterior half of each becomes lobulate. Later in life these lobes decrease in height. The caudal is first rounded, then truncate, then gently emarginate and in the adult is again truncate or rounded.

4. ELVERS OF ANGUILLA ELPHINSTONEI

Ceylon elvers belong either to the level finned species *A. bicolor* Mc Clelland, and *A. spengeli* Weber, or to the unequal finned *A. elphinstonei* Sykes in which the dorsal overlaps the anal by more than half a head length. The migration of the level finned elvers has been worked out already *vide* Deraniyagala, 1929, Ceylon Journal of Science, Volume XV, p. 8, but information concerning the large, unequal finned species has accumulated but slowly.

On November 13, 1928, four pelagic elvers of this species and five level finned elvers were taken at the surface between 9 and 11 p.m. on the pearl banks 12·87 kilometres from the mainland. Location Lat. 8°. 25·8′ N. Long. 79°·42·5 E. In the former the gape ended under mid eye, the dorsal overlapped the anal as in the adult and rudimentary pigment was present on the tail as a single row of rather widely spread stellate melanophores which extended anteriorly from the dark caudal fin, half way or entirely down the lateral line of the tail only.

The presence of pigment in these pelagic elvers suggests that they have travelled some distance at sea after metamorphosis and Dr. Anton Brunn of Copenhagen, who has examined the above mentioned specimens in conjunction with Dr. Johannes Schmidt, writes: "The interesting thing is, that they are not the very youngest stages of elvers, as we find them at the coasts of Europe. They have got more pigment than a single patch at the tip of the tail; that is to say, they have migrated some distance at sea after the metamorphosis. It should be very interesting to know if you ever get these very youngest stages in Ceylon waters, or if you may get them in some places and not in others; at least they have not been found in the rich collections of elvers hitherto made by you."

On November 3, 1930, a single elver of *A. elphinstonei* was taken from under a stone in the Beirai Lake at the lock gates which shut out the lake from the Colombo harbour. This elver had the gape ending under the posterior third of eye and was more pigmented than the pelagic specimens, but smaller. A single row of stellate melanophores extended anteriorly along the lateral line, but the melanophores were closer to each other than in the pelagic ones. They became remote from each other anteriorly near the cloaca and were represented by two or three isolated ones on the posterior quarter of the body. The rest of the body was unpigmented laterally. Similar large stellate melanophores were present on top of the head, while smaller and fainter stellate melanophores lay as a narrow vertebral band on the body and spread down the sides between the myomeres of the tail to the lateral line. There were no contracted melanophores as in level finned

elvers. Pigmented elvers 68 mm. in length and longer were also taken at Digela, Kehelwatta between Panadura and Moratuwa in October, 1927.

Hence for a certainty the months of migration of the elvers of *Anguilla elphinstonei* are October and November. It is probable that these are the months of maximum migration but that the process continues throughout the year as in the level finned eels, especially after heavy rainfall when the catches of level finned elvers is best. The increased advance of fresh water currents into the sea after rain appears to be helpful to the elvers which appear positively rheotropic in their quest of fresh water and land, whereas the adults seize this opportunity to migrate seaward. (See Ceylon Journal of Science, Vol. XV, p. 3).

The elvers of *Anguilla elphinstonei* are evidently strictly nocturnal in their migrations and descend to the bottom at dawn and hence escape capture, whereas the level finned elvers keep at the surface for an hour after sunrise and are taken in the dip net at Colombo, on the harbour side of the lock gates where they congregate after following the out-flow of fresh water from the Beirai Lake into the sea.

The dimensions in millimetres of the pelagic elvers and aquatic elver of *Anguilla elphinstonei* are :—

	Length.	*Head.*	*Head and trunk.*	*Overlap of dorsal.*
Pelagic elvers.	56	6·2	21·5	6·5
	55·5	6	20	6
	55·4	6	21·5	6·8
	55	6·1	21	5·9
Aquatic elver.	54	5·8	19	6

In conclusion it appears that metamorphosis of Ceylon Anguillidae occurs far from land, and that the migratory months of *A. elphinstonei* are the same as for the other Ceylon species. This form is probably more nocturnal in its habits. The young diminish in size as in other Anguillidae. The chief pigment in this form is a single row of stellate melanophores which extends anteriorly along the lateral line from the tail and a vertebral band of smaller stellate melanophores. These increase numerically and extend downward laterally, especially along the myomere interspaces. The gape shifts backwards from being under the eye, but the length of dorsal fin, which is in advance of the anal, does not alter. (See measurements of elvers and young eels in my previous paper in this Journal—Vol. XV, Pt. 1.)

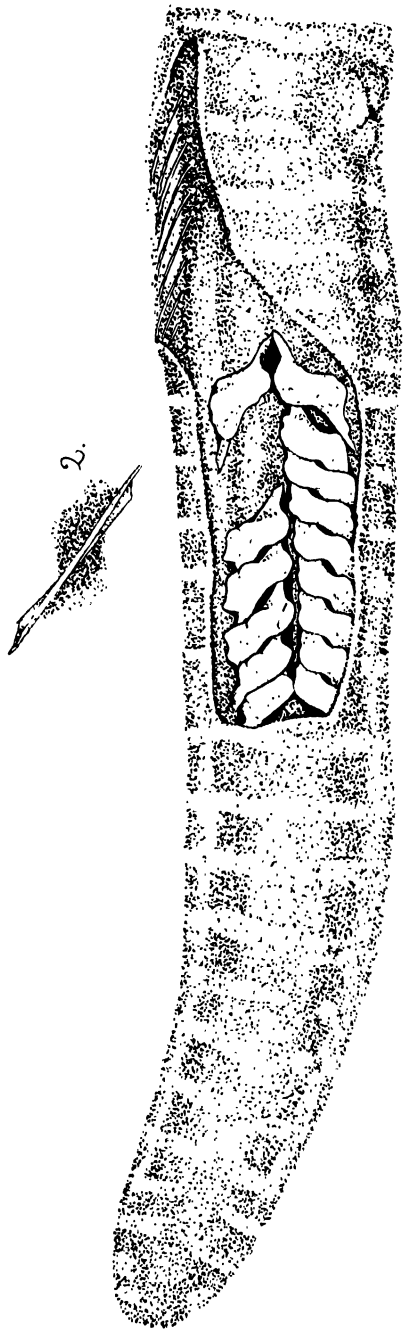
EXPLANATION OF PLATES

PLATE XXXI

Fig 1. Dissection of tail of *Arndha zebra* showing bony plates.
Fig. 2. Internal view of a plate.

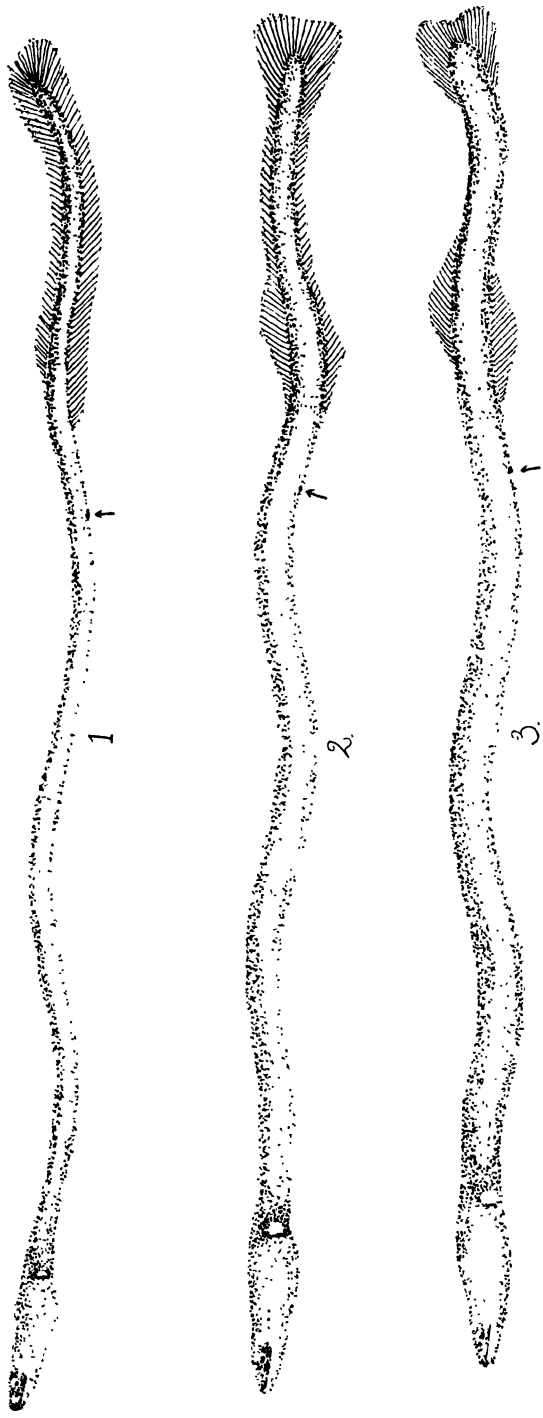
PLATE XXXII

Fin change in *Moringua macrochir*
Fig. 1. First stage
Fig. 2. Second stage
Fig. 3. Third stage



Arndha zebra (Shaw) gen nov.

P. E. P. Deraniyagala del.



Moringua macrochir

P. E. P. Deraniyagala del

Some Ceylon Lizards

BY

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Second Assistant Marine Biologist, Fisheries Department

WITH SIX PLATES

INTRODUCTION

This paper deals with all known Ceylon lizards other than the Gekkonidea. Although the lizard fauna of Ceylon is broadly akin to India, it shows several generic links with Madagascar and the East Indies which are unknown to India, and a number of genera are peculiar to Ceylon. To the already known list of Ceylon lizards is added one species new to Ceylon denoted by an asterisk, while two forms here described have not been examined by the writer and where such is the case the reader is informed of it in the description. Sinhalese (S.) and Tamil (T.) names of each species are given where known.

The writer acknowledges his indebtedness to Mr. H. W. Parker of the British Museum for his kindness in permitting him to examine several type specimens and for comparing several specimens with those in the British Museum collection and to Dr. Thomas Barbour of the Museum of Comparative Zoology, Harvard, U.S.A., for help in deciding some questions of priority. He also thanks that generous and enthusiastic collector, Mr. W. W. A. Phillips, for a splendid collection from Gammaduwa, Mr. E. D. Muthettuwegama of the Forest Department for a fine collection from the Puttalam District, Mudaliyar J. E. Perera for another from Veyangoda and Mr. D. A. Obeyesekere for a representative collection from Dikkanda near Gampaha.

Classification of Ceylon Lizards

Suborder *Sauria*

Superfamily *Gekkonoideae*

fam. *Gekkonidae*

Superfamily *Iguanoideae*
fam. *Agamidae*
Superfamily *Rhiptoglossoideae*
fam. *Chamaeleontidae*
Superfamily *Lacertoideae*
fam. *Lacertidae*
Superfamily *Platynotoideae*
fam. *Varanidae*
Superfamily *Scincoideae*
fam. *Scincidae*

Suborder **SAURIA**

Quadrate free distally, temporal arcades one or none. Teeth not in alveoli. Ribs single-headed. Eyelids and ear opening usually distinct. Tongue bifid or nicked. A paired copulatory organ. Cloacal opening a transverse slit. Four limbs usually present, may be vestigial or absent. Clavicle present when there are limbs. Sternum present. Integument scaly, with or without osteoderms.

Key to Families of Ceylon Sauria

A — Eyelids immovable .. .. *Gekkonidae*
B — Eyelids movable
α — Femoral pores absent
1. Tongue with an anterior nick
a. Tongue villose, body compressed
(1a) feet ordinary. *Agamidae*
(1b) feet zygodactylous *Chaemeleontidae*
b. Tongue with imbricate papillae, body depressed .. *Scincidae*
2. Tongue deeply forked .. *Varanidae*
β — Femoral poros present .. .. *Lacertidae*

Family **Agamidae**

Supratemporal fossa of skull not roofed over. Nasals distinct. Six cervical vertebrae. Dentition acrodont, teeth usually differentiated into incisors, canines and molars. Body compressed, dorsinuchal crest usually present. Tongue short, thick, slightly nicked, villose. Throat with or without a distensible, compressed gular sac. Tympanum exposed or subdermal. Limbs well developed, usually without femoral pores. Tail long, compressed or rounded. Arboreal or subarboreal. Capable of rapid and varied colour change. Reproduction ovoviviparous or oviparous with hard or soft shelled ellipsoid eggs.

Key to genera of Ceylon Agamidae

A. — Tympanum subdermal
  (a) Dorsal crest developed
    1. Supraciliary ridges simple, tail rounded *Cophotis*
    2. Supraciliary ridges end in points, tail compressed .. *Lyriocephalus*
  (b) Dorsal crest rudimentary
    1. Elongate rostral appendage .. *Ceratophora*
    2. No rostral appendage .. *Otocryptis*
B. — Tympanum distinct
  (a) 4 toes on hind foot .. .. *Sitana*
  (b) 5 toes on hind foot .. .. *Calotes*

Genus **SITANA** Cuvier

Tympanum exposed. Body nearly rounded, male with large gular sac, no gular fold. Scales unequal. Dorsal crest rudimentary, on neck only. Hind limbs with 4 toes. No femoral pores. Reproduction by soft shelled eggs. A single species.

Sitana ponticeriana Cuvier

Sitana ponticeriana Cuv. Règne. An. Edn. 2. ii, 1829.
Pulli bim katussa, Välli katussa (S.)

Snout acuminate, eye opening moderate. Gape extends well beyond orbit. Loreal space concave. Ear somewhat smaller than eye opening, 6 scales behind eye. Gular sac large with projecting, elongate scales, its base extends from chin along the anterior third of trunk, absent in female. Supralabials and infralabials nine. A row of enlarged scales two rows beneath infralabials usually present. Supraciliaries large, compressed with carinate outer edge. Body scales unequal, unicarinate. Dorsals in eleven longitudinal series, as large as ventrals and larger than laterals which have a few enlarged single scales. 50 scales round midbody, 30 scales from axilla to groin. Heel of adpressed leg reaches angle of jaw. Five toes on hand, four on foot. Tail round, slender with subequal, carinate scales and is 1·5-2·5 times length of head and body. When regenerated at times it ends in a tuber-like bulb. *Otocryptis* shows similar regeneration.

Colours: Male darker than female. Inside of mouth blue. Dorsally brown with five diamond shaped black marks in a single row from neck to hips. A yellow lateral band. Sides brown. Gular sac has orange or pink centre with a pale yellow or white outer margin and a lilac blue carina. Three dark bands across interorbital space. A few reddish brown rings on limbs and about 20 such on tail. Ventrally white

Food : Insects.

Reproduction : Three ovigerous females from Chundikulam on October 9, 1927, contained six to seven eggs which were 10 by 6 mm. Similar specimens from Point Pedro, October 9, 1927. An abundance of newly hatched young at Trincomalie, October 14, 1928.

Dimensions : (Male) head and neck 23 mm., axilla to groin 19 mm., tail 120 mm., leg (to heel) 30 mm., arm (to wrist) 15 mm.

Distribution : A purely ground dwelling form, living in burrows and found in dry areas of the low-country. It comes out to bask on the sand which is unbearably heated by the midday sun, runs with great celerity over short distances and finds refuge in its burrow or under scrub. When excited it distends and contracts its gular sac very rapidly several times in succession, producing the appearance of flickering sparks of light.

Chundikulam, Pt. Pedro, Tunukai, Mannar, Mankulam (N.P.), Mullaittivu, Kumana, Trincomalee (E.P.), Puttalam, Bathuluoya (N.W. P.), Palutupana, Pallaipothana (S.P.)

Ceylon, India.

Genus **OTOCRYPTIS** Wiegmann

Tympanum subdermal, male with large gular sac, no gular fold. Scales unequal, dorsinuchal crest rudimentary and present on nack only. Legs much longer than arms, fifth toe short, equals or shorter than first toe. No femoral pores. Tail long, rounded. Two species—one in India, the other in Ceylon. Reproduction by soft shelled eggs.

Otocryptis bivittata Wiegmann

Otocryptis bivittata Wiegmann, Isis, 1831
Kälä katussa, *Yak katussa*, *Pinun katussa*, *Thälli katussa* (S.)

Snout bluntly acuminate, orbit large, eye aperture moderate. Gular sac large extends from chin to half way down trunk, absent in female. 25 scales in mid gular line, 54 in midventral line from throat to cloaca. Supralabials 9-12, infralabials 8-11. A row of about 10 enlarged scales below infralabials on each side. Canthus rostralis straight, prominent, composed of carinate, compressed scales. An interorbital series of enlarged scales form a "U" shaped pattern remaining interorbital scales small. Body scales carinate, unequal and larger dorsally. Lateral scales small with patches of enlarged scales. Ventrals uniform, carinate and nearly as large as dorsals. Limbs with large subequal, carinate scales. At times a shallow pit in front of

shoulder. Heel of adpressed leg reaches tip of snout or slightly beyond, wrist of arm reaches eye. Twenty-five double rugae under fourth toe, three on fifth and five on inner toe. Tail rounded, fine, 2·5-3 times length of head and body. When broken, at times regenerates a terminal tuberous bulb covered with carinate scales.

Colours: Green interchangeable with chocolate. Males darker than females. Male has a silvery grey or cinnamon vertebral band with five black spots in it from nape to hips. Sides uniform chocolate or reticulated with darker. A black light-edged cross band over eyes and a spot near tip of snout. A light band from eye to angle of mouth. A dark band from jaw to shoulder. Iris yellow. Limbs crossed by 4 or 5, tail with 14 light brown bands. Gular sac green marked with a red blotch having a black centre. Ventral colour pale brown.

Food: Insects, grubs, tender shoots.

Reproduction: A female taken at Kandy, January, 1928, had four mature eggs 14 mm. by 7·5 m. A female from Kantalai laid 3 white leathery, ellipsoid eggs on October 22, 1928. A female taken at Gammaduwa, July 25, 1930, contained 4 mature eggs.

Dimensions: Male, head and neck 27 mm., axilla to groin 25 mm., tail 150 mm., leg (to heel) 52 mm., arm (to wrist) 21 mm.

Distribution: Essentially a ground living form preferring the neighbourhood of shady forest streams. When frightened it progresses in leaps and at times rises on its hind limbs and runs. When persistently pursued it occasionally ascends shrubs from which it soon descends. Found in the low-country and in the hills.

Yakvala (W.P.), Kandy, Peradeniya, Gammaduwa (C.P.), Maha Oya, Kantalai, Kumana (E.P.), Nambapana (Sab. P.)

Ceylon.

Genus **CERATOPHORA** Gray

Anga katussa (S.)

Tympanum subdermal. An elongate rostral appendage larger in males. Body somewhat compressed with unequal scales. Dorsinuchal crest on neck only and rudimentary. No gular sac or fold. No femoral or preanal pores. Tail slightly compressed distally. Reproduction by soft shelled eggs.

Ceylon.

Key to species of Ceratophora

A.—Gular scales larger than ventrals

1. Rostral appendage conical, smooth .. *C. stoddarti*
2. Rostral appendage compressed, scaly .. *C. tennenti*

B.—Gular scales smaller than ventrals .. *C. aspera*

Ceratophora stoddarti Gray

Ceratophora stoddarti Gray, Ill. Ind. Zool II. 1835

A conical, elongate rostral appendage having three or four ridges, lateral scales large and unequal, pointing upwards and back. Tail somewhat compressed distally. About 16 large and 21 small scales near midgular line about 55 to 60 scales in midventral line from throat to cloaca, 45 to 50 round midbody. Canthus rostralis straight or gently concave in outline. Interorbital space concave. One or two low conical bumps on postorbital part of head. Rostral appendage as long as two-thirds of snout in adult male but is short or absent in female. It is encased in three or four conical dermal thecae which are superimposed. Cephalic scales small, irregular, carinate or tuberculate; those on snout with sharp margins. A short occipital ridge on each side. Nostril in a large circular scale over third and fourth supralabials. 10-12 supralabials; 9-11 infralabials each with a row of 6-8 pores. Gular scales smooth, large, rhombic, arranged in regular series small on median gular line. Dorsal scales small, faintly carinate, irregular and unequal, laterals large, strongly imbricate and interspersed with smaller scales. Lateral scales run in an arc from shoulder to midbody. The lower two or three rows larger than the superior ones. Ventrals uniform, small, smooth. Caudals larger, subequal, carinate, ventrally. Limbs with unequal faintly carinate scales dorsally. Third and fourth fingers equal, outer toe longer than inner. Palms and soles finely granular. Toes of adpressed leg reach angle of jaw,. its heel reaches axilla.

Colours: Green with three or four oblique brown bands on sides and a broad vertebral band of cinnamon replaceable by green. Rostral appendage, throat and lips white, changeable to chocolate. A white streak behind eye and another on side of neck which is changeable to yellow. A dark line from under eye to above shoulder. The lower row of lateral scales at times yellow. Ventrally pale grey. Limbs and tail with rings of dark brown. A yellow ring at elbow and knee.

Reproduction: Four soft shelled eggs obtained by Willey at Hakgalla (C.P.) in January. (Willey, 1906.)

Dimensions: Head 28 m., rostral appendage 14 mm., snout to axilla 42 m., axilla to groin 37 mm., snout to cloaca 80 mm., tail 151 mm., leg (to heel) 43 mm.

Distribution: A mountain form. Subarboreal spending much of its time on the ground in search of insects and worms.

Nuwara Eliya, Hakgalla, Hevahetta, Dimbulla (C.P.).

Ceylon.

Ceratophora tennenti Günther

Ceratophora tennenti Günther, Tennent's Nat. Hist. Ceylon, 1861

A fleshy compressed rostral appendage, lateral scales equal and pointing upwards and back. Tail somewhat compressed distally. Eighteen to twenty-three scales in midgular line, fifty-two to fifty-eight in mid ventral line from throat to cloaca, forty-two to forty-three scales round midbody. Canthus rostralis faintly concave, composed of about eleven, somewhat compressed, imbricate, scales, interorbital space faintly concave. A conical bump over posterior corner of eye, best marked in young. Rostral appendage as long as snout in male ; thick, fleshy, compressed, covered with rows of large, blunt, irregular, low scales set amongst numerous smaller, the tip covered with a large bluntly conical scale. There are five or six large scales between this terminal scale and rostral scale. Outline of appendage elliptical in side view.

Cephalic scales small, irregular, carinate, supraoculars markedly enlarged in young. Two low occipital ridges. Nostril in a large oval scale over first or second supralabial. Supralabials and infralabials eleven, each scale with a row of five to ten pores. Three or four bluntly conical enlarged scales behind eye. Gular scales large, faintly carinate forming regular series which increase in size toward angle of jaw and are small at midventral line. Dorsinuchal crest low, consists of finely pointed small scales which extend to above shoulders. Dorsal scales irregular, the larger faintly carinate, laterals large, smooth or faintly carinate, in regular oblique rows descending gradually from shoulder to groin. Ventrals carinate, small, subequal. Caudals carinate, subequal as large as laterals. Limbs with subequal scales which are carinate dorsally. Adpressed heel reaches axilla, toes feebly bicarinate, palms and soles finely granular. Third and fourth fingers nearly equal, fourth toe longer than third.

Colours : Dorsally greyish yellow with a median row of seven or eight elongate brown spots. Two brown cross-bars connect eyes. A white band runs from eye to angle of jaw. Sides and tail darker grey, limbs with two or three dark cross-bars on a grey background. About twelve broad dark bands on tail. Ventrally lighter. The grey is replaceable by a bright green.

Reproduction : The young have a square head which resembles *Otocryptis*.

Dimensions : Male. Rostral appendage 6 mm., head 26 mm., axilla to groin 38 mm., head and trunk 80 mm., tail 137 mm., leg to heel 40 mm.

Distribution: In mountain regions above 3,000 feet. A rather slow moving form living on the moss covered trunks of trees. Frequently descends to feed on earthworms and insects.

Nuwara Eliya, Gammaduwa (C.P.).

Ceylon.

Ceratophora aspera Günther

Ceratophora aspera Günther, Rept. Brit. Ind. 1864

A small lizard with a very rugose exterior and an ill-defined collar of small scales, rostral appendage, carried horizontally. 27 scales in mid gular line. 52 scales in mid ventral line from throat to cloaca. 10-12 supralabials. 9-10 infralabials. Canthus rostralis of prominent carinate scales. Head with 6 short prominences on occipital area. Rostral appendage well developed in male and as long as eye and snout, rounded, conical surrounded by strongly carinate scales; a marked depression between orbits and appendage; 11 scales from rostral scale to tip of appendage where it is scaleless and fleshy with 6 converging ridges. Rostral appendage of female shorter and has only 6 such scales and equals snout in length. Dorsilateral scales directed straight back anteriorly, back and down posteriorly, faintly carinate with clusters of 2 or 3 enlarged, trihedral scales interspersed. Ventral scales larger than gular scales, uniform and strongly carinate. Head scales irregular, tuberculate. Nuchal crest absent. Limbs with carinate unequal scales, digits strongly carinate. Fifth toe shorter than third. Tail rounded, covered with strongly carinate scales.

Colours: Female, a bluish grey vertebral band with 4 diamond shaped black blotches and 3 longitudinal fine wavy dark lines on each side. A grey diamond shaped patch on snout. Sides dark cinnamon with 2 or 3 fine wavy dark lines. Posterior edge of hind limbs black. Throat orange brown. Belly brown. A white ring on upper arm and on fore-arm; 10-12 broad brown bands on tail separated by narrow, lighter interspaces.

Male darker; diamond marks indistinct. Throat orange. A white spot on gular region, upper lip orange, inside of mouth blue. Vertebral band greenish brown.

Dimensions:—

	♂	♀
Rostral appendage	7 mm.	3 mm.
Head	11	12
Axilla to groin.	15	16
Snout to cloaca	31	35
Tail.	44	45

Distribution : A mountain form, essentially ground dwelling. Slow moving and found amongst fallen leaves in jungle.

Ratnapura (Sab. P.), Udugama (C. P.).

Ceylon.

Genus **LYRIOCEPHALUS** Merrem

Canthus rostralis trenchant and produced into the supraciliary ridge which ends as a sharp point. Adult with a rostral knob. Tympanum subdermal. Gular sac developed as is the V-shaped gular fold. Scales small with a few rows of large ones. Dorsinuchal crest moderate. No femoral pores. Tail compressed. An arboreal form. Reproduction, hard shelled eggs. A single species. Ceylon.

Lyriocephalus scutatus (Linné) Plate XXXIII

Lacerta scutata Linné, Syst. Nat. i. 1776. Edn. 12.
Karamal Bōdiliya, Kandhu Bōdiliya (S)

Snout with a rostral knob in adult which is larger in the male than in the female and covered with smooth subequal scales. Canthus rostralis of 14-17 compressed scutes, prominent and continued as a compressed supraocular ridge ending in a distinct horn-like prominence above hind end of orbit. A pair of blunt spines on occiput. Top of head covered with irregular feebly carinate scales, sides of head with enlarged tubercles. 12-15 supralabials, nasal above 3rd and centre of eye above 11th scale. 11-14 infralabials. The first tooth in upper and lower jaw caninoid, rest compressed, trituberculate. Nostril in a circular nasal scale. 14 supraciliaries. 18-20 osseous plates below eye from snout to just beyond hind edge of gape, the last two plates circular and largest. Gular sac developed and more prominent in male which also possesses a nuchal hump. Gular scales large unicarinate pointing downward, largest near carina. An enlarged row of 13-16 plate-like scales on edge of lower jaw. Nuchal crest of close set, compressed, short scales, extends to above shoulders posterior to this, the dorsal crest consists of widely placed fleshy unicarinate scales which are closer together on hips and tail. Sides and back have fine scales with three regular longitudinal rows of enlarged scales from head to midbody and about 7 vertical irregular rows of enlarged trihedral scales on body. Ventral scales trihedral, large along outer edge. Tail strongly compressed, with bluntly rounded tip covered with large scales and a crest dorsally. Supracaudals unequal. Subcaudals strongly carinate, equal. Limbs with carinate scales, enlarged tubercles on thighs.

Colours (Adolescents) ; Head short and chubby. A cinnamon brown changeable to green. Gular sac yellow, its enlarged scales black. Numerous dark brown lines radiate from eye. Limbs and tail banded with brown.

(Adult) : Mouth bright red internally. Green to dark olive dorsally, white to a bright blue ventrally. Gular sac yellow, its enlarged scales green. Labials at times lighter than rest of head.

Food : Tender shoots, immature cardamom fruit, insects and in captivity boiled rice. (Kelaart, 1852 and Punnett, 1911).

Reproduction : Male has a nuchal hump and a larger rostral knob than female which, according to Kelaart (1852), lays three or four hard shelled eggs as large as those of a sparrow. A female taken at Gammaduwa on June 21, 1930, had five circular eggs which were immature.

Dimensions : Head 46 mm., gape 30 mm., leg (to heel) 68 mm., axilla to groin 60 mm., tail 141 mm.

Distribution : Hilly forests

Kandy, Peradeniya, Kadugannawa, Matale, Agrapatnas, Udugama, Gammaduwa (C.P.), Tebuwana (W.P.), Avisawella (Sab. P.), Kottawa (S.P.)

Ceylon.

Genus **COPHOTIS** Peters

Tympanum subdermal, gular sac very small, scales large, subequal, irregular. Dorsal crest strongly developed. No femoral pores. Tail rounded, prehensile. Reproduction ovoviviparous. Two species—one Ceylon, the other Sumatra.

Cophotis ceylanica Peters (Plate XXXIV)

Cophotis ceylanica Peters, M.B. Ak. Berlin, 1861. *Kuru Bōdiliya* (S.)

Snout rather long, about 1·5 times eye and bluntly accuminate. Orbit large, aperture of eye moderate. Nostrils lateral. Rostral rather deeper than supralabials of which there are 9-11, the 7th being the first subocular. Infralabials 9. Supraciliaries 4, elongate and followed by a pointed scale. Two contiguous, tuberculate scales dorsally at base of snout. Snout scales with carinate margins, those on head curved and flat. Nostril in a large hexagonal scale. Two cone-like clusters of pointed occipital scales separated by a single row of short wide scales. Gular scales triangular and decrease in size towards carina of gular sac. A single ridge of 20 elongate, distinctly separate acute scales commences from base of skull along top of back to hips less pronounced in females than in males. Scales on sides and back

large, irregular, some feebly unicarinate and bluntly triangular, others rounded and all directed obliquely downward. Ventral scales small, pointed, strongly unicarinate and degenerate into small blunt tubercles near cloaca and at bases of thigh, and arm which have large triangular scales dorsally, smaller rounded ones ventrally. Caudals large dorsally, small and unicarinate ventrally, decrease posteriorly. Fifth digit somewhat larger than the inner one. Teeth trituberculate, 14 on each jaw, those of lower jaw the longer and in both they increase in size posteriorly. Tail prehensile, rounded with strongly carinate scales dorsally.

Colours : Olive green with irregular oblique bands of white or yellow. Head olive, three irregular olive stripes on body interspersed with emerald green scales. Ocular skin dark red. Dorsal crest partly of green and partly of brown scales. A white transverse stripe connecting anterior corners of eyes. A white or yellow band from eye to shoulder, labials creamy or brown. Carina of gular sac white. A vertical white stripe on body from elbow nearly to dorsal crest surrounded by dark brown. An irregular greenish yellow vertical band on midbody, another across hips. Tail with 6 white rings surrounded by greenish yellow, interspaces brown or olive. Limbs olive with a scattering of green scales, and bluish green rings at joints. Iris bright yellow.

Reproduction: Ovoviviparous giving birth to five young at a time. According to Willey (1906), the egg is 13 mm. long when it descends into the oviduct. New born young from Gammaduwa near Matale, July 29, 1930.

Dimensions : A male measured as follows :—Head 23 mm., axilla to groin 33 mm., tail 80 mm., depth of body 17 mm., arm to wrist 17 mm., leg to heel 23 mm., total length 146 mm. A female with 5 embryos measured :—Head 22·5 mm., axilla to groin 37 mm., tail 67 mm., total 134 mm. One of the embryos measured :—Head 9 mm., axilla to groin 10 mm., tail 24 mm., total 42 mm.

Distribution : A slow moving arboreal form found about the moss-covered bases of tree trunks in mountain districts, Nuwara Eliya, Hakgalla, Matale, Alutnuwara, Gammaduwa (C.P.).

Ceylon.

Genus **CALOTES** Cuvier

Katussa (S.) *Ona* (T.)

A feeble transverse gular fold or none. A pit or fold in front of shoulder or none. Tympanum superficial. Body compressed. A dorsi-nuchal crest present or absent. A gular sac present or absent in male. Tail rounded or feebly compressed. No femoral or preanal pores.

Scales of sides in uniform rows. Supraocular scales always enlarged in young, remain enlarged throughout life in some species. Capable of considerable colour change. Fast moving, oviparous lizards with fragile tails. Reproduction by spindle-shaped or ellipsoid soft shelled eggs buried in the ground. These lizards have a peculiar habit of nodding their heads. Hitherto this has been considered to be a mating habit, but specimens of *Calotes liocephalus* nodded to the writer a few minutes after emerging from the egg. This action probably denotes excitement of any nature, sexual or otherwise. Essentially arboreal, but frequently descending to the ground to feed on worms and insects. They also live largely on tender shoots. Although seven species have been described from Ceylon only six occur. *C. mystaceus* Dum. et Bibr. has not been found and, according to Mr. H. W. Parker, no Ceylon specimens of this species are in the British Museum.

Distribution : India, Ceylon, East Indies, Philippines.

Key to Ceylon species of Calotes

A —Dorsal scales larger than ventrals.
(1) No shoulder fold.
.....*C. versicolor*[1]
(2) A shoulder fold.
(*a*) Lateral scales point upward.
.....*C. ceylonensis*
(*b*) Lateral scales point downward.
.....*C. liolepis*

B.—Dorsal scales smaller than ventrals.
(1) Head with spines in male
(*a*) Lateral scales point upward.
.....*C. ophiomachus*
(*b*) Lateral scales point downward.
.....*C. nigrilabris*
(2) Head spineless in male.
.....*C. liocephalus*

Calotes versicolor (Daudin)

Agama versicolor Daudin, Rept. iii. 1802.
Gara katussa (S.)

No oblique fold in front of shoulder. Male thick set, heavily built. Gular sac inconspicuous. Outline of canthus rostralis convex. Two spines well apart over ear. Tympanum as large as eye opening, five or six scales behind eye. Supraoculars not conspicuous, enlarged in adult. Dorsinuchal crest developed, extends a post orbital head length down tail. Gular scales smooth or faintly carinate, equal to or larger than ventrals,

1. The only Ceylon species without a shoulder fold containing fine granular scales.

and mucronate. Body scales carinate, especially ventrally, lateral scales directed back and obliquely upwards. Dorsal scales somewhat larger than ventrals. Twenty-three to twenty-six scales in mid gular line from mental to neck, fifty-four in mid ventral line from neck to cloaca, thirty-five to forty-seven scales round midbody. Fourth finger a little longer than third, fourth toe longer than third. Toes of adpressed leg reach tympanum or eye, heel reaches or does not reach axilla. Tail rounded.

Colours: Male similar to female when young, the adult a greyish brown changeable to a yellow ochre or dull pink, with a dull pink gular area bluish black at base of throat. Irregular dark brown or rust red blotches present or absent on sides ; usually present over pelvic area. Female reddish brown with a yellow dorsilateral band from occiput to middle of tail. Six dark brown cross bars dorsally interrupted by the lateral bands. A lateral row of five longitudinally elongate yellow spots. Tail with dark brown cross bars much narrower than interspaces.

Reproduction: Twelve eggs found July 30th, 1930, Dehiwela (W.P.), 14 to 18 mm. long by 10 to 11·5 mm. wide.

Dimensions : Snout 10 mm., eye to ear 7·5 mm., head 35 mm., axilla to groin 55 mm., snout to cloaca 110 mm., tail 261 mm.

Distribution: Very common all over Ceylon in all localities and at all elevations up to 5,000 ft. Prefers scrub to forest. Ceylon, India, Tenasserim, South China, Afghanistan, Baluchistan.

Calotes ceylonensis[1] (Müller)

Calotes mystaceus var. *ceylonensis* F. Müller, Verh. Naturf. Ges. Basel VIII, 1887.
Calotes kelaartii Nevill, Taprobanian II, p. 134. 1887.

Shoulder fold runs across throat. No gular sac. Canthus rostralis straight or faintly convex in outline. Six scales from eye to nostril. Loreal space oblique. Head with two small spines above each tympanum. Tympanum equals one-third orbit and is six or seven scales behind eye. Supraocular scales enlarged. Dorsinuchal crest rudimentary on neck, absent on body. Gular scales strongly carinate and much smaller than dorsals. Scales on sides of chest very small, granular. Dorsals larger than ventrals and smooth or faintly carinate, ventrals mucronate. Anterior lateral scales directed upward and back, posterior ones directed straight backward. Twenty-nine scales on median gular line, fifty-six from neck to cloaca in mid ventral line. Sixty scales round midbody. Toes of

1. It is probably this species which has been confused with *C. mystaceus* Dum. et Bibr. by Kelaart, a form which has not been collected in Ceylon.

adpressed foot reach hind edge of orbit. Tail rounded, basal scales strong, as large as tympanum.

Colours: Three large oval reddish brown blotches dorsally to above elbow. Three dorsal bands of brown on abdominal area. Dark brown or black reticulation on neck, shoulders and sides of chest. Ground colour greenish yellow to brown. Throat dark with a few white spots, belly with 4 brown "V" shaped bands directed anteriorly a greenish blue labial band. A short black occipital band. 16 brown rings on tail as wide as interspaces posteriorly. 7 or 8 bands on each limb as wide as interspaces. A pink band from snout to ear in alcoholic specimens.

Dimensions: Snout 11·5 mm., head 30 mm., axilla to groin 43 mm., snout to cloaca 83 mm., tail 176 mm.

Distribution: Mankulam (N.P.), Elahera (N.C.P.), Kumana (E.P.), Puttalam District (N.W.P.), Peradeniya, Kumbalgamuva (C.P.).

Ceylon.

Calotes liolepis Boulenger

Calotes liolepis Boulenger, Cat. Liz. I, 1885.

A shoulder fold with granular scales present. Gular sac present, very small. Canthus rostralis rather inconspicuous, its outline straight. Two strong spines set far apart over ear. Tympanum nearly half orbit and is about five or six scales behind eye of which the middle three scales are enlarged. Cephalic scales smooth, imbricate, supraoculars enlarged. Dorsinuchal crest of male consists of ten well developed spines on neck, rudimentary on posterior half of body and then disappears. The spines of crest are as long as orbit, narrow and apart from each other. Gular scales feebly carinate, not mucronate, larger than ventrals but smaller than dorsals or laterals. Body scales smooth dorsally, carinate ventrally. Ventrals much smaller than dorsals and laterals which latter are directed downward and backward.

Thirty-four scales in midgular line from mental to neck. Fifty-two in midventral line from neck to cloaca. Thirty-nine to forty scales round midbody. Third and fourth fingers equal, adpressed leg barely reaches tympanum. Tail round, its base with strong, large scales in male. Neural ridge extends for a headlength down tail before it bifurcates.

Colours: (Male). Two white blotches under eye. Gular sac an old red with three white blotches. Three dark brown parallel lines run diagonally across gular sac on each side of white blotches. A white dorsal mark from ear to above shoulders, then descends to shoulder. Two broad light green cross bands on body with three broader olive

brown interspaces. Limbs and tail with equal bands of dark olive and lighter.

Dimensions: Head 28 mm., eye 7 mm., axilla to groin 37 mm., snout to cloaca 72 mm., leg (to heel) 35 mm., tail broken in middle.

Distribution: Punduluoya, Gammaduwa, Kandy (C.P.).

Ceylon.

Calotes ophiomachus (Merrem)

Agama ophiomachus Merrem, Tent. Syst. Amphib, 1820.
Patché katussa (S.)

An oblique fold in front of shoulder only, and covered with small granular scales. Gular sac undeveloped. Canthus rostralis well defined, its outline straight, five scales from nostril to orbit, the fifth is longest. A group of short spines around a single long one above tympanum, at times two such groups. Tympanum one-third or half as large as orbit, and eight or nine scales behind eye. Supraocular scales slightly enlarged. Dorsinuchal crest developed. Gular scales feebly carinate and nearly as large as ventrals. Body scales faintly carinate or smooth dorsally, strongly carinate ventrally where they are mucronate and much larger than the dorsals. Lateral scales point backwards and upward. Twenty to twenty-three midgular scales from mental to neck. Thirty-nine to forty-four scales from neck to cloaca midventrally. Thirty to thirty-five scales round midbody. Third and fourth fingers equal, fourth toe longer than third. Toes of adpressed leg reach front of orbit or beyond. Tail rounded.

Colours: Bright green dorsally with four or five transverse bluish white or dark green cross bands. Head light yellow ochre to dark bluish green. Gular sac red or dark red. Bluish under ear and eye. Young, brown with six dark dorsal cross bars between two light lateral bands.

Reproduction: Six to twelve eggs from Gammaduwa during September, 1930. Eggs 18·5 mm. by 12· 5 mm.

Dimensions: Head 42 mm., axilla to groin 66 mm., snout to cloaca 122 mm., tail 495 mm., leg (to heel) 60 mm.

Distribution: Commoner in hills than in low-country.

Colombo, Gampaha, Dikkanda, Veyangoda, Matugama (W.P.), Madugoda, Peradeniya, Kandy, Gammaduwa (C.P.).

Ceylon, South India, Nicobars.

Calotes nigrilabris Peters

Calotes rouxii Blyth, J.A.S.B. XXII, 1853.
Calotes nigrilabris Peters, M.B. Ak. Berlin, 1860.

A well defined oblique fold in front of shoulder. Gular sac not developed. Outline of canthus rostralis nearly straight. A series of

three, five or six short spines above posterior of tympanum. Tympanum as large as or larger than half orbit, and about six scales behind eye. Supraoculars not enlarged in adult. Dorsinuchal crest developed, disappears in pelvic area or at base of tail. Gular scales carinate or smooth, larger than ventrals. Body scales feebly carinate dorsally. Ventrals much larger than dorsals and strongly carinate and mucronate. Seventeen to nineteen scales in midgular line from rostral to neck, about thirty-three scales from neck to cloaca in midventral line. Forty-three to forty-seven scales round midbody. Third and fourth fingers equal. Toes of adpressed foot reach eye. Tail round, and in male basal scales large and very strong, the upper dorsals forming a serrate neural ridge. The two lateral dorsal ridges unite at about one postorbital headlength behind cloaca.

Colours: Young, green with five pale blue cross bands on body and sixteen on tail. Adult, green with white black edged bars or spots. A reddish brown vertebral band present or absent. Lips and sides of head with a broad black band in male; female usually has a white, black edged horizontal bar below eye.

A specimen from Ohiya (in formal). Top of head to upper jaw dark bluish green. Throat and lower jaw white. A white band encircles neck, shoulders and arms. Legs below knee white. Remainder of body, tail and legs dark bluish green.

Reproduction: Two eggs from Gammaduwa December 2, 1930, were 23 mm. by 13 mm. They contained young ready to hatch.

Dimensions: Young ready to hatch. Snout to cloaca 30 mm., tail 74 mm., axilla to groin 12 mm.

Adult, head 33 mm., snout to cloaca 86 mm., axilla to groin 41 mm., tail 270 mm., leg to heel 42 mm.

Distribution: Hakgalla, Pattipola, Peradeniya, Nuwara Eliya, Gammaduwa, Ohiya (C.P.).

Ceylon.

Calotes liocephalus Günther

Calotes liocephalus Günther, A.M.N.H. (4) IX. 1872.

An oblique fold in front of shoulder. Gular sac undeveloped. Canthus rostralis not very prominent, its outline straight. Six scales from eye to nostril. Lower jaw rather undershot. Head without spines or rarely a rudimentary spine above one ear. Tympanum about half size of orbit and nine or ten scales behind it. Supraocular scales enlarged. Dorsinuchal crest poorly developed, strongest on head, low on neck and

rudimentary on body, composed of narrow, weak spines. Longest are about as long as tympanum.

Gular scales faintly carinate, much larger than body scales. Body scales faintly carinate, dorsals directed straight back, the laterals point downward and backward. Ventrals strongly carinate and a little smaller than dorsals or laterals. Twenty-five scales along midgular line from mental to neck, forty-seven scales from neck to cloaca in midventral line. Forty-five to fifty scales round midbody. Third and fourth fingers equal, fourth toe longer than third. Scales on base of tail large and strong. Neural caudal ridge bifurcates a headlength from cloaca.

Colours: Newly hatched young, green, with olive limbs and tail which has faint dark rings. Three faint white cross bars on body. A red or brown line at angles of eye. Adult male. Throat yellowish green. Three black cross bands from eye to eye. A black band runs along posterior half or upper lip through ear and meets its fellow above angle of jaw. Sides of lower jaw with black spots. Eye set in black skin. A broken black line along canthus rostralis. Head and chest a bright green changeable to bluish green, abdomen, hips and tail olive brown dorsally. Five dark cross bands dorsally on body, each about half the width of interspaces. Six black rings on arm and three to six white rings on digits. Tail with 15 light reddish brown rings about half width of interspaces.

Ventral colouration yellow or greenish yellow.

Reproduction: Three elliptical eggs 19·5 mm. by 11 mm. buried in loose silt in a field drain, Gammaduwa (C.P.), August 25, 1930.

New born young nodded their heads soon after hatching, thus showing that this action is not a purely sexual demonstration.

Dimensions: Just hatched. Head 10·5 mm., axilla to groin 11·5 mm., snout to cloaca 26 mm., tail 58 mm.

Adult male. Head 37 mm., axilla to groin 43 mm., snout to cloaca 91 mm., tail 261 mm., leg (to heel) 40 mm.

Distribution: Gammaduwa, Agrapatnas, Pundulu Oya (C.P.).

Ceylon.

Family **Chamaeleontidae**

Head with a bony casque dorsally. Nasals distinct. Three cervical vertebrae. Dentition acrodont, teeth triangular and tricuspid. Premaxillary edentulous. Body compressed with a feeble dorsal crest. No clavicles or interclavicles. Tongue trajectile to a considerable distance, clubbed in shape, with basal sheath. Tympanum subdermal, limbs well developed, zygodactylous. Tail long, rounded, prehensile.

Arboreal, slow moving, capable of quick and varied colour change, eyes act independently of each other. Reproduction : Ovoviviparous or oviparous.

Genus **CHAMAELEON**

Claws single, soles of feet smooth, tail as long as body or longer, prehensile.

Chamaeleon calcaratus Merrem

Chamaeleon calcaratus Merrem, Tent. Syst. Amphib., 1820.
Bodilima, Bodiliya (S.)

Shape : Two strong supraorbital ridges extend from snout to parietals and unite at apex of occipital casque which has a median ridge which commences just behind the eyes. Length of gape equals distance from gape to apex of casque. Eye large, covered by finely granular skin which leaves a small opening, teeth trituberculate, 15 on upper, 12-16 on lower jaw on each side. Head is 4 into head and trunk and 4·4 into tail. Scales small, granular, subequal. Those on top of head and casque largest. No enlarged rostral or mental. A ridge of bluntly pointed scales runs along top of back and a short distance down tail. Another ridge of distinctly pointed fleshy scales runs from mandibular symphysis to cloaca. 19-23 supralabials, 20-23 infralabials, one row of scales between orbit and supralabials. Body compressed, limbs long, tail rounded, faintly compressed dorsally in anterior half. Nostril midway between eye and tip of snout, above fifth supralabial. Heel of male with a distinct spur-like fleshy prominence.

Colour : Green to bluish green with a few lighter green or yellow blotches on body, ventral ridge white, commissure of gape white or yellow.

Dimensions : Snout to apex of casque 56 mm., gape 35 mm., eye 16 mm., arm (to wrist) 53 mm., head and trunk 162 mm., tail 192 mm., depth of body 56 mm.

Distribution : Arboreal, in forest regions especially in dry zone. Mankulam (N.P.), Puttalam (N.W.P.), Anuradhapura (N.C.P.).

Ceylon, India.

Family **Lacertidae**

Supratemporal fossa of skull roofed with dermal plates. Nasals distinct. Dentition pleurodont. Body slender and elongate, with large ventral scales in rows. Tongue depressed, bifid anteriorly and

posteriorly and covered with plicae or papillae. Tympanum distinct. Limbs well developed, femoral pores usually present. Tail long, rounded and fragile. Terrestrial. Reproduction : Ovoviviparous or oviparous.

Genus **CABRITA** Gray

Head shields enlarged. Nostril between two or three nasals. Upper eyelid rudimentary, lower well developed with a large, undivided transparent fenestrum. Scales imbricate ; small and carinate dorsally, large and smooth ventrally. Tongue with imbricate papillae. Limbs developed, digits compressed. Femoral pores present. Tail cylindrical, elongate, slender and fragile. Terrestrial.

Reproduction : Oviparous, eggs soft shelled.

Cabrita leschenaulti (Milne-Edwards) Plate XXXV

Lacerta leschenaultii Milne-Edwards, Ann. Sc. Nat. XVI, 1829.
Cabrita brunnea Gray, Ann. N.H.i., 1838.
Cabrita leschenaultii Boulenger, Cat. Liz. iii, 1887.

Limbs well developed, tail elongate fine, lower eyelid with a single, large, transparent fenestrum, ear about half size of eye with a large crescentric tympanic scale on its anterior upper margin and is seven rows of scales behind eye. Nostril in horizontal suture between nasal and supranasal which are equal and in contact with rostral. Supranasals broadly contiguous. Postnasal smaller. Canthus rostralis prominent, straight, composed of two or three scales. Frontonasal wider than long, as large as each of the two prefrontals and separate from frontal which last is elongate and contiguous with first three supraoculars and somewhat larger than or equal to frontoparietals and parietals together. Frontoparietals widely in contact, interparietal small, the broad parietals forming an isthmus behind it and bounded by two temporals on each side. A small occipital. Supralabials eight, with strongly carinate outer edge to anterior ones, the fifth is flat, subocular and enlarged. Two loreals, of which second is much larger than first. Supraoculars four, the first and last small. Infralabials eight, six pairs of enlarged chin shields, of which the first three are in contact at the midgular line. The first two pairs contiguous with mental. Dorsal scales moderate, carinate, equal on sides and back. Forty-two to forty-eight scales round midbody. Ventrals large, broader than long in six longitudinal and twenty-five to twenty-eight transverse rows. A large triangular preanal scale pointing anteriorly. Twelve to sixteen femoral pores on each side interrupted by a single median scale at apex of enlarged preanal scale. Ten large scales

on inner side of upper arm and of thigh. Twenty double keeled rugae under fourth toe. Caudals subequal, large, unicarinate ; adpressed leg reaches as far as or a little beyond ear.

Colours: Dorsally brownish yellow. Two white lateral lines, one from eye to tail, the other from lips through ear to thigh. These enclose a dark brown band. Above these is a narrow dark band from above orbit to base of tail, and below them a fainter one from axilla to groin in a bright green band. Limbs brown mottled with black. Ventrally white.

Reproduction : An Indian specimen examined by Stoliczka in April, 1870, contained six eggs.

Dimensions : Snout to ear 9·5 mm., snout to arm 16 mm., axilla to groin 16 mm., snout to cloaca 36 mm., tail 72 mm., arm (to wrist) 10 mm., leg (to heel) 18 m., leg (to end of toe) 32 m.

Distribution : A rare ground living, swift moving form, found in long grass near thin jungle. Mullaittivu (E.P.), Jaffna (N.P.)
Ceylon, India.

Family **Varanidae**

Supratemporal fossa of skull not roofed over. Nasals fused. Cervical vertebrae seven. Teeth pleurodont, acute. Tongue slender, deeply bifid and retractile into a sheath. Throat sac faintly developed. Body elongate rounded, tail long, subcylindrical at base, compressed distally; flagellate. Limbs strongly clawed and well developed. Reproduction: Oviparous. Large arboreal, terrestrial or amphibious lizards.

Genus **VARANUS** Merrem

Head with small polygonal scales, ear distinct, tympanum exposed. Dorsal body scales round and granular with or without osteoderms and often surrounded by rings of smaller granules. Ventral scales rectangular and in rows. A cross fold of skin present or absent on throat and also a lateral dermal fold on neck and body. Teeth, sometimes replacable ; none on palate. Preanal pores present or absent.

Reproduction : Numerous ellipsoid soft shelled eggs.

There are two species in Ceylon, neither of which possess preanal pores. The amphibious form *V. salvator* adapted for swimming with its depressed body and compressed tail and the more terrestrial *V. bengalensis* with its rounded body and tail and its convex snout with nostrils set far back showing fossorial adaptation. They are both of considerable importance economically, the former for its hide, and as a

scavenger and destroyer of snakes and crabs which undermine the bunds of paddy-fields, the latter for its hide and flesh and because it destroys large numbers of noxious insects and their larvae; chief of which are coconut beetles and centipedes. A few years ago they were both abundant, but today are being rapidly thinned out for their hides which find a very profitable market in Europe. Both animals appear to issue from their burrows in search of prey at about 10 a.m. and by mid-day may be seen basking in some sunny place. If unmolested they become very tame and can be approached to within a short distance, but *V. salvator* shows its disapproval of too close a proximity by lashing out with its powerful tail and it usually requires a good bull-terrier all his strength and activity to kill one as it inflicts nasty bites and scratches besides using its tail in combat.

Varanus bengalensis is of meeker disposition and does not defend itself with half the ferocity of its larger cousin, readily fleeing at the first indication of danger. The tick *Aponomma gervaisi* (Lucas) which is marked with yellow and brown to closely resemble the skin of the host, is usually found on both species. Both species are found at Kumbalgamuva (C.P.). (3,000 ft.)

Varanus salvator (Laurenti)

Stellio salvator Laurenti, Syn. Rept, 1768.
Kabaregoya (adult) *Mal kabaregoya* (young) *Kabaréya*,[1] (S.)

Head and body rather depressed, tail compressed especially distally. Snout as long as half head, depressed at tip. Nostril oval, twice as far from eye as from tip of snout. Canthus rostralis rounded, eye 5-5·5, interorbit 1·5-2, ear vertical and as long as eye. Head slightly shorter than neck, 14·75 into total length or 5·75 into head and trunk. Teeth acute and compressed, replacable, each having a number of small supplemental teeth behind it. Each upper jaw with 12-15 and each lower with 6-12 teeth. Premaxillary teeth small. Scales not surrounded by minute granules, rounded or hexagonal and carinate dorsally, rectangular and carinate ventrally with 85-95 cross rows from axilla to groin. Rostral and mental pentagonal, latter larger than labials, supralabials 33, infralabials 33. Scales on top of head flat with 4-8 enlarged supraoculars, 17 supraciliaries, 4 rows of scales between eye and gape. A lateral cutaneous fold on neck and body and a transverse fold at base of throat. In old specimens preanals hexagonal and enlarged in a triangular patch. Caudal scales large, rectangular and unicarinate

1 The suffix—goya is applied by the Sinhalese to birds also, *e.g.*, Kurulugoya, Batagoya, Mahavillagoya.

ventrally. Tail with a double row of strong, pointed scales forming a dorsal crest.

Colour: Dark brown or black dorsally with yellow ocelli in transverse rows of alternate large and small on body. Tail with 12 or more yellow bands. Lips yellow with 3 or 4 dark bands, cheeks yellow spotted with black. A black band from eye to ear with a yellow band below it. five transverse rows of yellow ocelli from axilla to groin with intervening rows of smaller ocelli. Tail with 12 yellow bands scattered with black as wide as interspaces; its tip yellow. Ventrally yellow with three "V" shaped black marks on throat, pointing anteriorly, 4 interrupted stripes on neck. Seven black bands run some distance into the belly colour from each side. In young the yellow colouration is most marked but tends to disappear with age.

Food: Carrion, fishes, amphibians, reptiles, mammals, birds and crustacea. A useful scavenger; also said to destroy crocodile eggs and young as well as snakes and is protected by law owing to its habit of feeding on fresh water crabs which undermine the bunds of paddy-fields by burrowing. It is also very fond of turtle eggs and dwells in pandanus groves near the sea shore during the breeding season of these animals.[1] An eye witness of a kabaréya devouring a rat snake *Ptyaf mucosus* (Linné) says that the aggressor was about 1200 mm., the victim about 1800 mm. The Kabaréya would seize the snake near the tail and worry and waggle it about until the victim managed to twine round a tea bush and drag itself so as to get the lizard's snout against the bush and force it to relinquish its hold, whereupon the snake would dart off with the kabaréya in hot pursuit and the process repeated. After several repetitions the snake was exhausted and the kabaréya began to swallow it alive tail first and it was not until about 450 mm. of its head and trunk remained that the snake thought of biting. Each time it struck the kabaréya's cheek it would be gently pushed down by a fore paw and the swallowing continued. The meal finished the lizard with its stomach bulging ludicrously, climbed with the utmost celerity up a tree. In attacking a cobra the lizard is said to keep circling round out of striking distance until the former has exhausted itself by frequent mishits when the kabaréya rushes in, seizes it by the back of the hood and kills it. In swallowing chickens, the kabaréya frequently discards the skin and feathers, which roll off as the chicken enters its throat. This lizard is frequently carried down to the sea while feasting and sleeping on the putrid carcasses of cattle which float down rivers. A specimen 2070 mm. long had swallowed a hard shelled tortoise *Geoemyda trijuga thermalis*

1 *Vide* Deraniyagala "Testudinata of Ceylon," Ceylon J. of Sc., Vol. XVI, Sec. B. p 49.

ERRATA

CEYLON JOURNAL OF SCIENCE (SECTION B.)
VOL. XVI.

p. 161, line 4, delete from "80 mm." to "extremities"; line 9 delete "It was abnormal" and add "25 eggs laid July, 1931, were 92 to 100 mm. long, 35 to 38 mm. wide."

160 mm. long in the carapace and 105 mm. wide. The gape of the lizard was rather less than 150 mm.

Reproduction: Eggs are elongate with a semicalcareous white leathery covering 80 mm. long, 50 mm. wide with pointed extremities. About 15 to 25 eggs are laid in burrows or hollow tree trunks. Newly hatched young were observed at Gampaha, April 13, 1928; recent egg shells were noticed at Battuluoya, June 1928. A single egg was laid by the solitary specimen in the Colombo Museum and was 93 mm. long, 32 mm. wide. It was abnormal.

Dimensions: Total length 2070 mm., snout to ear 152·4 mm., snout to axilla 304·8 mm., axilla to groin 406·4 mm., snout to cloaca 838·2 mm., arm to end of mid finger 279·4 mm., leg to end of mid toe 381 mm., tail 1257·3 mm.

Distribution: A diurnal, amphibious species inhabiting burrows or holes in trees near swamps, tanks and rivers. It is an excellent swimmer using only its powerful tail, the limbs being held close to the sides. Found foraging in the morning but at mid-day usually basks on the branch of a tree. Ranges from the low-country to an elevation of 3,000 ft., but is said to be absent from the Tissamaharama district (S.P.). Seen at Colombo, Veyangoda, Kalutara, Yakkvala (W.P.), Chilaw, Negombo (N.W.P.), Bentota, Galle, Veligama, Matara (S.P.), Pelmadulla, Madampe (Sab. P), Anuradhapura (N.C.P.), Kandy, Kumbalgamuva (C.P.).

Ceylon, India, Malay Archipelago, Andamans, Nicobars, S. China, Siam, Tenessarim, Nepal, Philippines, Cape York.

Varanus bengalensis (Daudin)

Tupinambis bengalensis Daudin, Rept. iii. 1802.
Tallagoya, Tallaya, Goya (S.), *Udumbu* (T.)

Head and body subcylindrical, tail subcylindrical at base faintly compressed in middle and rounded distally. Snout as long as rest of head, or twice distance from eye to ear, is high, arched and adapted for digging. Nostril oblique and much nearer to orbit than to tip of snout, especially in old specimens. Canthus rostralis rounded, eye 4-5, interorbit 2, ear oblique as long as eye. Head 12·75-14 into total length or 4·75-5·6 into head and trunk. Teeth replacable, each with or without a supplemental tooth behind it. Each jaw with 10-12 teeth. Scales small, and within rings of minute granules, hexagonal on head, oval dorsally, rectangular and smooth ventrally, in 90-110 cross rows from axilla to groin. Rostral and mental larger than labials, scales on snout largest, temporals smallest, supralabials 28-31, infralabials 25-31 on each side, supraoculars smaller than intraorbital scales, three or four

rows of scales between eye and gape. A transverse collar-like fold of skin across throat and a lateral cutaneous fold which in old specimens only extends from axilla half way down body. A low double row of acute scales form a dorsal crest along tail.

Colours : Dorsally cinnamon brown with black reticulation and rows of yellow spots with black margins, each spot about a third of orbit. Ventrally silvery white to pale yellow in young, dirty grey in adult. Tail with 18 yellow bands and two wide bands in its posterior half, in adult the proximal band persists and occupies about one-sixth of its length, tip of tail brown. A black lateral band from nostril to top of neck and a short yellow band above ; 4-6 transverse rows of yellow dots on neck, 12-15 such on body and 3 at base of tail and 18 yellow bands which are wider than interspaces. A broad brown band after first three-fifths of tail followed by a characteristic broad yellow band. Ventrally 5 transverse brown bands on throat, 5 on neck and 10-12 less distinct ones on body which are often interrupted or exist as spots. Tail yellowish to white ventrally, no stripes. Three interrupted stripes on thigh, four on calf. Yellow disappears in old specimens.

Food : Insects and insect larvae, centipedes, young rats, birds, squirrels, frogs and small reptiles, offal. A useful animal on coconut estates as it feeds on coconut pests.

Reproduction : Seven to twenty-five elongate soft shelled eggs laid in termite nests or in hollow trees. Seven eggs found in June at Anuradhapura (C.P.), by Abercromby (1913.) Twelve nearly mature eggs in a female at Vakvella (S.P.), February 11, 1928. Eighteen mature eggs in a female at Dehiwela January 2, 1929. Twenty-five eggs laid by a captive specimen at Veyangoda June, 1929. Newly hatched young from Neboda (W.P.), January 17, 1931. Six eggs from a termite hillock at Veyangoda (W.P.), January, 25, 1931, measured 56 mm. to 60 mm. in length, 28 mm. to 32 mm. in width.

Dimensions : Length 1,370 mm. Head 93 mm., snout tip to nostril 27 mm., snout to cloaca 525 mm., axilla to groin 230 mm., hind leg 230 mm. Very young specimen. Head 25 mm., snout tip to nostril 6 mm., snout to cloaca 104 mm., axilla to groin 50 mm.

Distribution : A terrestrial form living in holes in trees and in termite hillocks. Found in the low-country and up to about 3,000 feet above sea level. Most abundant in the dry zone. Anuradhapura, Medavachchiya (N.C.P.), Nikaveratiya, Kurunegala (N.W.P.), Periya Villuva (N.P.), Colombo, Gampaha, Veyangoda, Kalutara, Panadura (W.P.), Galle, Matara, Bentota, Tangalla, Hambantota, Tissamaharama, Kirinda (S.P.), Pallaipothana (E.P.), Kandy, Kumbalgamuva (C.P).

Ceylon, India, Burma.

Its flesh is edible and that of young specimens is well flavoured resembling veal. It is eagerly hunted for its skin, flesh and eggs. A common method is to pursue it up a coconut tree, when it jumps off the fronds to the ground where it is caught by men and dogs. The animal is able to leap from a height of 10-20 meters without incurring any injury. It is also smoked out of its burrows or taken in a slip noose set at the mouth of its burrow. The animal is killed instantaneously by doubling its head under its chest placing it on the ground and hitting the nape of its neck sharply with the closed fist. It frequently takes to the water when pursued and usually dives down and remains submerged with its head thrust ostrich-like into a clump of weed.

Family **Scincidae**

Supratemporal fossa of skull roofed over with bony dermal plates, nasals distinct. Dentition pleurodont. Body depressed, scales have osteoderms which are pierced by tubules. Head scales enlarged, lower eyelied scaly or with a transparent fenestra. Tongue depressed, nicked anteriorly, bifid posteriorly, covered with rhomboid papillae. Tympanum distinct or subdermal. Limbs developed, vestigial or absent. Tail long and fragile. Arboreal, terrestrial or fossorial. Ovoviviparous or oviparous with soft shelled eggs.

The Scincs are a confusing family of reptilia for classification as there is considerable variation within the species which are very numerous, in the number and position of scales. They present a very interesting sequence of development from the normal limbed lizard to the types which are snake-like with vestigial limbs which are often totally absent in one species. The snake-like forms are fossorial and nocturnal. Many with short legs belonging to the genus *Lygosoma* spend most of the day under stones or amongst decaying vegetation, whereas the normal limbed *Mabuya* is found scrambling about rocks rendered intolerably hot by the midday sun. These lizards are of considerable value in checking insect pests ; thay have numerous enemies, chief of which are the large rock scorpion and snakes such as the *Thel karavala* (S.), *Lycodon aulicus* (Linné) and others. Considerable superstition and myth has been attached to these harmless lizards which are supposed by many to be virulently poisonous and are also said to carry a gem in their heads. Much interest also arises in the double tailed specimens which at times appear in the genera with short legs. This feature is due to a fresh tail regenerating from an injury to the original which was not sufficient to cause it to break off. The phenomenon is common to several animals which regenerate their tails and is not rare amongst the Gekkonidae.

Key to genera of Ceylon Scincidae

A. Lacertiform, limbs developed, with 5 toes; nostril in nasal. Palatines touch at mid line of palate.
(*a*) Palatal cleft reaches eye level.
.....*Mabuya*
(*b*) Palatal cleft behind eye level.
.....*Lygosoma*

B. Anguiniform, limbs vestigial or absent, toes 4 or less; nostril in rostral. Palatines separate at mid line of palate.
(*a*) Nostril close to posterior border of rostral.
.....*Chalcidoseps*
(*b*) Nostril near tip of rostral joined to its posterior border by a groove
.....*Acontias*

Genus **MABUYA** Fitzinger

Hickenälla (S.), *Arenai* (T.)

Pterygoids entirely separated by palatal cleft which extends forward to a line connecting centres of eyes. Nostril in a single nasal. Supranasals, prefrontals and frontoparietal present. Interparietal azygos or double, at times fused with parietals. Limbs strong, five toed. Eyelids movable, ear distinct, tympanum sunken. Maxillary teeth conical or bicusped, pterygoid teeth minute or absent.

Reproduction: Ovoviviparous or oviparous.

Distribution: Africa, Madagascar, Southern Asia, East and West Indies, Central and South America.

Key to species of Mabuya

(1) Lower eyelid with fenestra.
.....*M. bibroni*
(2) Lower eyelid scaly.
(*a*) First supraciliary largest.
.....*M. carinata*
(*b*) Third supraciliary largest.
.....*M. macularia*

Mabuya bibroni (Gray)

Tiliqua bibronii Gray, Ann. N.H. ii. 1838.
Lai hickenälla (S.)

Lacertiform, snout obtusely acuminate and longer than eye. Lower eyelid with a transparent fenestra. Ear about half size of eye, with two or three elongate scales on its anterior edge, the upper one longest and equals diameter of ear which is four scales behind eye. Nostril in

nasal and bounded by a supranasal and postnasal which are above first supralabial. Supranasals separate. Rostral with convex hind edge, contiguous with nasal, supranasal and frontonasal. Frontonasal as wide as or wider than long, contiguous with first loreal, prefrontals, and usually the frontal. First loreal separate or narrowly contiguous with first labial, slightly higher than second which is much longer. Frontal as wide as or narrower than frontonasal and longer than frontoparietals and interparietal combined, is contiguous with second or first and second supraoculars. Parietals wide, completely separated by the hexagonal interparietal which at times fuses with one of them. Two pairs of nuchals. Supraciliaries five, the longest being the second. Supraoculars four or five, the second greatly enlarged, the last very small. Six or seven supralabials, the fifth elongate and subocular. Body scales subequal with three to seven carinae dorsally. Mental with straight hind edge and contiguous with a pair of chin shields followed by a pair of enlarged shields which are separated from each other by a single scale in the mid ventral line. Ventral scales smooth, preanals not enlarged. About 54 widened sub-caudals. Twenty-eight to thirty-two scales round mid-body and about thirty from axilla to groin. Limbs strong, overlap when adpressed. Smooth rounded ridges under digits, fifth toe much longer than first, third and fourth fingers equal. Inner finger has 7, fourth has 12, inner toe has 8, fourth toe has 18 sub-digital ridges.

Colours: Dorsally a greyish mauve with lighter round spots which extend to limbs and are most distinct on tail. A yellow median band on head bordered by two black lateral bands on each side, which are broken up into dots on neck. A scarlet lateral band in adults from ear to groin and above this a bright yellow band. Ventrally white. Young specimens tinged with a pale crimson.

Dimensions: Snout to ear 10 mm., snout to arm 18 mm., axilla to groin 21 mm., snout to tail 42 mm., tail 58 mm., arm (to wrist) 10 mm., leg (to heel) 12 mm.

Distribution: In burrows under low vegetation on sand dunes near sea. Chundikulam, Mullaittivu (E.P.).

Ceylon, India (Carnatic).

Mabuya macularia (Blyth)

Euprepes macularius Blyth, J.A.S.B. XXII. 1853.
Euprepes rufescens part, Günth. Rept. Brit. Ind. 1864.
Euprepes brevis Günther, P.Z.S. 1875.
Mabuia macularia Boulenger, Cat. Liz. III. 1887.

Pulli hickenälla (S.)

Lacertiform, snout obtusely acuminate, short. Lower eyelid scaly. Ear as large as pupil and four scales behind eye. Nostril in nasal, supra-

nasal above, without postnasal and located above first labial. Supranasals separate. Rostral with convex hind edge. Frontonasal wider than long, contiguous with frontal and first loreal which is higher than second loreal. Prefrontals half as large as frontonasal or a little larger. Frontal narrower than frontonasal and as long as frontoparietals and interparietal combined and contiguous with first and second, or second supraocular. Frontoparietals contiguous with second, third and fourth supraoculars. Parietals wide and separate. Interparietal as wide as frontal or narrower. A pair of nuchals. Supraciliaries five, the third elongate. Supraoculars four or five, the largest being the second, the last very small. Six or seven supralabials, the fifth being largest and subocular. Body scales subequal with three to five carinae dorsally. Mental with straight or faintly convex hind edge contiguous with a single broad chin shield, six or seven infralabials. Ventral scales smooth, preanals not enlarged. Tail compressed distally, subcaudals faintly expanded distally. Twenty-six to thirty scales round midbody, twenty-six from axilla to groin. Limbs strong. Toe of adpressed leg reaches nearly to axilla. Palms and soles tuberculate. Inner finger with five sub-digital rugae, fourth finger with twelve, inner toe six, fourth toe fourteen. Third and fourth fingers equal.

Colours (Young): Brassy coloured head becoming smoky towards hips. A black lateral band. Tail sooty black. Throat yellow, belly pale grey. Bronze dorsally with two yellow lateral bands enclosing a dark brown lateral band which runs from snout to base of tail. A faint dark lateral band under lower yellow band. White spots with black rims present or absent, conspicuous on black lateral band of adolescent. Ventrally white.

Reproduction: Oviparous. Eggs were obtained from Gammaduwa (C.P.), buried in the loose silt of field drains on August 31st and September 18th, 1930. Shape of egg a pointed ellipse 16 or 17 mm. by 11 or 12 mm. Two or three eggs. Egg covers of tough skin and polished like celluloid, not calcified. Just hatched young were very active, some suffered from cataleptic fits when alarmed.

Dimensions: Snout to ear 16 mm., axilla to groin 35 mm., snout to cloaca 70 mm., tail 94 mm., leg 33 mm.

New born.	*A.*	*B.*
Snout to arm	12·5 mm.	12 mm.
Axilla to groin	13	14
Snout to cloaca	30	30
Tail	38	38

Distribution: A mountain form.

Peradeniya, Gammaduwa, Kumbalgamuva (C.P.), Haputale (U.P.). Ceylon, India.

Mabuya carinata (Schneider)

Scincus carinatus Schneid. Hirst Amphib. ii. 1801.
Euprepes rufescens part. Günther. Rept. Brit. Ind. 1864.
Tiliqua rufescens Kelaart, Prodr. Faun Zeyl. 1852.
Euprepes (Tiliqua) rufescens Nevill, Taprobanian. Vol. II. Pt. II. 1887.

Gärendi hickenälla, Thel hickenälla (S), *Arenai* (T).

Lacertiform, snout obtusely acuminate, moderate. Lower eyelid scaly. Ear with or without three faintly lobulate scales on anterior edge, about half size of eye with four rows of scales behind it. Nostril in nasal above first labial and bounded by a supranasal, no postnasal. Supranasals separate or rarely contiguous. Rostral with convex hind edge, contiguous with nasals, supranasals and frontonasal. Frontonasal slightly wider than long, usually contiguous with rostral and frontal and with first loreal. It is about two-thirds as long as frontal. Prefrontals well developed. Frontal somewhat narrower than or as wide as frontonasal and as long as or shorter than frontoparietals and interparietal together, and contiguous with second and at times with first supraocular. Frontoparietals distinct, longer than interparietal, contiguous with second, third and fourth supraoculars. Parietals large, completely separated by the interparietal. One or two pairs of nuchals. Six supraciliaries, the first largest. Four supraoculars, the second is largest. Six supralabials, the fifth is largest and subocular.

Dorsal scales with three to eight carinate ridges. Thirty to thirty-four scales round midbody. Mental with straight hind edge, touches a single chin shield behind which are two pairs of large shields separated in the mid ventral line by a single row of scales. Ventral scales smooth, preanals not enlarged. Subcaudals widened distally. Tail rather compressed distally. Thirty to thirty-four scales round midbody. Twenty-nine or thirty scales from axilla to groin. Toes of adpressed limbs overlap. Limbs well developed. Smooth sub-digital scales six on inner finger, twelve on fourth, seven on inner toe, seventeen on fourth toe.

Colours (Young): Dorsally dark bronze with a yellow lateral band from snout to base of tail. A broad chocolate band from snout to tail and below this a faint light lateral band which ends near groin. Ventrally white shading to brown which deepens on tail.

(Adult): Dorsally a light bronze with four to six rows of black dots. A dark lateral band bounded above and below by a narrow yellow band. Specimens from the Eastern Province had a scarlet lateral band above

chocolate band. Belly greenish yellow or white. The lateral bands become indistinct in old specimens which are at times a uniform brown. Some specimens have a red patch behind each thigh. This is due to colonies of red mites which infest these areas.

Reproduction : Ovoviviparous.

Dimensions : Snout 12 mm., snout to ear 30 mm., snout to arm 48 mm., axilla to groin 63 mm., snout to cloaca 108 mm., tail 190 mm., arm (to wrist) 26 mm., leg (to heel) 30 mm.

Distribution: All over Ceylon. Basks at mid-day on heated rocks. Very swift moving.

Ceylon, India, Burma.

Genus **LYGOSOMA** Gray

Hiraluva (S.)

Pterygoids, contiguous anteriorly, the palatal cleft ends far behind a line joining centres of eyes. Nostril in nasal. Supranasal present or absent. Eyelids movable, ear distinct or hidden. Limbs well developed or feeble. Maxillary teeth conical or obtuse, pterygoid teeth minute or absent.

Reproduction: Ovoviviparous or oviparous.

This genus has more species than any other reptilian genus. Found in all tropical and temperate parts of the world except Europe.

Key to Ceylon sub-genera and species of Lygosoma

Subgenus *Riopa*

Lower eyelid with fenestra or scaly, supranasals present, ear ordinary, limbs feeble.

.....*L.* (*R.*) *punctata*

Subgenus *Sphenomorphus*

Lower eyelid scaly, ear equals pupil of eye, limbs short.

(A) Postnasals present, 38 scales round midbody.

.....*L.* (*S*) *dussumieri*

(B) Postnasals absent, less than 30 scales round midbody

α Azygos frontoparietal.

.....*L.* (*S.*) *fallax*

β. Two frontoparietals.

1. Frontoparietals contiguous.

.....*L.* (*S.*) *taprobanensis*

2. Frontoparietals separate.

.....*L.* (*S.*) *punctatolineatus*

Subgenus *Keneuxia*

Lower eyelid scaly, ear equals nostril, limbs well developed.

(A) No supranasals, colour brown.

.....*L.* (*K.*) *megalops*

(B) Supranasals present, colour grey with black bands.

.....*L.* (*K.*) *halianus*

Lygosoma (Sphenomorphus) dussumieri Dum. et Bibr.

Lygosoma dussumierii Dum. et Bibr. Erp. Gen. V. 1802-1803.

Lacertiform, strong limbed, tail thick at root and tapering gradually to a blunt point. Lower eyelid scaly. Tympanum visible. Ear with three small lobulated scales on anterior margin and is about five or six scales behind eye which it almost equals. No supranasals. Postnasals present. Snout moderate, bluntly acuminate, loreal region concave. Scales smooth, laterals somewhat smaller than dorsals or ventrals. Rostral with convex hind edge broadly contiguous with frontonasal. Nostril in hind edge of nasal which has a postnasal. Frontonasal wider than long, contiguous with frontal which separates the prefrontals and is longer than the frontoparietals and interparietal together. It is contiguous with the first three supraoculars. Frontoparietals touch the third, fourth and fifth supraoculars. Interparietal does not separate parietals which are narrowly contiguous. Nuchals faintly developed. Laterally a large temporal. Ten supraciliaries, five supraoculars, the last small, seven supralabials of which the fifth and sixth are subocular, the latter being the largest. Thirty-eight scales round midbody, sixty-eight from axilla to groin. Mental with a straight hind edge, contiguous with a single chin shield, behind which are two other pairs of which the first are contiguous in the mid ventral line. Infralabials seven. Preanals an enlarged pair. Subcaudals slightly enlarged posteriorly. Limbs well developed. Heel reaches elbow when limbs adpressed. A double row of carinate rugae on thumb, unicarinate on fingers. Palms granular, soles smooth. Inner toe has six rugae, fourth toe has twenty.

Colour: Pale olive brown dorsally, lighter ventrally. A broad dark brown lateral band from snout through eye and ear to half way down tail, with a light band above. Tail reddish.

Dimensions: Head and neck 19 mm., axilla to groin 24 mm., tail 53 mm., arm (to wrist) 13 mm., leg (to heel) 20 mm.

Distribution: Peradeniya (a single specimen[1]).

Ceylon, Malabar (India).

Lygosoma (Sphenomorphus) punctatolineatus Boulenger

Lygosoma punctatolineatum Boulenger, Spolia Zeylanica, Vol IV, p. 173, 1907.

Lacertiform, limbs weak, tail as thick as body, tapering gradually to a point and as thick at its middle as at base. Prefrontals separate.

1. The author's determination has been verified by Messrs. H. W. Parker and Malcolm Smith.

Lower eyelid scaly, tympanum hidden in a hole which is four scales behind eye. No lobular scales on anterior edge of ear hole. No supranasals, head short, snout short and acuminate. Scales smooth, subequal. Rostral with a slightly convex hind edge broadly contiguous with frontonasal and nasals. Nostril in nasal which is above first labial. Frontonasal contiguous with the small prefrontals, frontal and first loreal and is wider than long and much shorter than the elongate frontal which widely separates the small prefrontals. Its suture with frontonasal nearly equals suture between frontonasal and rostral. Frontal contiguous with first and second supraoculars and somewhat shorter than frontoparietals and interparietal which equal each other. in length. Frontoparietals distinct, touch second, third and fourth supraoculars. Parietals wide and form a broad line of suture behind interparietal. A pair of nuchals and temporals. Seven supralabials, of which the third, fourth and fifth are subocular. Supraciliaries seven, supraoculars five, the last very small. Mental with a concave hind edge followed by a single chin shield which is followed by a pair of contiguous chin shields and then another pair which are separated in the median line. Infralabials six, preanals and subcaudals not enlarged. Twenty-six scales round midbody, forty-three scales from axilla to groin. Preanals not enlarged. Adpressed limbs just fail to meet. Subdigital lamellae smooth. Inner finger has three, fourth finger nine, inner toe has four, fourth toe has twelve lamellae.

Colours : Bronzy brown dorsally with indistinct dark brown spots, one on each scale. A light lateral band below which is a dark band from eye to root of tail. Belly yellowish in middle, grey on sides.

Dimensions : Tip of snout to arm 18 mm., axilla to groin 23 mm., tail 70 mm., arm (to wrist) 7 mm., leg (to heel) 9 mm.

Distribution : Hakgalla. 5,000 feet.

Two undamaged specimens, adult and young.

Lygosoma (Sphenomorphus) taprobanensis (Kelaart)

Eumeces taprobanensis Kelaart, Prod. Faun. Zeyl. II. 1852.
Thel hīraluva (S.)

Elongate, weak limbed with tail thick at root and tapering gradually. Prefrontals contiguous. Head shields variable. Lower eyelid scaly, tympanum hidden in a hole 5-6 scales behind eye and has two or three small lobular scales. No supranasals, head short, snout short and obtusely acuminate. Scales smooth or nearly so, some dorsals show faint traces of three carinae. The cephalic scales are variable in their arrangement. Rostral with a slightly concave hind edge broadly contiguous

with frontonasal and nasals. Nostril in nasal which is above first labial. Frontonasal contiguous with prefrontals and at times with frontal and the two loreals. Frontonasal wider than long, much shorter than the elongate triangular frontal which touches the first two supraoculars and the two frontoparietals which are distinct and partially separated by the interparietal. Prefrontals contiguous or occasionally narrowly separated by frontal and are contiguous with the first supraocular. Frontoparietals distinct, touch third, fourth and at times the fifth supraocular. Parietals large and partially separated by interparietal which equals frontoparietals in size. A single row of nuchals or none. Supralabials six to eight, the fifth is subocular, infralabials five to six, supraoculars four, rarely five, supraciliaries nine. Mental with a straight hind edge, broadly contiguous with a single chin shield which is followed by a paired chin shield behind which are another two pairs separated in the median line by a single row of scales from those of the opposite side. Twenty-four to twenty-six scales round midbody, six to eight scales from axilla to axilla, 38 to 42 scales from axilla to groin, preanals not or slightly enlarged. Subcaudals enlarged posteriorly, marked increase in width especially when tail regenerated. Legs longer than arms and are longer than distance from mideye to arm. Adpressed limbs do not meet. Subdigital rugae smooth or tubercular. Inner finger has two rugae, fourth has eight, inner toe has four rugae, fourth has thirteen to nineteen.

Colours: Reddish olive dorsally with dark spots or six fine broken black lines. A dark brown lateral band from snout to tail with two or three rows of small white spots. Cheeks and throat bluish grey spotted with white or pale blue in males. Yellow ventrally.

Newly hatched young similar to adult.

Reproduction: Oviparous. One or two soft shelled eggs 12·5 mm. by 7 mm. laid under dead leaves or buried in loose sand. The egg covers have numerous fine longitudinal granular pleats. Young hatched out from eggs sent by Mr. W. W. A. Phillips from Gammaduwa on September 29, 1930.

Dimensions : Just hatched young :—

Snout to arm 9 mm., axilla to groin 9 mm., tail 21 mm., total length 40 mm.

Adult from Gammaduwa. Snout to cloaca 41 mm., tail 52 mm.

Distribution : Under fallen leaves, chiefly in hill country, Hapugastenna, Peradeniya, Namunukula, Kandy, Madugoda, Ramboda, Dickoya, Kotagalla, Gammaduwa (C.P.), Gampaha (W.P.),

Ceylon.

Lygosoma (Sphenomorphus) fallax Peters Plate XXXVII

Lygosoma fallax Peters, MB. Ak. Berl., 1860

Body elongate, limbs short, tail long and somewhat slender. Lower eyelid scaly, ear five scales behind eye, small, round with one or two small lobulate scales on anterior edge, snout short, bluntly acuminate, no supranasals. Scales smooth, subequal. Rostral with slightly concave hind edge broadly contiguous with frontonasal and nasal; nostril in single nasal. Frontonasal touches first loreal, two prefrontals, and at times the frontal and is about half the length of frontal and wider than long. Frontal touches 2nd and 3rd supraoculars and frontoparietal which is azygos and about as long as frontal. Frontoparietal azygos, wider posteriorly than anteriorly and touches 2nd, 3rd and 4th supraoculars, the interparietal and parietals, which latter are narrowly contiguous. Nuchals present or absent, 8-9 supraciliaries, 4 supraoculars, 6-7 supralabials. Mental with straight hind edge contiguous with one chin shield, behind which are two pairs of enlarged shields which are separated in the median line by a single row of scales. 5-6 infralabials, 26-28 scales round midbody, 38-40 scales from axilla to groin; preanals 4, slightly enlarged, subcaudals faintly enlarged posteriorly. Limbs developed. Palms and soles with papillae, rounded rugae on fingers and toes, inner finger 3 rugae, 4th finger 9, inner toe 5, 4th toe 15.

Colour: Dorsally olive brown, head and snout at times darker. A dorsilateral olive yellow stripe above a dark brown lateral band which may be absent. Belly pale olive to yellow. Young, dorsally copper red with five light bands between two wide yellowish lateral bands, under each of which is a black band followed by five thin black lateral bands. Ventrally a pale pink. In adult males, pale blue spots on a pale crimson, dark purple or chocolate coloured throat. Limbs reticulate with dark brown. Iris reddish gold shaded with brown.

Dimensions: Head and neck 13·5 mm., trunk 23 mm., tail 67 mm.

Distribution: Under dry leaves from which they emerge at dawn, midday or twilight.

Colombo, Dehiwela, Horana (W.P.), Kumana (E.P.), Gammaduwa, Kandy (C.P.), Kantalai (E.P.),

Ceylon.

Lygosoma (Riopa) punctata (Linné)

Lacerta punctata Linné, Syst. Nat. i. 1776:
Riopa hardwickii Gray, Cat. Liz. 1845.
Lygosoma punctatum Boulenger, Cat. Liz. iii. 1887.

Pulli hīraluva, Penda rathu hīraluva, Penda dekai hīraluva (S.)

Elongate, limbs weak, do not meet when adpressed, tail thick, contained 1·2 to 1·4 times in head and body and tapers abruptly to a point.

Snout short, bluntly acuminate, lower eyelid with an undivided transparent fenestra, in rare instances one lower lid may be scaly. Ear small, oval, with or without small anterior lobules and five scales behind eye. Supranasals present and contiguous with each other and with rostral. Nostril in a single nasal which is above first labial. Frontonasal wider than long, touches supranasals, first loreal, prefrontals and frontal. Frontal completely separates prefrontals, equal to or somewhat longer than the combined length of frontoparietals and interparietal and contiguous with the first two or three supraoculars. Frontoparietals contiguous with second, third and fourth supraoculars. Interparietal as long as frontoparietal and does not completely separate parietals. A single pair of nuchals and temporals. Six or seven supraciliaries first largest, four or five supraoculars, the second is largest, six supralabials, the fifth is subocular and rectangular. Mental with straight hind edge, touches a single chin shield which is followed by a pair of contiguous ones, behind which are a pair separated from each other in the mid ventral line.

Scales smooth and subequal. Twenty-four to twenty-six scales round midbody, 56 to 58 scales from axilla to groin ; eight from axilla to axilla. Preanals normal or enlarged. Subcaudals not or slightly enlarged. Palms and soles with carinate rugae. Inner finger has four rugae, fourth has nine, inner toe has four rugae, fourth has fourteen.

Colours : Dorsally golden brown, with a yellow lateral stripe from snout, above eye, to hips. Each dorsal scale with a large black centre. Six dorsal rows of such spots between the lateral yellow lines. Belly white or yellow with or without spots.

Tail pale crimson. Young suffused with pale crimson.

Reproduction : Blanford found four eggs in the body of a female he dissected in India. Neck and tail of young narrower proportionately than in adult.

Dimensions : Head and neck 20 mm., axilla to groin 46 mm., tail 70 mm., arm (to wrist) 4·5 mm., leg (to heel) 11 mm. Another with broken tail is 80 mm. from snout to cloaca.

Distribution : Fairly common in arid regions. Diurnal and found under decaying vegetation. Occasionally possesses a double tail caused by regeneration of a new tail from a lateral wound on the tail.

Colombo, Gampaha, Dikkanda, Veyangoda (W.P.), Vakvella (S.P.), Puttalam (N.W.P.), Trincomalee (E.P.), Peradeniya (C.P.).

Ceylon, India.

Lygosoma (Keneuxia) megalops Annandale

Lygosoma (Keneuxia) megalops Annandale, Spolia Zeylanica, Vol III, pt. XI, 1906.

" Habit lacertiform ; length from snout to fore limb contained about 1½ times in the length from the axilla to groin ; limbs well developed, pentadactyle, overlapping when adpressed ; snout short, obtusely pointed ; eye large ; diameter of orbit as great as length of snout ; distance from orbit to ear opening much longer than snout ; ear opening much smaller than eye, circular, without denticulations.

Rostral much broader than deep, forming a straight suture with the frontonasal ; no supranasals ; nasal undivided. Frontal nearly as long as frontoparietals and interparietal together ; interparietal completely separating parietals ; no distinct nuchals. Four large subequal supraoculars ; seven or eight supraciliaries ; six upper and five lower labials. Dorsals and laterals smooth, ventrals feebly keeled ; body scales subequal, imbricate, in twenty-four to twenty-six rows round body ; anals and caudals not enlarged ; no enlarged scale on heel ; middle toe with twelve to fourteen subdigital plates. Colour almost uniform dark brown. Length of head and body 2 inches ; length of tail 2 ⅜ inches.

Localities : One specimen from Puttalam ; another from Kitulgala. " Specimens not seen by me.

Ceylon.

Lygosoma (Keneuxia) halianus (Haly et Nevill)[1] Plate XXXVII

Euprepes Halianus Haly et Nevill, Taprobanian Vol. II, Part II, 1887.
Theconyx halianus Annandale, Spolia Zeylanica Vol, III, Part XI, 1906.

Polon hīraluva (S.)

Adult thick set, with well developed limbs and resembling a Mabuya in general appearance, tail thick at base. Young more elongate, tail correspondingly thin. Lower eyelid scaly, supranasals present, ear minute, without lobular scales, equals nostril in size and is seven scales behind orbit. Scales with three to five faint carinae dorsally, smooth and smaller ventrally, carinae indistinct in young. Rostral with straight hind edge, contiguous with frontonasal, supranasal and nasal which last contains the nostril. Supranasals narrow. Frontonasal as wide as long, contiguous with frontal and first loreal. Prefrontals separate. Frontal about three times as long as wide and narrower than supraocular

1. Nevill named and published in the Taprobanian, of which he was editor, the description of this skink which was written by Haly at his request.

region, touches first and second supraoculars. Frontoparietals distinct, usually touch third and fourth supraoculars. Parietals large, distinct and either contiguous or separated by interparietal which may be small or large. Nuchals present as a single pair or absent. Seven supralabials, of which the fifth is subocular and the longest, seven infralabials, seven or eight supraciliaries, four or five supraoculars. Mental scute with convex hind edge, touches a single chin shield which is followed by two pairs of enlarged shields which are separated from those of the opposite side by a single median row of scales. Twenty-four or twenty-five scales round midbody and thirty or thirty-one scales from axilla to groin, eight scales from axilla to axilla. Preanals not enlarged, subcaudals enlarged, broad and short. Palms and soles with smooth or faintly carinate rugae ; inner finger seven rugae, fourth finger fourteen rugae, inner toe eight rugae, fourth toe eighteen rugae. Third toe nearly as long as fourth. Claws not retractile although Annandale, 1906, after examining spirit specimens at the Colombo Museum thought them to be retractile and formed the new genus Theconyx in consequence.

Colours : Dorsally a greyish olive to white, with black cross bars, ventrally yellow. Young pink with black cross bars. Head has a black cross band from ear to ear. A lateral band runs from each end of this to tip of snout. A shorter band runs on each side of frontal scute and converges with its fellow behind frontonasal. In old specimens signs of this union have disappeared. There is one black band on neck, one on shoulders, three or four on body, one on hips and eight to ten black rings on tail equal to or somewhat narrower than interspaces. No bands on limbs.

Dimensions: Head and neck 26·5 mm., axilla to groin 40 mm., tail 51 mm., arm 20 mm., leg 23 mm.

Distribution : A rare form. According to Haly (1893): "The rarity of this species is accounted for by the fact that it lives on the tops of high trees" a statement open to some doubt, as the specimen taken at Dambulla was on a low mud wall near a pond. Dambulla (C.P.), Elahara, Horana, Anuradhapura (N.C.P.), Palutupana (S.P.), Gampaha (W.P.), Jaffna (N.P.).

Ceylon.

Genus **CHALCIDOSEPS** Boulenger

Palatine bones do not meet at median line. Nostril in rostral and close to its posterior border. No supranasals, prefrontals or frontoparietals. Body anguiniform, limbs very short, tetradactyle.

Ceylon.

Chalcidoseps thwaitesi (Günther)

Nessia thwaitesii Günther, A.M.N.H. (4) IX. 1872.
Chalcidoseps thwaitesii Boulenger, Cat. Liz. III. 1887.

Snout acuminate, mouth terminal, head wide between eyes and merging into neck which is as thick as head. Tail as thick as body, its tip thick and abruptly pointed. Limbs very weak. Young lacertiform ; neck narrower than head, limbs better developed, tail gradually tapering to a point. Eye small, lower lid scaly. Ear much smaller than pupil and 8 to 9 scales behind eye. Distance from eye to ear exceeds that from eye to tip of snout.

Rostral of medium size about one-third of snout, nares in posterior edge of rostral. Frontonasal wider than long and wider than frontal with which it is broadly contiguous. Frontal elongate, twice as long as frontonasal, with sides emarginate anteriorly where contiguous with second supraocular. Five supraoculars, seven supraciliaries. Interparietal triangular and about half length of frontal and narrower than this shield. Parietals contiguous behind interparietal. A pair of nuchals and temporals present. Six supralabials of which the first is largest and the third is subocular. Mental followed by a single chin shield behind which are three pairs of enlarged shields, of which only the first pair are contiguous at the mid ventral line. Five infralabials. Twenty-four to twenty-six scales round midbody. Seventy-two scales from axilla to groin. Preanals not enlarged; scales smooth. Limbs with four toes, of which the inner two are short. Four or five carinate rugae under fourth hind toe.

Colours : Young, darker than adult. Dark brown dorsally, lighter ventrally, each scale with a dark centre ; adult olive brown dorsally, pinkish yellow sides and belly. Each scale with a dark centre.

Dimensions : Total length 107 mm., snout to arm 15 mm., axilla to groin 43 mm., tail 44 mm., hind leg to heel 5 mm.

Lacertiform young—snout to cloaca 35 mm., tail 32 mm., taken July 27th, 1930.

Distribution : A mountain form, above 4,000 feet. Found among dead leaves and vegetation.

Mousakanda Group, Gammaduwa (C.P.), altitude 5,200 feet.
Ceylon.

Genus **ACONTIAS** Cuvier

Depath Hiraluva (S.)

Palatines do not meet in median line of palate which is edentulous. Nostril in the large rostral which partially covers snout, a horizontal

groove connects nostril with posterior border scales. Supranasals, prefrontals and frontoparietals absent. Eye small with or without a transparent fenestra in lower lid, upper lid fixed. Ear present, minute. Body anguiniform, limbs vestigial or absent. Habit fossorial.

South Africa and Madagascar (subgenus *Acontias*), Ceylon (subgenus *Nessia*).

Key to Ceylon Species of Acontias

A.	Four limbs, one loreal	
	1. Tridactyle	*A. burtoni*
	2. No toes	*A. monodactylus*
B.	Fore limbs absent	
	1. One loreal	*A. layardi*
	2. Two loreals	*A. sarasinorum*

Acontias (Nessia) burtoni Gray

Nessia burtonii Gray, Ann. N.H. ii. 1839.
Acontias burtonii Boulenger, Cat. Liz. iii. 1887.

Anguiniform with minute tridactyle clawed limbs. Snout acuminate, jaws strongly overshot, mouth subterminal, head conical. Lower eyelid with a transparent fenestra, ear minute and seven scales behind eye, distance from nostril to eye equals distance from eye to ear. Rostral covers a third of snout, nostril pierced in its anterior end and connected to its posterior margin by a groove. Frontonasal longer than rostral but shorter than frontal which is contiguous with the first three supraoculars and is emarginate laterally where it touches the second supraocular. Interparietal as long as frontal but wider and contiguous with fourth supraocular, parietals narrow and narrowly contiguous. Nuchals in a single row or absent. Supraoculars four, or five, supralabials three, the first equals loreal and much longer than rostral, the second is subocular. Mental moderate, contiguous with a single chin shield behind which are two or three pairs of elongate shields which are separated in the mid line by a single row of scales, infralabials three. Twenty-four to twenty-six scales round midbody, 105 scales from axilla to groin. Preanals at times faintly enlarged.

Colours: Brown, the dorsal scales outlined in darker, lighter ventrally.

Food: Probably consists largely of earthworms as the regurgitated food contains a considerable amount of mud which is similar to that swallowed by earthworms.

Dimensions: Snout to axilla 13 mm., axilla to groin 53 mm., tail 43 mm., depth of body 5 mm.

Distribution: A burrowing form, found under stones. Emerges at night and when caught regurgitates its food. The limbs are scarcely

ever used in moving which is by a series of colubrine twists. Common in hilly country above 100 feet from sea level. Ambagamuwa, Kadugannawa (C.P.)., Allagalla, Rakwana (Sab. P.), Matugama (W.P.).

Ceylon.

Acontias (Nessia) monodactylus (Gray)

Evesia monodactylus Gray, Ann. N.H. ii. 1839.
Nessia monodactyla Günther, Rept. B.I. 1864.
Acontias monodactylus Boulenger, Cat Liz. iii. 1887.

Anguiniform with four toeless limb buds. Snout shorter than in *A. burtoni*, more obtuse, mouth less subterminal. Lower eyelid with a transparent fenestra, ear minute and seven scales behind eye. Rostral shield covers nearly half snout. Nostril in rostral and connected by a groove with its posterior border. Frontonasal somewhat shorter than rostral or frontal which latter is as long as wide with emarginate sides where it is contiguous with the first supraocular. Supraoculars four or five. Interparietal as long as frontal, usually wider, parietals wide and narrowly contiguous. No nuchals. Supralabials two, the first not much longer than rostral, the second subocular. Mental moderate followed by three pairs of elongate shields which are separated from those of the opposite side by a single median row of scales. Infralabials three. A single loreal as long as first supralabial. Scales smooth, 23 or 24 round midbody. Preanal scales not enlarged.

Colours: Brown dorsally, lighter ventrally, each scale outlined with dark brown.

Dimensions: Snout to axilla 30 mm., axilla to groin 70 mm., tail 33 mm.

Distribution: A burrowing form found in mountainous country. Peradeniya, Nawalapitiya (C.P), Moneragalla (U.P.).

Ceylon.

Acontias (Nessia) sarasinorum Müller

Acontias sarasinorum F. Müller Verh. Nat. Ges. Basel VIII. 1889. p. 702, pl. X.

"Head conical, snout obtuse, prominent; ear opening distinct, but very minute; rostral covering not quite half the snout; mental moderate; frontonasal shorter than the rostral or the frontal; the latter shield a little broader than long, angularly emarginate on each side by the first supraocular, 4 supraoculars, interparietal triangular, equilateral, much narrower than the frontal; parietals narrow; 2 loreals, together as long

as the first labial, which is shorter than the rostral; second and third labials entering the orbit. 24 (22?) scales round the middle of the body. Bud-like rudiments of hind limbs. Preanal scales not enlarged. Length of tail about one-third of the total. Pale brown, each scale edged with darker. Total length 5·5 inches; tail 1·9.

Hab.: Ceylon."

The description is Boulenger's adaptation of Müller's account. This species has not been seen either by Boulenger or the present writer.

Acontias (Nessia) layardi Kelaart Plate XXXVIII

Acontias layardi Kelaart, Jour. Asiatic Soc., Ceylon, 1853.

Anguiniform, limbless, occasionally with vestiges of hind limbs. Head conical, mouth subterminal, nostril set in middle of the large rostral. A groove runs from nostril to eye which latter has a transparent fenestra or scales on lower lid. Ear minute and seven scales behind eye. Distance from eye to snout tip equals that from eye to ear. Rostral extends over half snout or slightly less. Frontonasal as long as rostral or frontal or somewhat shorter, wider than frontal, which shield is as long as wide, contiguous with first, second and third supraoculars and emarginate where it touches the second supraocular. Interparietal as long as frontal and wider, at times partially fused with parietals which are narrowly contiguous behind this shield. A single row of enlarged nuchals or none, supraoculars three or four, supralabials four, of these the first is the largest, and as long as the loreal, and slightly longer than rostral. Second labial is subocular. Mental moderate, followed either by a single chin shield or two or three pairs of enlarged shields which are separated from each other in the midventral line by a single row of scales. Infralabials four, scales smooth, 22 to 28 round midbody. Preanal scales not enlarged. At times vestigial hind limbs are present as minute bumps on each side of cloaca and are surrounded by small scales.

Colour: Reddish brown with dark edges to dorsal scales, lighter ventrally.

Dimensions: Snout tip to ear 8 mm., tail 31 mm., total length 106 mm.

Distribution: A burrowing form found under stones and decaying vegetation in mountainous country. Kelaart reports it from Colombo (W.P.), probably a mistake. Gammaduwa (C.P.).

Ceylon.

EXPLANATION OF PLATES

PLATE XXXIII *Lyriocephalus scutatus*
PLATE XXXIV *Cophotis ceylanica*
PLATE XXXV *Cabrita leschenaulti* (1) Ventral view
(2) Enlarged head
PLATE XXXVI *Lygosoma (Sphenomorphus) fallax*
PLATE XXXVII *Lygosoma (Keneuxia) halianus*
PLATE XXXVIII *Acontias (Nessia) layardi*

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Lyriocephalus scutatus

P. E. P. Deraniyagala del

Cophotis ceylanica

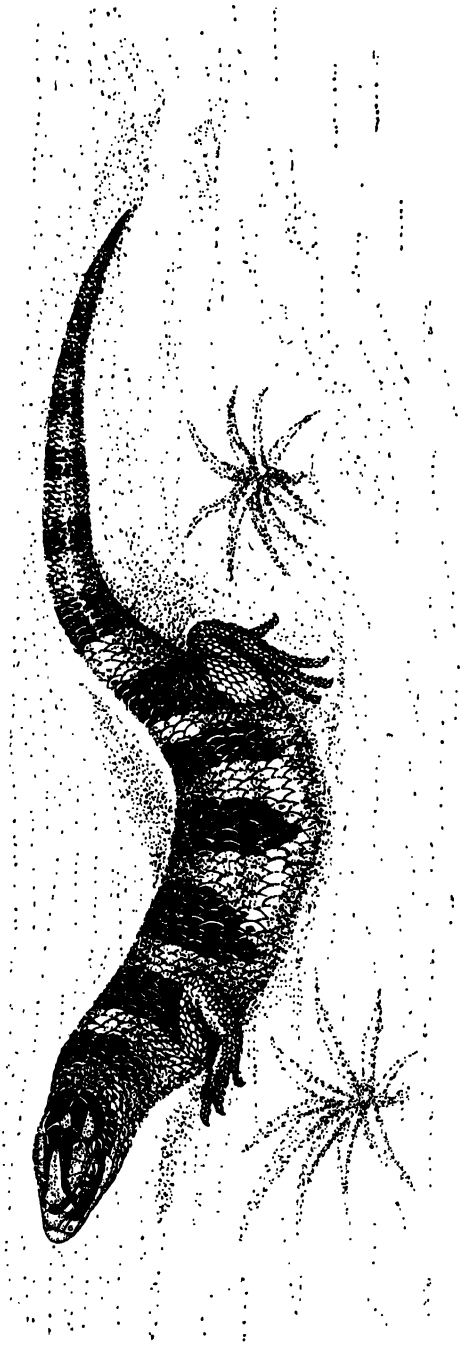
P. E. P. Deraniyagala del.

Cabrita leschenaulti

P. E. P. Deraniyagala del.

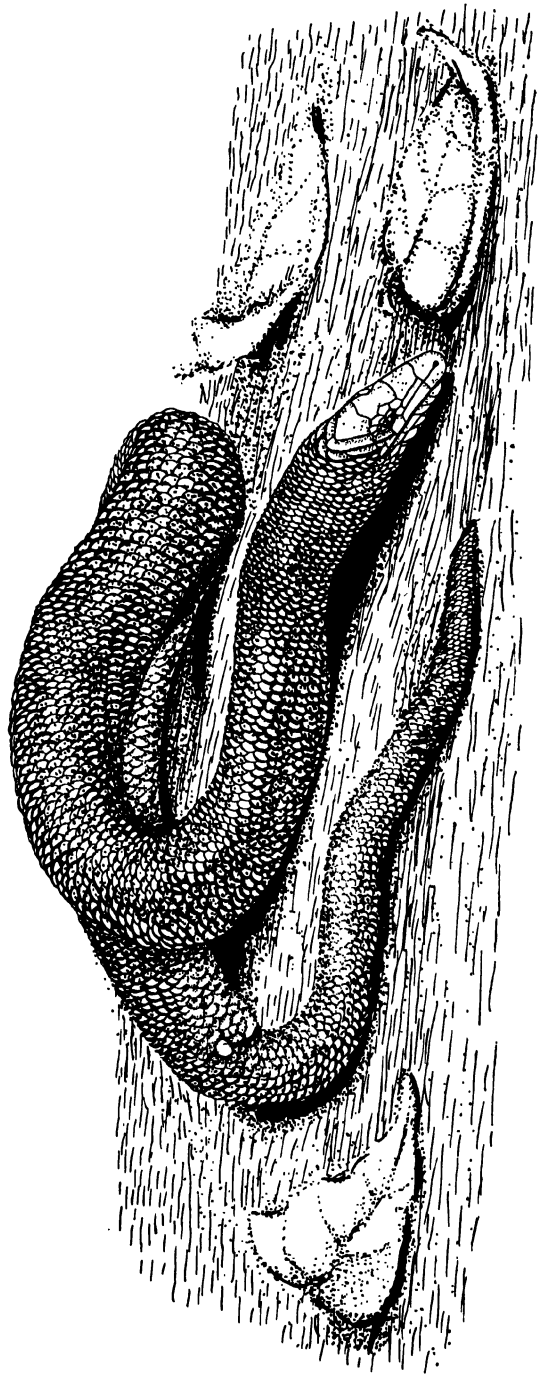
Lygosoma fallax

P. E. P. Deraniyagala del.



Lygosoma (Keneuxia) halianus

P. E. P. Deraniyagala del.



Acontias layardi

P. E. P. Deraniyagala del.

Oceanic Bird Wanderers to Ceylon[1]

BY

W. E. Wait, C.M.G., M.B.O.U.

Before entering on any account of our oceanic bird wanderers we should get a clear idea, from the map, of the position of Ceylon in relation to the surrounding expanse of ocean. Practically due north of us stretches the great wedge of the Indian Peninsula, the only large land surface within hundreds of miles. To the north-west lies the Arabian Sea, which in turn communicates with the two land-locked arms of the Persian Gulf and the Red Sea. To the north-east is the Bay of Bengal, from which lead the Straits of Malacca, opening into the devious water-ways through the Malayan Archipelago to the China Seas and the Pacific Ocean. To the south of us spread the main waters of the Indian Ocean ; flanked on the west by the coast of the African Continent and on the east by Sumatra, Java and the western coast of Australia. Thirty-five degrees south of the equator Cape Leeuwin and the Cape of Good Hope mark the south-eastern and south-western boundaries of this ocean ; but southward the open sea continues without a break through the cold waters of the Antarctic, until we reach the belt of ice which surrounds the South Polar Continent. It is also of interest to observe how the majority of the routes which traverse the Indian Ocean lead directly to Ceylon. The three great steamer-lanes to Europe from Calcutta, Singapore and Freemantle converge off the south coast of the Island. Practically every ship which plies between Port Said and Eastern India, Australia, and the Far East touches at Colombo, or passes within sight of our shores. A less frequented route runs between South Africa and Colombo, while every coasting steamer passing between the eastern and western sides of India has to round the Island.

As I shall mention at the end of my paper this constant passage of steamers round our coast, from all parts of the Indian Ocean, may have some bearing on the number of oceanic bird wanderers which occasionally and unexpectedly turn up on our shores.

While we are still on the threshold of our subject there is yet another point which has to be made clear. How are we to define the phrase " Oceanic Wanderer " ? Following the example of all good scientists

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we must have some working definition of the term, in order that we may form a sufficiently precise idea of the matter with which we are dealing.

In a useful little hand-book, entitled "Birds of the Ocean," published in 1928, Mr. W. B. Alexander includes six groups, or orders of birds, as coming within the scope of his scheme :—

1. *Tubinares.*—Albatrosses, shearwaters and petrels.

2. *Longipennes.*—Gulls, terns, and skuas. In Stuart Baker's " Birds of India " this group is reduced to the rank of a sub-order—*Laro-limicolae,* in the large order *Charadriiformes,* which also comprises the plovers, sandpipers and their allies.

3. *Impennes.*—Penguins.

4. *Alcae.*—Guillemots, auks and puffins.

5. *Steganopodes.*—A comprehensive order which includes frigate-birds, pelicans, gannets and boobies, cormorants and tropic-birds.

6. *Limicolae.*—Waders.—The oceanic members of this order are confined to a small family, the phalaropes or sea snipe.

With two of these orders we, in Ceylon, have no concern. The penguins are a group of flightless, marine, swimming birds, which are mainly confined to the colder waters of the southern hemisphere. In the south of the Indian Ocean they are found off the coasts of South Africa and Australia, but never range as far north as the tropic of Capricorn. In the Pacific one species has its headquarters, on the equator, at the Galapagos Islands.

In the northern hemisphere, the penguins have their counter-part, more or less, in the guillemots, auks, and puffins, which are restricted to the colder seas. Though they are not flightless, and are sufficiently at home in the air as to breed on ledges in precipitous cliffs round the coast, their wings are small and narrow and they spend most of their time swimming and diving.

No representative of the last, little group on the list—the phalaropes —has as yet been recorded from Ceylon, though two of the three species have occurred round the coasts of India, and may yet find a place on our list. I shall return to this group in a short paragraph later on.

The " Birds of the Ocean " which are known to haunt the waters round Ceylon are thus confined to three of the six groups mentioned above. In one of these groups, the *Tubinares,* all the members are strictly oceanic, *i.e.,* they spend the greater part of their existence right out at sea, only coming to land during the breeding season. Most of them nest on oceanic islets, others resort to coastal islands, or in some cases to the more unfrequented shores of the mainland. In the other two groups the members vary from truly oceanic species to those which spend the whole of their existence on inland waters. Some species

are migratory, others breed and live all the year round in one locality. Some again are confined to a comparatively restricted area, others may range all over the world.

Alexander frankly does not attempt to decide whether any particular species is to be considered oceanic, but describes all known species of the groups included in his volume, whether they frequent the open sea, or are found mainly, if not exclusively, on estuaries, lagoons, or inland waters.

Further, as his survey takes in the whole of the globe, he is not hampered by any necessity of defining the term wanderer. For each species there must be some portion of the world, which is to be regarded as its usual habitat; some area, whether circumscribed or extensive, in which its occurrence may be set down, not as casual, but as habitual.

For the purpose of this paper more discrimination is necessary. In order to qualify any bird as a wanderer to Ceylon its occurrence on our shores must be casual and intermittent, not regular. As regards the term oceanic we may perhaps allow a little more latitude, ruling out all species which usually haunt lagoons and inland waters, but admitting a few species, which though not oceanic in the stricter sense, are generally found upon the high seas and the open coast.

We can roughly divide these oceanic wanderers into the following three categories:—

1. Casual migrants, *i.e.*, marine species which breed in higher latitudes and winter in warmer waters, but which do not usually wander quite so far south as Ceylon.

2. Oceanic species which habitually haunt the open seas round Ceylon, but which do not breed on our coasts, and only land here when driven ashore by stress of weather.

3. Chance visitors which are not usually met with in this quarter of the globe. These last may be either oceanic species, driven right out of their usual beat by storms, or chance marine migrants which have strayed half across the world in their wanderings.

We are now in a position to select and describe the various species which can be brought within our definition, and I shall take first the large group which comprises the gulls, terns and skuas. As I have mentioned before, according to Stuart Baker, these three families are included in the sub-order, *Laro-limicolae*, of the order *Charadriiformes*. It so happens that each family illustrates one of the three categories into which I have divided our oceanic wanderers. The gulls give us two species which may be classed as marine migrants a little off their usual beat; the terns three oceanic species which haunt the tropical parts of

the Indian Ocean, but which do not breed on our shores ; and the skuas three species which are not usually met with in this part of the world.

Most of you, I presume, are familiar with the general appearance of the gull family—*Laridae*. They are fairly stout in build ; the wings are long and when closed extend beyond the tail ; the tarsus is fairly short and the feet are large ; the three front toes are fully webbed. The upper mandible of the bill is curved at the end into a moderate hook ; the nostrils are long, oval slits, opening on the sides of the upper mandible without any covering. In all Indian species the tail is practically square. In nearly all forms the mature bird has a white body and tail, while the wings and back are black or gray. In some species the head is white, but many acquire a dark hood in the breeding season. In most species the plumage of immature birds is wholly or partly of a dingy, mottled, light brown colour.

Gulls habitually rest on the surface of the water, sitting very buoyantly. They feed mainly on dead fish, floating garbage and crustaceans. They are not strictly oceanic and few species are found really far out at sea. When gulls are seen hovering round a ship in eastern waters, it is a sign that land is not very far off. Many species are migratory and a large number nest by inland waters, or in marshes in high latitudes, migrating in winter to the shores of seas in warmer climates.

One medium sized species, *Larus brunnicephalus*—The Indian Brown-headed Gull—is a regular visitor to the Island : two other species have occurred and may be classed in our first category.

The first of these is *Larus ichthyaëtus*—The Great Black-headed Gull. This is one of the largest species and has a total length of about 26 inches, with a wing-measurement of about 19 inches. Mature birds have a gray mantle, and in the breeding season the whole of the head is jet black. In the winter this hood disappears, but the upper part of the head and the nape become white, streaked with brownish black. This species breeds on the shores of the Caspian and Black Sea, and on plains adjoining the great rivers and lakes of Central Russia. In winter it migrates to the coasts of North-east Africa and India ; a few specimens are occasionally driven by stress of weather as far south as Ceylon. Unfortunately, as is so often the case, these stragglers are immature birds, with the dull, mottled plumage which is so general throughout the young of the family. They may, however, be distinguished by the tail coverts and base of the tail, which are practically all white.

The second species is *Larus fuscus taimyrensis*—The Dark-backed Herring Gull. This race breeds on the tundras of North Russia and Siberia and winters in the coastal waters of Palestine, Arabia, Mesopotamia and North-west India. It occasionally turns up on our shores

in rough weather, during the north-east monsoon. It is a large bird with a total length of about 24 inches and a wing-measurement of about 17 inches. The adult has a gray mantle, but no dark hood in summer plumage. Here, again, the infrequent stragglers to Ceylon have all been immature specimens in dingy, mottled plumage. The tail coverts, however, and the base of the tail are a mixture of brown and white and not pure white, as in the preceding species.

We now come to the terns—*Sternidae*, a family in which several species are familiar objects on our lagoons and inland tanks during the north-east monsoon. They bear a general resemblance to gulls in structure and appearance, but are usually smaller and slimmer. All our resident species and habitual visitors have the same colour-scheme; pearly grey wings and mantle, white under parts, at any rate in winter plumage, and frequently a black cap.

The bill is generally long, slender, and gently curved, but never hooked. The amount of webbing on the three front toes varies; in some species it is fully developed, in others the web is deeply scalloped.

Unlike gulls, terns seldom settle on the surface of the water and do not usually feed on dead fish, or refuse. They live almost entirely on small fish, which they catch in their bills, diving down on their prey after the manner of a kingfisher. At night they roost on the beach, or on drifting logs or floating sea-weed. At least two species met with round our coasts—the Large Crested Tern and the beautiful Roseate Tern—are almost oceanic in their way of life; but as they breed off our shores in moderate numbers, they must be excluded from our list of wanderers. Both these species wear the typical colour-scheme of the family, save that the Roseate Tern, in living specimens, has the under parts suffused with a beautiful rose-pink; but the three species which can be classed in our second category are, fortunately, easily distinguished from all our other terns by the darker hue of the mantle.

The Panayan and Indian Sooty Terns have forked tails and almost white under parts, but the wings and mantle, instead of being clear gray, are dark grayish brown or sooty black. In the Philippine Noddy the tail is wedge-shaped, and practically the whole plumage is sooty brown. A more detailed description of these three species is as follows:

Sterna anaetheta—The Panayan Tern. An oceanic species which is often seen far from land, and breeds on islands scattered throughout the tropical seas all round the world. It is a bird of medium size with a total length of about 14·5 inches and a wing-measurement of about 10 inches. There is a white arrow-shaped patch on the forehead, which extends above the eyes; the crown, nape and a stripe behind the eye are black; the hind neck is grayish white; the rest of the upper parts,

dark grayish brown. The lower parts are white with a sooty tinge on the breast, abdomen and flanks. The tail is long and deeply forked.

Three races, or sub-species, occur in Indian waters—*Sterna anaetheta anaetheta*, which breeds in the Philippines, and the islands round the mainland from China to the Gulf of Siam, and ranges more or less regularly as far west as Mergui in the south of Burma ; *Sterna anaetheta antarctica*, which breeds on the islands in the west of the Indian Ocean from Mauritius to the Laccadives, and on the Vingorla Rocks off the west coast of India ; and *Sterna anaetheta fuligula*, which nests on islands in the Red Sea and Persian Gulf. Curiously enough, of the few specimens, which have turned up from time to time on our shores and are now in the Colombo Museum, none appear referable to the race which breeds nearest to us. One specimen appears to be the Red Sea form *S. anaetheta fuligula*, and three others *S. anaetheta anaetheta* from the seas farther east of India.

Sterna fuscata—The Sooty Tern—is a slightly larger and darker edition of the Panaya Tern. The total length is about 17 inches with a wing-measurement of 11·5 inches. The white arrow-shaped patch is broader than in the preceding species, but does not run so far back, stopping above the middle of the eye ; while the upper plumage is sooty black. Like the Panayan Tern this bird ranges throughout the tropical and sub-tropical seas. It is even more oceanic in its mode of life, and out of the breeding season seldom comes ashore, except after rough weather, when it occasionally wanders far inland. In November, 1922, a specimen turned up in Bogawantalawa 60 miles from the coast and 4,000 ft. up in the hills.

Only one race is found in the Northern Indian Ocean, *viz.*, *S. fuscata infuscata*, which breeds on oceanic islands from Mauritius to the Laccadives and Andamans. It has been recorded about half a dozen times from Ceylon.

The Philippine Noddy—*Anous stolidus pileatus*—belongs to a single species in the genus, which ranges throughout the tropical seas, except on the west coast of South America. As stated above, the tail is wedge-shaped, not forked, and the general tone of both upper and lower plumage is a dark, smoky brown. The forehead and crown are pale gray, which darkens on the nape to the hue of the body plumage. Noddies are as oceanic as the two preceding species but are slower in their movements. Unlike most terns they seldom hover and plunge after live fish, but settle on the water and feed on small surface molluscs, dead fish and floating fragments of food. The breeding haunts of the sub-species named above stretch from the Japanese Islands to the Laccadives. Several specimens have been obtained at intervals near Colombo.

The last of the three families in the sub-order is the *Stercorariidae*—Skuas. This family is confined to a few species, all of which possess a dingy plumage rather resembling that of immature gulls. They are characterized by their powerful, strongly hooked beak, which is covered at the base by a membrane, or cere; and by their sharp, curved claws. All of them breed in high latitudes, either in the Arctic or Antarctic, but some species range far and wide during the winter and are found further out at sea than most gulls.

Their mode of life is ruffianly and piratical. They obtain their living chiefly by chasing other sea birds on the wing, forcing them to drop any food they have secured, and pouncing on the booty thus relinquished. They also harry breeding colonies of sea birds, devouring the eggs and nestlings. The powerful Antarctic Skua in its summer haunts is said to live largely on petrels.

Three forms have occurred in Ceylon, and all three come within the third of our categories. The most surprising record is that of MacCormick's Skua—*Stercorarius antarcticus maccormickii*. This is a heavily built, powerful bird with a total length of 21 inches and a wing-measurement of about 15·5. The general tone of the plumage is almost grayish brown. In adults the nape and neck are strongly tinged with straw-yellow, and the breast has a fainter wash of the same hue. The wing quills, tail and abdomen are rather darker.

In the immature specimen now in the Colombo Museum the nape, neck and breast are faintly mottled with grayish brown. This specimen was caught in an exhausted state on the beach, during rough weather, by the lighthouse-keeper at Foul Point near Trincomalee. The skin was sent home to the British Museum and identified there. The record seems to be quite genuine, though the actual date is not now available. The bird was thousands of miles off its usual beat, as this form breeds on the Antarctic Continent and is seldom seen north of the Antarctic seas.

There are also in the Museum two skins of an allied sub-species—*Stercorarius antarcticus antarcticus*. This is a rather darker form, with a length of about 23 inches and a wing-measurement of about 15·5. One specimen was obtained at Chilaw in October, 1885, and one at Kalutara in September, 1907. This form breeds in southern latitudes from the Falklands to Kerguelen and Heard Islands. In winter it wanders a good deal further north than MacCormick's Skua, and has been obtained at Walfisch Bay on the west coast of South Africa and in Madagascar. Apart from our Ceylon records, however, neither form has been known to occur in Indian seas.

The third species of skua on our list is a smaller, slighter, northern form—*Stercorarius pomarinus pomarinus*—The Pomatorhine Skua. The general tone of the plumage in adult birds is dark grayish brown. The top of the head is sooty black; round the neck is a white collar, edged with straw-yellow; the bases and shafts of the primary quills are whitish, forming a pale band on the spread wing. There is a phase in which the under parts are much lighter. Young birds are more mottled and barred. In our Colombo specimen the centre of the breast and the abdomen are almost white. The tail is wedge-shaped; the middle feathers are rounded and have a curious vertical twist. The total length of the bird is about 21 inches and the wing-measurement about 14.

The Pomatorhine Skua breeds within the Arctic circle on the most northerly swamps and marshes. During the winter it ranges far and wide, having been recorded from Peru, South Africa and Australia. It has only been found in Indian seas twice; once at Colombo in 1912, and once at Moulmein in North Burma.

The second order for our consideration is that known as the *Steganopodes*. This order comprises five families which differ considerably in outward appearance, but all members may be distinguished at once from other birds by their feet, in which all four toes are webbed. The hallux or hind toe, which is long, is turned inwards and forwards, and is connected by the web to the three front toes.

With two of the five families we have, now, no concern, as none of the pelicans and cormorants found in Ceylon frequent the open sea, but are restricted to inland waters and lagoons. The other three families are oceanic, and all three furnish species, which breed on islets scattered over the Indian Ocean, and may be placed in the second of our categories.

We will begin with the frigate-birds—*Fregatidae*. "The large tropical sea birds which constitute this family," as Alexander remarks, "are the most completely aerial of waterbirds, and perhaps of all birds except swifts." Their enormously long wings and slender build give them a power of flight unsurpassed even by the albatrosses. Though often met with in mid ocean they seldom settle on the water, and owing to their very short legs, would probably find some difficulty in rising from the flat surface of a calm sea. At night they return to their headquarters to roost on trees near the shore. Like the skuas they obtain their food largely by chasing other birds on the wing and forcing them to disgorge, but they will also swoop down to the water, to catch with their bills such fish, crustaceans and infant turtles as show themselves on the surface. They are also apt to develop cannibal instincts, during the breeding season, if any young chick in a neighbouring nest is left unguarded. The homing instincts of frigate-birds are strong,

and in some of the Pacific Islands they are tamed sufficiently to be used, like carrier-pigeons, for conveying messages from one island to another.

A dried skin, or stuffed specimen, gives one a very poor idea of the living bird. The effortless ease of its flight must be seen before one can realize the grace of the bird in its natural element, the air.

The prevailing colour of the plumage in all species, especially on the upper parts, is black. As stated above, the wings are extremely long and pointed, while the tail is long and deeply forked. The bill is long, slender and sharply hooked at the tip, which is covered by a dertrum or nail. The tarsus is very short and is feathered, a sure sign that the bird is not a constant swimmer.

The feet are small for the size of the bird, and the webbing between the toes is not very fully developed. There is a naked patch on the chin; in males this becomes a bright red pouch, which can be inflated to a large size; it is in fact sported by the cocks as a courting adornment.

Three species breed on islets within the limits of the Indian Ocean, and all three have been recorded, on rare occasions, as storm-driven waifs to our shores. Immature birds of the various species are rather confusing, as all have white heads, while the white area on the under parts is apt to be more extensive and less well-defined than in the adults of either sex. Adults of the three species may be distinguished as shown below :

Fregata minor aldabrensis—The Great Frigate-bird. The male is black all over, with a brown band across the wing. In females there is a brown collar round the neck; the chin and throat are white, mixed with a little brown; the lower neck, breast and sides are white, but the abdomen is black. The total length is about 40 inches and the wing-measurement about 24. This race breeds on Aldabra and the Seychelles and has once been recorded from Ceylon.

Fregata andrewsi—The Christmas Island Frigate-bird. This species is practically of the same size as the last. The male, however, has a white abdomen. In the female the throat is black, but both the breast and abdomen are white.

The breeding range of this species, so far as is known, is restricted to Christmas Island, south-west of Java. It wanders over the north-east of the Indian Ocean and has occurred in Ceylon on several occasions.

Fregata ariel iredalei—The Lesser Frigate-bird. This is somewhat smaller than the other two species, the total length being about 30 inches and the wing-measurement about 22. The male is entirely black above; the under parts are slightly more brown, and there is a splash of white on each side of the abdomen. In the female this white patch is more

extensive and covers not only the side, but the whole fore-part of the abdomen and the breast.

The present sub-species breeds on oceanic islands from Aldabra to the Cocos-Keeling group, and ranges over the tropical Indian Ocean, from Madagascar and the Somaliland coast to Ceylon. It is the least rare of the frigate-birds in its visits to the Island, and there are three specimens in the Colombo Museum.

The next family is the *Sulidae*—Gannets and boobies. They are all heavily built birds, about the size of a goose. The neck is stout and of medium length ; the bill is powerful and pointed, while the inner margins of both mandibles are serrated. Young birds have small nostril holes near the base of the bill, but in adults these openings are completely closed. The wings are long and pointed, the tail fairly long and wedge-shaped, and the tarsus short, but powerful.

The family is found all over the world ; the more active gannets inhabiting temperate seas, and the more sluggish boobies the warmer waters of the tropics. They are all birds of the open sea, nesting on oceanic islands, or precipitous cliffs, and, except in the breeding season, they spend most of their time away from the land. They are excellent swimmers and voracious fish-eaters, frequently diving from a considerable height and pursuing their prey under water. It is stated by Alexander that gannets have been caught entangled in fishing nets at a depth of ninety feet.

Young birds of nearly all species are brown, and the full adult plumage, which in most forms is mainly white, is not assumed until the second or third year.

Three boobies which range all round the tropics breed in the Indian Ocean. Two species have occurred in Ceylon and the third may yet turn up.

The first of these is the Brown Booby—*Sula leucogaster plotus*. Adults have the whole of the upper parts, including the head, neck, wings, and tail, chocolate brown. The lower parts are white, and there is a patch of white on the wing-lining. The bill and the naked skin round the eye and on the throat are yellow ; the legs and feet are pale yellow and the iris silvery gray. The total length is about 29 inches and the wing-measurement about 15·5. This sub-species breeds off the north coast of Australia, and ranges throughout the Malayan Archipelago. It has strayed several times to Ceylon, and has once been recorded from the Laccadives.

The second species is *Sula dactylatra*—The Masked Booby, in which the adult bird is mainly white. The tail, most of the wing quills and the greater wing coverts are chocolate brown. The naked facial skin is

bluish-black. The total length is about 34 inches and the wing-measurement about 16·5. Two sub-species or races are found in the Indian Ocean. *Sula dactylatra melanops* is the western form, which occurs from the Red Sea and Persian Gulf to Madagascar. It has been recorded from the west coast of India. In this race the bill is greenish yellow and the legs and feet dark, slaty blue, at times almost black.

The only specimen in the Colombo Museum came from the north-west coast of Ceylon and appears to belong to the eastern form, *Sula dactylatra personata*, with a rather coarser bill, which is yellow without any green tinge, and paler, greenish blue legs. This race is found in tropical Australian waters, and ranges through the Malayan Archipelago to the coasts of Indo-China, occasionally straggling westwards to the Bay of Bengal.

The third species, which has not yet turned up in Ceylon, is *Sula sula rubripes*—The Red-legged Australian Gannet. It has much the same range and general appearance as *Sula dactylatra personata*, but may be distinguished by its red legs, feet and bill, and its white tail. The naked facial skin is purplish, or reddish.

The last family in the order is the *Phaëthontidae*—Tropic-birds. It comprises only a few species; which, as the English name implies, are confined to tropical seas. Even in the dried skin their beauty and grace of form is manifest. In size, build, and general appearance they are not unlike the larger terns, but at all ages they may be distinguished by their feet, in which all four toes are webbed, while in adults the two central tail feathers are produced into long, narrow streamers. Their flight rather resembles that of a pigeon. They breed on oceanic islands and for the greater part of the year may be met with far out at sea. They swim well and easily, riding high in the water and keeping their tails elevated. They feed mainly on small fish and squids. Like terns, they spend most of their time on the wing, swooping down on their food from a height, but not diving. They capture live fish with their bills, but when following in the wake of a ship they pick up scraps with their feet.

Immature birds are barred on the back with black and in one species this barring persists in the adult; in the other forms the adult plumage is mainly satiny-white, with some black on the wings.

Three forms breed within the Indian Ocean; one has definitely occurred in Ceylon. The other two may turn up some day, in fact one of them is said to have been seen in the Gulf of Mannar.

The first of these is *Phaëthon lepturus lepturus*, of which several specimens have been obtained near Chilaw and Colombo, while others have been seen in Ceylon waters. This form is found over the whole of

the tropical part of the Indian Ocean. It breeds in Rodriguez, Mauritius, the Seychelles, and probably on other scattered islets within its range. The wing-measurement is about 10·5 inches, and the long, white black-shafted streamers run to about 18 inches. The bill is pale yellow.

The Short-tailed Tropic-bird—*Phaëthon indicus*, is another species, which is said to have been seen in the Gulf of Mannar. This is the form in which adults as well as young birds are barred on the back with narrow black markings. The streamers are shorter than in the preceding species and run to about 12 inches. The bill is orange red or dusky red. It breeds in the Persian Gulf and ranges over the Arabian Sea.

The third species is *Phaëthon rubricauda*. Adults may be recognized at once by their beautiful carmine red streamers. One sub-species, *P rubricauda rubricauda*, is found in the western Indian Ocean from the Red Sea and Persian Gulf to Mauritius. Another race, *P. rubricauda westralis*, breeds on Christmas Island and off the north-west coast of Australia. Individuals of either race may some day straggle to Ceylon.

The third of the three orders of marine birds in which we are interested is that of the *Tubinares*. Like the *Steganopodes*, members of this order possess an external character by which they may be distinguished at a glance from all other birds. They are the only birds in which the nostrils are carried in short external tubes, instead of being mere slits in the upper mandible.

Classification within the order has been, and still is, a matter of some controversy. For our present purpose it will be most convenient to follow a scheme which recognizes three families :—

1. *Diomedeidae*—Albatrosses.
2. *Puffinidae*—Petrels and shearwaters.
3. *Procellariidae*—Stormy petrels.

The scientific name *Puffinidae* is a little disconcerting to the tyro who would imagine that there was some relation between this family and the well-known English Puffin. This is not the case, however, as that bird belongs to a very different order, the *Alcae*, and has little structural affinity with the shearwaters.

All three families contain a large number of species, all of which are oceanic. The great majority of forms are met with in cold or temperate seas, and only a small number are found in the northern parts of the Indian Ocean.

Except in the Pacific, those magnificent sea-birds, the albatrosses, are seldom seen north of a line drawn about 30° south of the equator, and none ever venture into the tropical seas between Africa and North Australia. Our Ceylon records, therefore, are confined to a few members of the other two families.

The *Puffinidae* are usually birds of medium size—the four species on our list range from 14 to about 20 inches in length—and distinctly sober plumage. The upper mandible of the bill is deeply grooved and generally sharply hooked at the tip ; the three front toes are fully webbed ; the wings are long and pointed.

Petrels usually breed on islands, or on steep cliffs on the mainland, and lay their eggs in holes, burrows or rock-crevices. Out of the breeding season they spend most of their time at sea. Some species confine themselves to a more or less restricted area in the vicinity of their breeding grounds, others undertake long ocean migrations about which little is, as yet, known. They seem, however, to conform to some instinctive plan which is as definite as the migrations of land-birds ; while, as with land-birds, certain individuals of the more migratory species are apt to wander, now and then, far from their usual course : a fact which would account for three out of four of our Ceylon records.

Petrels, especially shearwaters, generally skim low over the waves with a rapid, gliding flight, occasionally interrupted by wing-flaps. They frequently glean their food from the surface as they fly, but at times they will settle and feed while swimming. In the breeding season they usually congregate into vast colonies, and, even at sea, may be met with in flocks.

Four species have occurred in Ceylon, but three of them are stragglers from outer seas and only one can be said to come within our second category.

This is *Puffinus pacificus hamiltoni*—The Wedge-tailed Shearwater, which breeds in Mauritius, the Seychelles and other islands in the western Indian Ocean, and ranges at other times as far north-east as Ceylon. There are several skins in the Colombo Museum. The upper plumage is dark, smoky-brown ; the under parts a little paler, and with a grayish tinge, which is most pronounced on the chin and throat. The bill is greenish, and the legs and feet fleshy white. The total length is about 16 inches and the wing-measurement about 11.

P. carneipes carneipes—The Flesh-footed Shearwater, has practically the same colour-scheme, but is somewhat larger, with a total length of about 19·5 inches, and a wing-measurement of 12·5. The bill, legs and feet are flesh-coloured. This bird breeds on the west coast of Australia, and the specimen, now in the Colombo Museum, which was found at Panadure, is the only record for the seas round India.

A second straggler is *P. leucomelas*—The White-fronted Shearwater. It is of about the same size as the last-mentioned species, with a slightly longer wing and a somewhat shorter tail ; but is at once recognizable, as the whole of the lower parts are white. The face and neck are streaky

black and white, and the upper parts dusky brown with rather paler edges to the feathers. This species breeds off the coasts of Japan, and ranges southward to the Philippines and New Guinea. The only record for Indian seas is a specimen caught at Mt. Lavinia and now in our Museum.

The last truant member of the family is the Cape Pigeon—*Daption capense*. This petrel hails from the far south. It breeds on scattered islets all round the Antarctic seas, and is the commonest species in the southern hemisphere. In the winter it ranges into temperate latitudes and has been seen even north of the equator. Once again, however, the only record for Indian seas is a single specimen, obtained many years ago in the Gulf of Mannar.

It is smaller than any of the three preceding species, the total length being about 14 inches and the wing-measurement 10·5. For a petrel, its plumage is distinctive and variegated. The under parts are white; the head, hind-neck, upper back and wing coverts are brownish black; the wing is pied black and white, while the feathers from the centre of the back to the tail coverts are chequered black and white; the tail is white at the base with a broad, black, terminal band.

The two remaining members of the order are little birds, about the size of a magpie robin, which belong to the family *Procellariidae*—Stormy petrels. They have much the same habits as their larger relatives, but are more daintily built. Their wings are rather broader in proportion; their legs are more slender and generally longer. They fly very low over the water, following the undulations of the waves so closely that they frequently pat the surface with their feet. Their flight is often erratic, reminding one of a butterfly wandering round a bed of flowers. They are frequently seen in squally weather and their appearance is looked upon by many seamen as heralding a storm.

The first species, *Oceanites oceanicus oceanicus*—Wilson's Petrel, is not uncommon on the seas round the island. Small parties may occasionally be seen a few miles out from Colombo harbour, especially during squally weather at the change of the monsoons, but it is very seldom driven ashore.

It is the most widespread and common member of the family. It breeds in southern seas, but wanders in winter as far north as California, Labrador and the British Isles. The race found in Ceylon breeds in the South Orkneys and South Georgia, and ranges at other times all over the South Atlantic and Indian Ocean. The upper parts are sooty black; the forehead and under parts rather browner and paler; the greater wing coverts are grayish brown; the upper tail coverts and hindmost flanks pure white. The legs are fairly long and the tail square.

The second form *Oceanites homochroa socorroensis*—The Ashy Storm Petrel, is of practically the same size with a length of 7·5 to 8 inches and a wing of just over 6 ; but it has a forked tail, shorter legs, and no white band across the tail coverts. The species is found over the Northern Pacific from Japan to California and southwards to the equator, but curiously enough, the only specimen obtained in Ceylon was sent home to the British Museum for identification, and turns out to belong, not to the Japanese race, but to a sub-species which breeds off the coast of California and Mexico.

It was taken two or three years ago at Colombo, and Mr. Stuart Baker informs me that, about the same time, several other specimens of this race visited the Straits Settlements. Its occurrence here seems due to a sudden impulse, which at times moves migratory birds to extend their winter journey. Among land-birds the Rose-headed Starling and Short-eared Owl are well-known species which undertake such invasions at more or less regular intervals.

This concludes the list of the oceanic bird wanderers recorded from Ceylon. The beginner may think that list somewhat lengthy, and wonder how he is to determine, from it, the identity of any strange marine species which may possibly come his way. The task, however, is not really difficult. Any specimen may be referred at once to its proper order. If all four toes are webbed it is one of the *Steganopodes*; if there are external nostril tubes it belongs to the *Tubinares* ; if it has neither of these peculiarities it will be one of the *Laro-limicolae*.

Each order, again, is divided into fairly clear-cut families, and thus one should arrive at the species without any insuperable difficulty. The question of the sub-species, however, in many cases requires expert knowledge and comparison with a series of other specimens.

We now come to a subject on which I promised further information at the beginning of my paper. There is a curious little family of a fourth order, the *Limicolae*, or Waders, of which representatives may, one day, occur on our shores ; but, here again, identification at a glance is quite easy. This little group—The phalaropes—is closely allied to the sand-pipers ; in winter they wear the gray and white plumage so characteristic of many sand-pipers, so, if anyone comes across a "swimming snippet," in which each of the three front toes is bordered by a broadish fringe of skin, like the lobed toes of the coot or dabchick, he will know that he has added a phalarope to the list of Ceylon birds. Phalaropes breed among the pools and rivers of the marsh-lands which, both in the Old World and in America, occupy such a large portion of the area in, or near, the Arctic circle. In winter, like many other

sand-pipers they migrate far southwards. Their winter quarters, however, are not on land, but in tropical seas.

The species most likely to occur is the Northern Phalarope—*Lobipes lobatus*. In Asia the main winter haunts of this species are certain fairly definite areas in the Arabian Sea, off the Mekran Coast, and in the seas off Borneo and the Northern Coast of New Guinea. It is just possible that stragglers from the Arabian Sea may eventually wander as far south as Ceylon.

Before I conclude I should like to revert briefly to the three categories into which I divided our oceanic wanderers, and to take another glance at the map.

All round the world the main oceans extend southwards, from the equator to the polar regions, in broad expanses of water; but whereas the Pacific and Atlantic are also open to the north, the Indian Ocean is closed on the north by the Asiatic Continent. Ceylon is situated as an out-post close to the Indian Peninsula, that great central bastion of the land-mass which forms the northern boundary of the tropical seas between Africa and North Australia. We do not, therefore, find in Ceylon any marine migrants which breed in northern seas, and which migrate, coast-wise, in winter to tropical waters. Migrant visitors from the southern temperate coasts are not numerous and most of them are so rare as to come within the third category.

The only members of the first category—casual marine migrants, which even in winter frequent the coast—are two gulls, which breed far inland and migrate over land to their usual winter quarters in the Arabian Sea.

The second category, as I stated before, consists of oceanic birds which do not breed in Ceylon, but which more or less habitually frequent the tropical waters of the Indian Ocean. It comprises three species of the tern family, three frigate-birds, one booby, one tropic-bird, one shearwater and one stormy-petrel, *i.e.*, ten species in all. The third category consists of rare stragglers from the Malayan Archipelago or from the temperate waters of the South Indian Ocean, *viz.*, one shearwater and one booby, or unexpected visitors from the outer seas. The latter include two skuas and one petrel from the Antarctic, and one petrel, one stormy-petrel and, probably, one skua from the Northern Pacific.

To sum up, out of the 20 species, definitely recorded, 10% are casual migrants which come to us from the north, down the coasts of the Indian Peninsula; 50% are oceanic birds which haunt the tropical parts of the Indian Ocean; while no less than 40% come from far distant waters.

You may notice from my previous remarks on each species that, of the eight birds in our third category, only two, the Pomatorhine Skua and Brown Booby, have been recorded from localities in India. For the other six species the Ceylon records are the only records from Indian seas.

It seems to me that the location of Ceylon, at the focus of so many important steamer routes, has considerable bearing on the question. I do not imply that the birds have been brought here by deliberate human agency. I do not think that any of them are species which would be likely to survive captivity for more than a day or two on board ship, and practically all our oceanic visitors, even those from the Indian Ocean, have been obviously storm-driven. Many of them, when found, have been at their last gasp.

Most of the specimens in the Colombo Museum have been secured simply because they were too exhausted to swim or fly properly. The only wanderer which I myself have handled alive, or in the flesh, was a Sooty Tern, which I found on the beach a few miles north of Puttalam. It was too exhausted to move its wings for more than a stroke or two at a time. I picked it up and tried to revive it but it refused all food and died during the night.

Let us try to imagine the position of an oceanic bird, which has been driven far out of its course by a storm, and is wandering over the Indian Ocean. It is so weary and buffeted about that its senses are confused and it has lost control of that strange instinctive faculty which would, normally, enable it to direct its course homewards.

If it is lucky it eventually sights a steamer. Now, even in the farthest seas, except in the far south of the Antarctic, a steamer must be a fairly familiar object to all sea-birds. Our wanderer may, in some dim way, hope that it will prove to be a guide to accustomed surroundings. At any rate it will provide food; scraps from the galley if it feeds upon garbage, or, if it rejects such fare, small fishes and other little forms of marine life which are killed or stunned by the revolutions of the screw, and which float to the surface in the wake of the vessel. The masts, rigging and awnings of the boat would afford a temporary resting place, though such a perch is more often resorted to by stray land-birds on migration, than by oceanic waifs. And so our bird struggles on, keeping up with the steamer. In most parts of the Indian Ocean, say from 10° north to 30° south and eastward of 55° east, it is not very far short of an even chance that the boat is heading for Colombo, and that Ceylon will be the first landfall. As soon as land is sighted, the bird leaves the vicinity of the vessel and struggles ashore.

Such an explanation would afford a possible reason for the occurrence of so many strange species on our list. I would not advance it dogmatically. It may, perhaps, be that the central geographical position which has made Colombo such a rendezvous for steamers has also made Ceylon, as it were, a magnet for oceanic wanderers. I offer the explanation for what it is worth, and having offered it, bring my paper to a conclusion.

A Note on the False Killer Whale, Pseudorca crassidens (Owen)

BY

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Marine Biologist to the Ceylon Government

WITH THREE PLATES

On August 3, 1929, a school of 167 large dolphins varying from six to fifteen feet in length was stranded on the Island of Velanai near Kayts in the Northern Province (Plate XXXIX). Owing to the remoteness of the spot I was not informed of this occurrence for some time and when Mr. E. C. Fernando, the Taxidermist of the Colombo Museum, reached the spot the carcases were in an advanced stage of decomposition and many of them had already been buried. Several females gave birth before they died but Mr. Fernando was unable to examine or preserve any of the material owing to its decomposed condition. Ultimately two complete skeletons and twelve skulls were procured for the Colombo Museum and on examination they proved to be the False killer whale *Pseudorca crassidens* (Owen) sometimes known as the Lincolnshire Killer or Tasmanian Blackfish. This was not a new record for Ceylon as a complete skeleton has been in the Colombo Museum for many years prepared from a specimen captured at Moratuwa, Western Province, in 1891 (month unknown).

Whales, presumably from the southern seas, are not infrequently stranded on the Ceylon coast, but precise records of such occurrences are difficult to obtain owing to (*a*) the ignorance of the fishing population, (*b*) the inaccessibility of a large part of the coast, and (*c*) the rapidity with which a whale carcase disintegrates in the tropics.

Pseudorca crassidens has a very interesting history. It was first described by Owen in 1846 from a fossil skull found in the Lincolnshire fens.[1] Owen named it *Phocaena crassidens*. Fifteen years later this

1. Nearly eighty years later two other fossil skeletons of this species were unearthed near the place where the original specimen was found. (Garrod. 1924. p. 177)

species appeared in the flesh on several occasions in the Baltic and provided Professor Reinhardt with material for a monograph (Reinhardt, 1862) in which he assigned the species to a new genus, *Pseudorca*. Most subsequent writers have accepted this generic distinction though the points in which it differs from *Orca* are not very great. In 1864 Flower established the species *meridionalis* for the Tasmanian Blackfish which he believed to differ from the northern form (Flower, 1863), but twenty years later the same writer stated that he had been unable to detect any constant differences between the northern and southern forms (Flower, 1883).

Our knowledge of the teeth and skeleton shows that the species is subject to considerable variation, but nothing definite has been determined which would indicate that the northern and southern forms are distinct and unfortunately no evidence on this point is available from an examination of the soft parts.

Pseudorca crassidens is now the accepted name but at various times it has been described under different names and has acquired a somewhat complicated synonymy as may be seen from the following:— *Phocaena crassidens* Owen, 1846, *Orca crassidens* Gray, 1846, *Pseudorca crassidens* Reinhardt, 1862; *Orca meridionalis* Flower, 1864; *Orca destructor* Cope, 1866; *Globicephalus grayi* Burmeister, 1868; *Pseudorca meridionalis* Hector, 1873; and one or two other doubtful identifications.

Distribution: The distribution of this species is world-wide and presents points of exceptional interest. In Europe it has been found as a fossil in the Lincolnshire fens on two occasions and the living animal has been recorded from the Baltic, the North Sea, and the Mediterranean. On the Atlantic coasts of America it has been recorded from Florida, the Caribbean Sea and the Argentine. Its occurrence has also been noted from California and Peru on the Pacific side of America. It is apparently abundant in the South Pacific where there are records from Tasmania, New Zealand and Chatham Islands. It has been recorded in the Indian Ocean from Ceylon and Travancore (South India) and recently (December, 1928) a large school was stranded near Cape Town. Flower described this form as rare, but Oliver stated that it is to be found in large shoals in New Zealand and Tasmanian waters.

Pseudorca crassidens is fairly common in the colder waters of the southern hemisphere, and apart from the few records from the north-west coast of Europe the known distribution of this species is not inconsistent with the view that it is a sub-antarctic oceanic form which occasionally wanders northward in large schools into the Pacific, Atlantic and Indian Oceans. Is it not possible to regard the occurrence of this species in the North Sea as fortuitous? I am inclined to this

opinion and regard the three recorded appearances of this cold-water species in South India and Ceylon as being less remarkable than the comparatively few records from the North Sea.[1]

It would be interesting to know whether the occurrence of this cold-water form in tropical waters is accidental or whether there is a definite seasonal migration during the breeding season in order that the young may be born under conditions less rigorous than those which obtain in higher latitudes. The school recently recorded from Ceylon contained many pregnant females and appeared in the month of August which is a winter month in the Antarctic Seas. Unhappily for this hypothesis the solitary recorded appearance of this species in India occurred in the month of February.

This whale is black in colour; the pectoral fin of moderate size, narrow and pointed. The dorsal fin is situated near the middle of the back and is of moderate size. The head in front of the blow-hole is high and compressed anteriorly. The snout is truncated.

Measurements : The following are the measurements of the Velani skeleton:

Length of skull	56·5 cm.
Greatest width of skull	30 cm.
Length of cervical region of vertebral column	10 cm.
Length of dorsal ,, ,, ,, ,,	76·5 cm.
Length of lumbar ,, ,, ,, ,,	98 cm.
Length of caudal ,, ,, ,, ,,	170·5 cm.
Total length of skeleton	401·5 cm.

Skull: The skull, which has been described in detail on more than one occasion, calls for no special comment. (Views of the skull are shown in Plate XLI).

Teeth: Teeth are present in upper and lower jaws and the dentition shows considerable variation. The number varies between the two extremes $\frac{8+8}{8+8}$ and $\frac{11+11}{12+12}$ and the most usual dentition would appear to be $\frac{8+8}{10+10}$.

The following table gives the dentition of all recorded specimens :—

Dentition.	$\frac{8+8}{8+8}$	$\frac{8+8}{9+9}$	$\frac{8+8}{10+10}$	$\frac{9+9}{9+9}$	$\frac{9+9}{10+10}$	$\frac{9+9}{11+11}$	$\frac{10+10}{10+10}$	$\frac{11+11}{11+11}$	$\frac{11+11}{12+12}$
No. of specimens.	1	3	9[2]	7[3]	5	1	4[4]	1	1

1. It is not unlikely that the records from Kiel in November, 1861, and from the Baltic Islands in the following summer had reference to the same school of whales.

2. Also one specimen $\frac{8+8}{9+10}$ which may be included in this group.

3. Also one specimen $\frac{8+9}{9+9}$ which may be included in this group.

4. Also one specimen $\frac{10+9}{10+10}$ which may be included in this group.

There does not appear to be any racial distinction between northern and southern forms as regards teeth. For instance, an examination of 15 Ceylon skulls, 14 of them belonging to the same school, presumably southern forms, gives the following result :—

Dentition.	$\frac{8+8}{9+9}$	$\frac{8+8}{10+10}$	$\frac{9+9}{9+9}$	$\frac{9+9}{10+10}$	$\frac{10+10}{10+10}$
No. of specimens.	2	4	4	4	1

Vertebral column : Flower and Lydekker, in their well-known book on "Mammals," gave the vertebral formula as C 7, D 10, L 9, C 24 (Total 50), and Beddard in the "Mammalia" of the Cambridge Natural History agreed. Reinhardt (1862) gave C 7, D 10, L 10, C 23. Probably the discrepancy is due to the interpretation of the two vertebrae to which the first chevron bone is attached. Reinhardt considered the hindmost of the two vertebrae to be the first caudal. If, however, we accept the foremost vertebra of the two as being the first caudal we find there are only 9 lumbar and 24 caudal vertebrae.

In the Velani skeleton, which has recently been mounted for the Colombo Museum (see Plate XL), we have the following arrangement:—

Cervical : First six vertebrae fused, last one free.

Dorsal : There are 11 dorsal vertebrae and 11 pairs of ribs. The first six pairs of ribs are double headed and the first seven pairs are connected with the sternum by means of sternal ribs. The 8th rib has a sternal rib which, however, does not actually reach the sternum. The last three pairs are without sternal ribs and the 11th pair do not reach the vertebral column. Reinhardt quotes a somewhat similar circumstance in the Middelfart specimen described by him "an eleventh dorsal vertebra is to be found behind the tenth and to this additional vertebra an eleventh rib belongs, lying loose in the flesh on the right side, to which we find no corresponding rib on the left side." As the eleventh pair almost reach the vertebral column we are justified in giving the number of dorsal vertebrae as 11.

Usually there are 10 pairs of ribs and in the two other complete skeletons in the possession of the Colombo Museum there are 10 pairs.

Lumbar : If we follow Reinhardt in his definition of the 1st caudal vertebra, there are 10 lumbar vertebrae.

Caudal : There are 22 caudal vertebrae. A very careful search did not reveal the presence of an additional vertebra, but it is not improbable that the last caudal vertebra has been lost. This gives a formula of C 7, D 11, L 10, C 22 (?).

Pectoral girdle and fore limb : These agree with the descriptions given by Reinhardt except that the two carpal bones opposite the ulna are fused. (In the skeleton obtained at Moratuwa in 1891 the carpal bones are five in number as shown by Reinhardt).

Pelvic girdle : The pelvic girdle is shown in Plate XL. Each half is a curved rod 18·5 c.m. long.

Since the above note was written a contributor to *Nature* (December 6, 1930, p.892) stated that this species is "regarded as on the verge of extinction." In the same journal (January 10, 1931, p.60) Sir Sidney Harmer expressed the opinion, with which I agree, that there appears to be very little justification for this belief.

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EXPLANATION OF PLATES

PLATE XXXIX

School of *Pseudorca crassidens* stranded at Velani near Kayts.

PLATE XL

Skeleton of *Pseudorca crassidens* from the left side. ($\times \frac{1}{28}$)

PLATE XLI

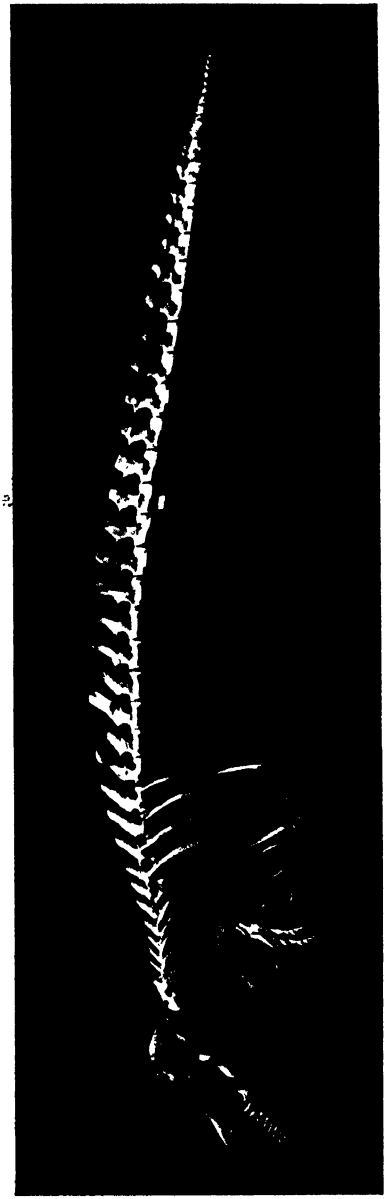
Skull of *Pseudorca crassidens.*

A. Showing the palate. ($\times \frac{1}{7}$)

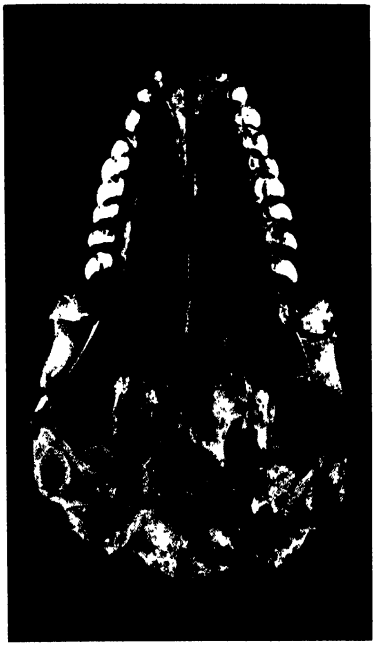
B. Dorsal view. ($\times \frac{1}{7}$)

C. Lateral view. ($\times \frac{1}{5}$)

Pseudorca crassidens



Pseudorca crassidens



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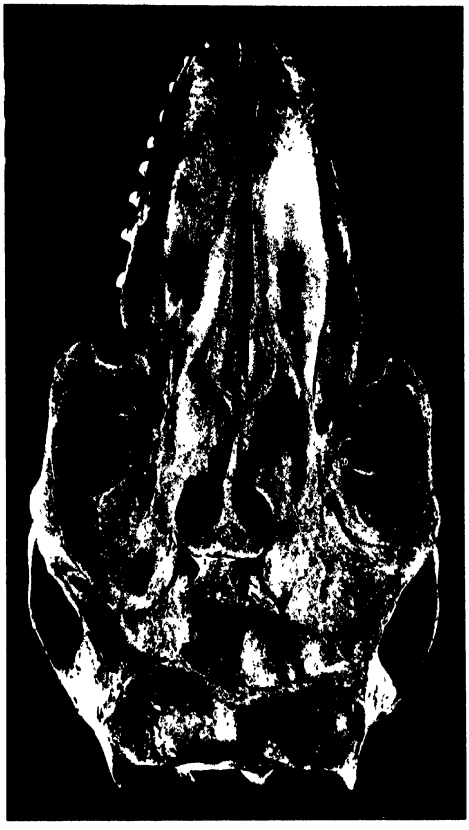

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3

Pseudorca crassidens

The Food of the Ceylon Slender Loris (Loris tardigradus) in Captivity

BY

W. W. A. Phillips, F.Z.S., M.B.O.U.

WITH ONE PLATE

A few months ago, a Slender Loris, which had been caught on this estate, was brought to me by a labourer. This surprised me greatly as the Ceylon Loris is generally found exclusively in the forests of the low-country and low foothills, to an altitude of 2,000 ft. at the most; but this animal was caught on the edge of a jungle on Mousakande Group, Gammaduwa, well over 3,000 ft. above sea level.

Except that it is greyer in general hue than average specimens, it appears to be quite typical. This greyness is probably due to the colder and damper climate in which it has elected to live, for the Mousakande forests are extremely wet and leech-infested most of the year round. Whether the species is resident and whether there is a distinct race in the jungles of this neighbourhood, I have not yet been able to ascertain. Possibly, if not truly resident, this individual may have gradually worked its way up from the low-country below. Certainly, the species is very uncommon at this altitude; never previously have I seen, or heard of, one up here during my residence of several years.

When it was first brought to the bungalow this Loris was placed in a large wire netting cage, where it has lived ever since. For a few days immediately after capture it was somewhat frightened and too nervous to eat properly but on the third night, after having been placed in a quiet corner, it ate a little plantain. Since then it has rapidly grown used to its changed surroundings and has become partially tame. To-day it appears to be quite contented, or at least resigned, and will feed while being watched, will take from the fingers insects held out to it and will submit, without much protest, to being taken out of its cage and handled.

Throughout the day it generally sleeps in the typical ball-like attitude of the Lorises. Squatting on a branch in the top of the cage, it holds on with all four hands with its head tucked well down between its arms, its nose almost touching its stomach.

It remains in this position for the greater part of each day, but it will deign, occasionally when hungry, to descend and partake of a few mouthfuls of plantain or to devour a grass-hopper or other insect presented to it.

The Loris is popularly supposed to be, by choice, chiefly a fruit eater. But I do not find that this is the case with our present specimen. True he eats plantains and they form his staple diet but he eats them only when nothing more appetising is forthcoming.

I have tried him with a number of other fruits—mangoes, pine-apples, papaws, apples and coconut but he has disdained them all. This surprises me as I am confident that Lorises will usually eat, at least, papaws and mangoes. However, our Loris will have nothing of them, but confines himself to two or three plantains each evening.

These he generally eats on the floor of his cage, making large bites and wolfing the pulp until he has satisfied his hunger. Sometimes, however, he will hang down from a branch by his hind legs and will hold the fruit steady with his hands while he bites lumps out of it. This is also his favourite position when dealing with anything of which he is a little nervous ; he hangs suspended by his hind legs ready to draw himself up out of harm's way, while he examines closely, and sniffs, at what has excited his curiosity.

He is most agile in these gymnastics, and relatively quick. The word "slow" as used in connection with this Loris is hardly an apt term. Certainly in the glare of the sun and bewildered by unusual surroundings and noise, he is hesitating and cautious in the extreme;—he is nervous, defenseless and rather pathetic, knowing not which way to turn to escape. But see him at dusk, in familiar surroundings and he is a very different animal. Wonderfully agile and absolutely noiseless he arrives like a fleeting shadow and departs again in ghost-like silence—a true spectre of the gloom to the lesser folk of the woodlands, on whom he preys.

In order to learn his partialities, I have tried him with a great variety of potential food. His tastes appear to be catholic. With few exceptions he relishes equally almost all fresh animal food, evidently much preferring it to fruit when both are available.

Of the lesser vertebrates, he refuses all small mammals, such as mice and small shrews, but small birds he devours with avidity—a White-eye and a Kelaart's Munia, which had killed themselves at night

against the lighted windows of the bungalow, were put into his cage; they disappeared *in toto*, with the exception of one or two of the larger wing feathers. The flesh, bones and feathers were all devoured, including the skull and most of the large tail and wing feathers.

The same treatment is meted out to small lizards, skinks, geckoes and frogs; they are completely devoured without a trace being left, unless an odd foot or the tip of the tail drops off while the victim is in process of being masticated.

If he has any preference at all, I think it is for geckoes—the large and succulent ones—*Gymnodactylus frenatus*—of which he will tackle the largest.

His method of attack is always the same, whether dealing with a small vertebrate or a large insect; a quick cautious stalk, ending in a lightening grab with both hands, either pinning his victim down or gathering it to him, followed by a swift bite or bites through the head. He then proceeds to chew off and devour the head after which the rest of the body, limbs and tail follow in due course. It is interesting to see the way in which everything disappears down his throat—without any previous preparation whatsoever; wings are crushed to the body, by the grip of the hands and are masticated together with the bones, feathers or scales, skin or wing cases, limbs and tail—nothing is discarded.

Although so voraceous with the smaller vertebrates, he is timorous: he will not tackle anything that he cannot overpower at once. The powerful Agamoid, *Lyriocephalus scutatus*, he leaves well alone, neither will he touch a full grown Calotes lizard or anything else that can defend itself in any way. I have even seen him refuse one of the large Rhinoceros beetles, of which he appeared to be distinctly nervous, although smaller beetles of most species he consumes in large quantities.

Most insects are acceptable to him, and they probably formed his chief diet in the wild state. He will stuff himself with winged termites, grass-hoppers and crickets of all species, dragon-flies and diptera, cock-roaches, beetles, grubs, small spiders and most moths and butterflies with their caterpillars.

With regard to the Lepidoptera, however, he is careful. Most species he grabs, crushing their wings against their bodies, and devours head foremost, but there are some moths and butterflies of one or two families that he will not look at, or, if he has seized one in error, he will release it again immediately without killing it. Notably this is the case with moths of the Tiger-moth family (Arctiidae?) and the white Ghost moths also with some of the red bodied swallow tailed butterflies (*Papilio*). Nor will he touch any hairy caterpillars.

On the other hand, he delights in all the Hawk moths (Sphingidae) and their caterpillars; even the largest Death's Head Hawk moth (*Acherontia lachesis*) caterpillars being consumed *in toto*, although in some cases riddled with ichneumon larvae.

I have tried him also with birds eggs; the smaller ones he eats if quite fresh but he does not seem to care for larger ones.

Having studied the likes and dislikes of this Loris in captivity, I do not doubt that, in the wild state, Lorises are broadly speaking omnivorous, but feed chiefly on insects, and small vertebrates—with an occasional meal of fruit when they happen to come across it, and I feel sure that the direct cause of failure in so many attempts to keep these little animals, for any length of time, in captivity is attributable to their having been fed chiefly on fruit, with an insufficient quantity of fresh animal and insect food to keep them in good health. A mixed diet would appear to be essential to their well-being in captivity.

The Ceylon Slender Loris
(*Loris tardigradus*)

The Giant Squirrels (Ratufa) of Ceylon

BY

W. W. A. Phillips, F.Z.S., M.B.O.U.

In view of the fact that the giant squirrels of the forests in the neighbourhood of Gammaduwa, in the East Matale Hills, appeared to be referable to no described race of Ratufa with which I was familiar, I spent, recently, some little time in examining all the specimens of this species in the Colombo Museum and in studying the relative literature. This paper gives the conclusions at which I have arrived as a result.

The Gammaduwa district lies on one of the most northern spurs of the hill ranges of the Central Province and immediately overlooks the extensive low-country jungle tracts of the North-Central Province. The hills rise almost directly from the low-country to between 4,000 ft. to 5,000 ft. and still contain much virgin jungle. As might be expected, much of the fauna and flora found in the neighbourhoood is purely alpine, but some low-country forms make their way up into the jungles of the lower slopes. A few species and sub-species of various groups which have been discovered during the last few years, appear, however, to be entirely peculiar to the locality—due probably to the fact that the district is somewhat isolated from the main mountain cluster.

The giant squirrels of this neighbourhood are considerably larger and darker in general colour than the form found in the low-country below, yet they are not so purely black as to be referable to typical *macroura* of the higher ranges.

My first intention was to describe the Gammaduwa form as a new geographical race—believing it to be peculiar to the district—but I find upon referring to Thomas and Wroughton's paper on the Giant Squirrels (J.B.N.H.S., Vol XXIV, p. 34) that their description of their so-called low-country form, *dandolena*, is clearly applicable to the Gammaduwa form.

This seems curious until it is noticed that the type specimen, from which the race *dandolena* was described, came from Wellawaya, in the Uva Province, at an altitude of 608 feet—scarcely the low-country proper.

As it happens, Wellawaya is situated in very much the same position as Gammaduwa—that it to say, it lies on the slopes of a spur of the main mountain cluster of the Central and Uva Provinces. Immediately above, the mountain ridges run up to over 5,000 feet, while the real low-country lies directly below.

One would expect to find here, not the typical low-country race, nor the pure alpine form, but an intermediate form between the two—and, although owing to my being resident in Ceylon I have not had the opportunity of examining the type specimen of *dandolena*, from the description and measurements given I am convinced that it is a specimen of an intermediate form and not of the typical low-country race at all.

Messrs. Thomas and Wroughton appear themselves to have been somewhat uncertain at the time they jointly described the sub-species. In their description and remarks they state "general colour above grizzled grey with an underlying brownish suffusion; *a varying area on the shoulders and middle line of rump often black or blackish*," and again "this squirrel which would appear to be the common form of the low-lands of Ceylon, *is very variable in colour*, but may always be distinguished by its grizzled grey body, with which the black frontal patch contrasts strongly, its buffy cheeks and grey tail"

Certainly I have seen some specimens from the low-country proper that have considerably darker upper parts than what I would call "typical specimens;" this is, I am inclined to believe, due to a seasonal change of coat—but no low-country specimen that I have examined has been as dark in colour as specimens from the foot-hill country.

It is, however, chiefly with regard to size that the differences between the foot-hill form and the true lowland race become most definitely marked. The sub-montane form is considerably the larger—the lowland form being the smallest of all the races.

Thomas and Wroughton give the body measurements of their type (a large female) as, head and body, 377 mm ; tail, 415 mm ; hind foot, 71 mm ; ear, 26 mm ; weight, 2 lbs. ; and the greatest length of the skull, 68 mm ; but the largest specimen that I have been able to find from the true low-country (a male) measures only, head and body, 350 m ; tail, 335 mm ; hind foot, 69 m ; ear, 23 mm ; and greatest length of skull, 66 mm ; while the largest female measures only, head and body, 330 mm ; tail, 335 m ; hind foot, 68 mm ; ear, 22 mm ; with the greatest length of the skull, 64·5 mm.

The differences between the two forms are so great that they must, I think, be considered as separate races, the name *dandolena* being restricted to the sub-montane form, of which the type locality must be Wellawaya.

The true lowland form, however, requires a new name; to this race I propose to give the name *sinhala*.

A comparison of the measurements of the four Ceylon races shows that the largest form of Ratufa is found in the highlands of the Central Province, while the smallest inhabits the jungles of the Low-country Dry Zone.

The following tables give the average measurements of the specimens of each form, measured for purposes of this paper.

It will be noted that, with the exception of *macroura*, of which race only one small male is available, the males average larger than the females in every race. In individual cases, however, a large female may sometimes measure larger than an average male. The length of the tail in all races is very variable, in some individuals it is longer than the head and body, in others shorter.

AVERAGE MEASUREMENTS OF THE CEYLON RACES OF RATUFA MACROURA

Body Measurements

	Head & Body	*Tail*	*Hind foot*	*Ear*	*Weight*
macroura					
♂s 1 only	341 mm	374 mm	68 mm	28 mm	?
♀s Average of 6	375·1 ,,	385·5 ,,	71·3 ,,	25·3 ,,	3 lbs 4 ozs.
melanochra					
♂s Average of 5.	369 ,,	387 ,,	74 ,,	25 ,,	3 lbs. 6 ozs.
♀s Average of 6.	360 ,,	388 ,,	73·5 ,,	27 ,,	3 lbs. 2 ozs.
dandolena					
♂s Average of 5.	369 ,,	366·2 ,,	71·8 ,,	25·4 ,,	3 lbs. 1 oz.
♀s Average of 4	354·7 ,,	396·2 ,,	71·7 ,,	25 ,,	2 lbs. 9 ozs.
sinhala					
♂s Average of 9.	334 ,,	328·1 ,,	65 ,,	24·4 ,,	?
♀s Average of 5.	314 ,,	345·2 ,,	66·8 ,,	24·6 ,,	?

Skull Measurements

	Greatest length	*Condylo-incisive length*	*Mastoid breadth*	*Inter orbital breadth*	*Zygomatic breadth*	*Dental length*
macroura						
♀s (6)	70. mm	63·4 mm	32. mm	28·5 mm	43·8 mm	14·2 mm
melanochra						
♂s (5)	73·8 ,,	64. ,,	32·5 ,,	27·3 ,,	43·4 ,,	13·9 ,,
♀s (5)	71·4 ,,	64·4 ,,	32·7 ,,	27·3 ,,	43·5 ,,	14·4 ,,
dandolena						
♂s (4)	70·2 ,,	63·7 ,,	32·5 ,,	27·8 ,,	43·3 ,,	14. ,,
♀s (3)	68·5 ,,	61·8 ,,	31·1 ,,	26·1 ,,	42·3 ,,	13·8 ,,
sinhala						
♂s (8)	65·1 ,,	58·1 ,,	30 ,,	26·1 ,,	40·5 ,,	13 2 ,,
♀s (5)	64·5 ,,	58·1 ,,	29·6 ,,	25·5 ,,	40·2 ,,	13·3 ,,

The four races, now recognised in this paper, may be easily distinguished from one another by the following distinctive characteristics :

Key to the four Ceylon races of Ratufa macroura

A. General colour of the upper parts, pure black ; tail uniformly either pure black or pure black frosted with white.
   a. Tail black, frosted with white — *R. m. macroura* (Pennant's Long-tailed Giant Squirrel)

   b. Tail pure black, with no white hairs — *R. m. melanochra* (The Black and Yellow Giant Squirrel)

B. General colour grizzled grey or brown ; tail heavily frosted with white with the terminal portion chestnut brown.
   c. Size larger ;
      General colour grizzled dark brown. — *R. m. dandolena* (The Foot-Hills Giant Squirrel)

   d. Size smaller
      General colour grizzled light brown — *R. m. sinhala* (The common Ceylon Giant Squirrel)

The following short descriptions of the above four forms follow as far as possible Thomas and Wroughton's original descriptions as given on pages 35 and 36 of Vol. XXIV of the Journal of the Bombay Natural History Society.

Ratufa macroura macroura (Penn.)

Pennant's Long-tailed Giant Squirrel

Forehead and whole upper surface deep black (fading to maroon in bleached skins) but with the rump usually with some slight whitish grizzling. Under parts and fore arms, wrists and lower legs all round, generally clear buff or pale yellow, with grizzled black or grey along the flanks and sides where the yellow or buff merges into the black of the upper parts; base of fur of the under parts, blackish brown. Muzzle tawny buff; forehead and crown of head black, usually with a sprinkling of white and whitish hairs; cheek pure black, with a smallish buffy area immediately below the ears; crown patch, between the ears, well developed, buffy brown. Fingers and toes black. Tail with its very long hairs deep black, tipped (except just at the base and sometimes towards the end) with pure white, and with an inconspicuous line of short light buffy hairs along the centre on the under surface. In some specimens the terminal portion of the tail is inclined to be slightly brownish black instead of pure black. Nose and fleshy parts of the face, flesh pink ; eyes dark hazel.

Measurements are as given above.

Type locality : "Central highlands of Ceylon."

Habitat : The highland jungles (roughly above 3,500 feet) in the Central and Uva Provinces of Ceylon.

The race is essentially a highland form; at lower altitudes than approximately 3,500 feet it gradually merges into the race *melanochra* in the south-west and into *dandolena* in the lower hills in all other parts.

Ratufa macroura melanochra (Thomas and Wroughton)

The Black and Yellow Giant Squirrel

Forehead and upper parts wholly deep black, with no sign of any grizzling on the rump or sides. Underparts and forearms, wrists and lower legs all round, deep ochraceous buff or orange yellow, considerably deeper, usually, than in *macroura*, and with a sharply defined line along the flanks and sides where the yellow of the under parts meets the black of the upper. Base of the fur of the under parts blackish or brownish grey.

Muzzle tawny; forehead and crown of the head black, rarely with one or two white hairs; cheeks black with a small area below the ears, tawny buff. Ears pure black; crown patch, between the ears, generally small and sometimes almost wanting, brown with a lighter spot in the centre. Fingers and toes, black as in *macroura*. Tail with the very long hairs pure black and with the inconspicuous centre line on the under surface buffy but with no white frosting.

Nose and fleshy parts of the face, flesh pink; eyes dark hazel brown as in *macroura*.

Young : A half grown juvenile is exactly like the adult with the exception of the texture of the fur which is relatively longer and softer and a little more glossy.

Measurements are as given above.

Type locality : "Kottawa, Southern Province, Ceylon."

Habitat : Confined to the jungles of the south-western portion of the Island, in what is known as the Low-country Wet Zone.

Roughly, the range of this race extends from the foot of the Adam's Peak hills, throughout the Ratnapura and Kelani Valley Districts to the sea coast in the Matara, Galle, Kalutara and Colombo Districts. Inland the northern boundary of its range is somewhere towards Kegalle, from which district the boundary skirts the hills, southward and eastward to beyond Balangoda. From thence, the Walawe Ganga roughly forms the boundary down to towards Ranna on the south coast.

In the low hills above Kitulgalla and around Adam's Peak this race gradually merges into the highland form, *macroura*—I have seen specimens from above Kitulgalla with a distinct white frosting on the tail.

Ratufa macroura dandolena (Thomas and Wroughton)

The Foot-hill's Giant Squirrel

General colour of the upper parts, dark grizzled brown, with usually a distinct maroon tinge between the shoulders; grizzling considerably more pronounced towards the rump and along the sides. Shoulders dark blackish brown. Underparts and forearms, wrists and lower legs all round, light buff or lemon yellow, with much grizzled grey along the flanks and sides where the yellow merges into the darker colour of the upper parts; base of the fur in some specimens yellow, but more usually grey brown.

Muzzle light tawny buff; forehead black, usually with a number of white hairs interspersed, paling to blackish brown on the crown; cheeks yellowish buff with a small area, of varying size, dark brown—in some specimens this dark cheek patch is moderately well developed, in others it is practically wanting. Ears with the longer hairs usually black, but sometimes dirty buff; crown patch between the ears, well developed, brownish buff. Fingers and toes black, often with the interstices buff.

Tail with the longer hairs dark blackish brown for roughly two-thirds of its length, paling to brown, with usually a distinct chestnut tinge, towards the tip, the whole heavily frosted with pure white; the white frosting of the tail is heavier in this race than in any of the others; inconspicuous centre line of short hairs on the lower surface, light buff. Young not examined.

Measurements are as given above.

Type locality : Wellawaya (alt. 608 ft.) in the Uva Province, Ceylon.

Habitat : This race inhabits the lower foot-hills surrounding the central mountain cluster of the highlands of the Central and Uva Provinces on all sides with the exception of the south-west. Its habitat is the forests clothing the lower hills between the low-country and the highlands to roughly 3,500 feet altitude, though in some places on the outskirts of the highlands it may be found even higher.

The race is intermediate between the highland form, *macroura*, and the true lowland race *sinhala*; as would be expected, specimens

from higher altitudes are darker and more closely akin to *macroura* than specimens from lower altitudes.

Whether there is any seasonal change in the colour of the coat, in this race, I am not quite sure; probably the newly assumed coat is rather darker and more distinctly grizzled than the worn coat.

Ratufa macroura sinhala sub-sp. n.

The Common Ceylon Giant Squirrel

General colour of the upper parts light grizzled brown, lighter and less grizzled between the shoulders and on the middle back, but slightly darker and with more grey grizzling along the sides and on the rump; shoulders dark blackish brown but scarcely as dark as in *dandolena*. Under parts and forearms, wrists and lower legs all round, light whitish buff in the type, but pale yellowish buff in some, with grizzled grey along the sides and flanks where the buff of the under parts meets the brown of the upper; base of the fur of the under parts light greyish brown in the type, but occasionally uniform buff.

Muzzle whitish buff; forehead black, with a number of white hairs interspersed, paling to brown on the crown; cheeks buff, with small dark areas, corresponding to the blackish cheek patches in the other races; ears with the longer hairs brown and lower parts involved in the buff of the cheeks; crown patch, between the ears, broad, light whitish buff, contrasting strongly with the brown of the head and shoulders, Ends of the fingers and toes black gradually merging into the buff of the feet.

Tail with the long hairs blackish brown for roughly half its length, paling to chestnut brown on the distal half, the whole heavily frosted with white; the inconspicuous centre line on the under surface whitish buff. The long hairs of the tail in this race are not as long as in *dandolena* —the tail in that race is particularly well developed.

Fleshy parts of the face, flesh pink ; eyes dark hazel as in other races.

Young. In a sub-adult female, from Habarana in the North-Central Province, the general colour is light sandy grizzled greyish brown, with none of the darker colouring of the fully adult.

Measurements: The body measurements of the type are as follows : —Head and body 344 mm ; tail, 309 mm ; hind foot, 63 mm ; ear, 23 mm. Skull, greatest length, 64 mm ; condylo-incisive length, 57 mm ; mastoid breadth, 29 mm ; dental length, 12·5 mm ; inter-orbital breadth, 25 mm ; zygomatic breadth, 40·5 mm. Average measurements are as given previously.

Type: Adult ♂, collected at Nikawewa in the Veddichchai Game Reserve for the Colombo Museum, by W. W. A. Phillips, on February 21st, 1929. Through the courtesy of the Director, Colombo Museum, the type has been presented to the British Museum.

Type locality: Nikawewa in the Veddichchai Game Reserve, about 10 miles south of Kantalai in the Eastern Province of Ceylon.

Habitat: This race inhabits the jungles of the low-country proper, throughout what is commonly called the Dry Zone. It is found in suitable country over the whole of the northern, eastern, and southern forest tracts, but it is absent from the south-western low-country "Wet Zone" where its place is taken by the black and yellow form, *melanochra*. At the foot of the hills of the Central and Uva Provinces it gradually merges into the sub-montane form, *dandolena*. Throughout its range it is generally quite common.

As regards the colour change to which this race appears to be subject, as far as I can ascertain at present, the new coat (generally assumed during the early months of the year—the Spring in north temperate climates) is rather dark, grizzled greyish brown; but this new coat soon bleaches in the strong sunlight to a lighter brown and as the ends of the hairs break off, loses much of its greyish grizzling, causing a distinct change in general hue.

PROCEEDINGS OF THE CEYLON NATURAL HISTORY SOCIETY, 1930.

Eighteenth Annual General Meeting

The Eighteenth Annual General Meeting of the Society was held in the Colombo Museum Reading Room on the 27th February, 1930, at 5.30 p.m.

H. E. Sir Herbert Stanley, K.C.M.G., Patron, took the Chair and there were 34 members and 2 visitors present.

The minutes of the previous general meeting were read and confirmed.

The report of the Hony. Secretary and the report and balance sheet of the Hony. Treasurer for 1929 were taken as read, and adopted.

The following Office-bearers for the year 1930 were elected :

Patron : H. E. Sir Herbert Stanley, K.C.M.G.

Vice-Patron : The Hon. Mr. B. H. Bourdillon, C.M.G.

President : Dr. Andreas Nell.

Vice-Presidents : Very Rev. Father M. J. Le Goc, Hon. Mr. W. E. Wait, Dr. Joseph Pearson, C. T. Symons, Esq., Sir Solomon Dias Bandaranaike, K.C.M.G.

Hony. Secretary : D. R. R. Burt, Esq. (Mr. E. C. T. Holsinger to act while Mr. Burt is away from the Island.)

Hony Treasurer : A. H. Malpas, Esq.

Council : W. W. A. Phillips, Esq., Prof. N. G. Ball, Dr. S. E. Fernando, E. C. T. Holsinger, Esq., Dr. R. L. Spittel.

The Chairman then called upon Dr. Joseph Pearson to deliver his lecture on "The Ceylon Pearl Fisheries."

Dr. Pearson dealt with his subject in two parts : (*a*) Biological problems, and (*b*) administrative difficulties.

After describing the habits and life history of the pearl oyster, he discussed the main factors said to be responsible for the failure of fisheries, viz :—(1) Predaceous fishes, (2) silting sand, (3) sargassum, (4) currents, (5) over-fishing.

With regard to predaceous fish, such as rays, Dr. Pearson pointed out that their extermination might result in the absence of pearls in the oysters as the pearl is formed as a secretion round the larva of a tape-worm, and since the ray is the host of the adult tapeworm, the fish is necessary for the parasite to complete its life-cycle. He did not support the view that predaceous fishes were the chief factor in causing intermittent fisheries, but was inclined to the view that silting sand was probably the most important factor in causing the disappearance of oysters from the banks. Undoubtedly the strong currents of the north-east and south-west monsoons produced considerable movement of sand which either smothered oysters or caused them to break away from their anchorage and to disappear. In order to combat this adverse factor, two proposals had been made : (1) The laying down of a cultch, and (2) the transplanting of oysters. Dr. Pearson explained that both proposals were impracticable.

Sargassum at times occurred in great abundance on the pearl banks and Dr. Pearson put forward the view that the presence of this weed was also responsible to a considerable degree for the disappearance of oysters. Referring to currents, he said that a hundred years ago, James Stuart, then Master Attendant of Colombo, ascribed the disappearance of pearl oysters to currents in the Gulf of Mannar Dr. Pearson strongly supported this view as being a contributory cause. He next referred to the theory that over-fishing in the past was responsible for the intermittent fisheries during recent years and said that since it was not possible to fish out the pearl banks, this theory had no value. He criticised the proposal put forward by the Madras Fisheries Department of farming oysters with a view to extending

experimental studies ; since it is impossible to run a farm under natural conditions, Dr. Pearson did not think that the results obtained would have a practical application.

He concluded the first part of his lecture by emphasizing the fact that the difficulties of artificial control of the pearl fisheries were such that attempts in this direction were doomed.

Passing to the administration of the pearl fisheries Dr. Pearson first explained the functions of the Government Agent of the Northern Province and of the Marine Biological Department. He considered that the administration of a pearl fishery was extravagant, and suggested methods of minimising the cost. He criticised the present method of selling pearls by auctioning the oysters and was of the opinion that more money would accrue to revenue if Government washed all the oysters and sold the pearls in London and Paris.

At the conclusion of the lecture questions were asked and comments were made by Messrs. H. Wicebloom, E. C. T. Holsinger, Professor N. G. Ball and Capt. Kirkham.

H. E. the Governor thanked Dr. Pearson for his interesting and lucid lecture. He referred to the project of an Aquarium in Colombo and expressed his regret that the public had lost interest in the idea. He hoped that when the financial anxiety became less acute public interest in the establishment of an Aquarium would be resuscitated.

Dr. Andreas Nell proposed a hearty vote of thanks to H. E. the Governor for presiding at the meeting.

The meeting then terminated.

Ninetieth General Meeting

The Ninetieth General Meeting of the Society was held in the Colombo Museum Reading Room on Tuesday, 10th June, 1930, at 5.30 p.m.

The President, Dr. Andreas Nell, took the Chair. There were 29 members and visitors present.

The minutes of the previous general meeting were read and confirmed.

Mr. N. Wynne-Jones was elected an Ordinary Member of the Society.

The Secretary read a letter from Mr. J. A. Jafry of Agra regarding the formation of an Association for the protection of the Fauna of India, and asking for the co-operation of the Ceylon Natural History Society. The matter was discussed and on the motion of Dr. Nicholls, seconded by Mr. Wicebloom, it was agreed that any action to be taken in the matter should be left to the Council of the Society.

The Chairman called on Dr. Nicholls to give his lecture on "Pathogenic Bacteria."

Dr. Nicholls said that life on the earth could be divided into two groups, the seen and the unseen ; by the unseen he meant forms of life not visible to the naked eye, but whose total weight had been estimated to be greater than that of the seen. The discovery of bacteria depended on the microscope. Bacteria were concerned with the building up of matter, as in the case of the nitrogen-fixing bacteria ; and the breaking down of the matter already built up ; as in the case of bacteria causing putrefaction. All life, including plant life, was dependent upon bacteria ; if it were not for bacteria there would be no higher forms of life.

A certain number of bacteria had acquired the habit of invading the human body, these were known as the germs of disease, or pathogenic bacteria. Their number compared with the number of bacteria known to exist was not large.

Dr. Nicholls exhibited a number of cultures of bacteria and explained how they were made and how one could identify them by their appearance and reactions. The exhibits, cultures of tubercular bacilli, dysentery, cholera, typhoid and other bacilli and streptococci—were passed round the audience.

A number of questions were asked and in reply Dr. Nicholls explained the theory of the treatment of disease by inoculations.

Dr. Nell proposed a hearty vote of thanks to the lecturer, which was carried with acclamation.

The meeting then terminated.

Ninety-first General Meeting

The Ninety-first General Meeting of the Society was held in the Colombo Museum Reading Room on Tuesday, 8th July, at 5.30 p.m.

The Hon. Mr. W. E. Wait, in the absence of Dr. Nell, took the Chair and 9 members and 8 visitors were present.

The minutes of the previous general meeting were read and confirmed.

The Chairman called on Dr. Chandrasena to read his paper on " Plants introduced into Ceylon at various times."

In his introductory remarks Dr. Chandrasena discussed the uses of plants and drugs in Ayurvedic medicine, and said that his work on the chemical constitution of the active principles of these plants had led him to enquire into their origin. Popular belief held that the shape of a plant or flower was indicative of the ill for which it might be used as a remedy, as in the case of plants used against snake-bites and intestinal troubles. Another popular belief was that the Kumbuk tree when growing beside a well, softened the water ; in point of fact the bark contained much lime.

Many plants in Ceylon are not indigenous. The baobab tree (*Adansonia digitata*) Tamil Anaipuli-maram, noteworthy for its great girth, is a native of Central Africa. Those at Mannar, the largest of which in 1890 measured 61 ft. in girth and 30 ft. in height, were probably introduced by Arab traders. The fruits are spongy, acid, and edible.

Three theories exist regarding the origin of the cocoanut palm :

(1) That it originated in the Indian Archipelago and the Pacific Islands. (De Candolle, Beccari, Chiovenda and others). This view has support from the facts that there are many varieties in the East, some of which have been used for a long time by the Hindus in worship ; that tapping is a hereditary occupation of the Tiyans in Malabar ; that the Dravidian name Tenkai means " nut of the south" and that it was in common use in India in 400 B.C. The etymology of many of the words used for the palm is obscure : there is Pol and Tenkai also Narikela, Hindi, Nariyal and Persian names allied to the Sanskrit one. The name in the Pacific is Niur or a derivative, and everything points to those names being of great antiquity. This lends support to the Pacific theory. There is also the Portuguese " Cocos" and the Spanish "Macoco." In the Pacific there is the association of the Robber Crab *Birgus latro* and the cocoanut, but it is doubtful whether any deductions can be made from this. In Sinhalese literature the palm is mentioned in the *Mahavansa*, Chap. XXIII, in connexion with the 10 giants of King Dutugemunu (B.C. 101-77).

(2) The second possibility for its origin is in South America, where O. F. Cook attempts to prove its origin in the valley of the Andes, and its transportation by human agency.

(3) The third possibility is that it originated in the now submerged land in the region of the Maldive and Laccadive Islands.

The Anonaceae, introduced early to the East, were natives of tropical America. The custard apple has been identified among the sculptures of the Ajanta caves as well as of the Banhut Stupa, which is opposed to the theory that the plants is an introduced one. The Portuguese may have brought the plant although it was already in India. The names Ramphal and Sitaphal, two varieties of the Custard Apple, show that from very early times it was grown and honoured by the Hindus.

The Pineapple, *Ananas sativus* (Sinh. Annasi. Tam. Anasaphalam) is also a native of Tropical America. It was first introduced into Europe in 1513 by Goncatlo Hermandes, and into India by the Portuguese in 1594. Its introduction is especially mentioned by Indian authors such as Abul Fuzl, and the author of the Dhara Shekoih. The rapidity of its spread is unparalleled, hence apparently the purity with which its American name has passed through many languages.

Carica papaya (papaw, papaya, papeta, tree-melon, Sinh. Pepol, Tamil, Pappasi) is believed to be a native of the shores of the Gulf of Mexico, and of the West Indies and doubtfully of Brazil. It was not known before the discovery of America. It is regarded by Atkinson as introduced by the Portuguese into India. In 1626 seeds were sent from India to Naples so that it must have been taken to India shortly after the discovery of America.

Opuntia dillenii (Sinh. Katupatok), is the American cactus introduced by the Portuguese. It was first described by the Spanish and Portuguese in 16th and 17th centuries as a curiosity of the New World, whence it was brought to India.

In the discussion following the lecture, Professor Ball made some remarks on the doctrine of signatures in old Herbals. Mr. Burt mentioned, regarding the distribution of the cocoanut that its dispersal across oceans was possible without human agency, and that insects were carried in this way to the Pacific Islands from the nearest mainland. The Chairman spoke of the dispersal of the Mimosa by goats as the seeds passed unchanged through their bodies, and he confirmed the remarks of the lecturer regarding the Kumbuk tree, as the lime in the bark was a source of lime for betel-chewers.

The lecture terminated with a hearty vote of thanks to Dr. Chandrasena which was passed with acclamation.

Ninety-second General Meeting

The Ninety-second General Meeting of the Society was held in the Reading Room of the Colombo Museum on Tuesday, 9th September, at 5.30 p.m.

The President, Dr. Nell, took the Chair, and there were 4 members and 10 visitors present.

The minutes of the previous meeting were read and confirmed.

Dr. (Mrs.) U. Leembruggen was elected an Ordinary Member of the Society.

The President called on Dr. Bhatia to give his paper " On the Growth of Scales in the Trout *Salmo fario*."

The Rainbow trout which fed uniformly throughout a year grew at a uniform rate, though there was great individual variation in size. The size of the scales and the number of circuli formed increased more rapidly relative to the growth of the fish in early stages, but was proportionate subsequently.

The number of circuli obtained from a particular area of a growing trout depended on the size of the fish irrespective of its age.

Specimens fed uniformly throughout one year did not show any formation of the so-called "periodic rings" on their scales. All the rings found corresponded to the summer type, and the so-called winter rings were not formed during winter.

Specimens obtained from the hatchery and fed excessively for about ten months had a rapid rate of growth and showed the formation of abnormally broad rings at the periphery. The width of the scale rings did not show any correspondence to the seasonal variations in temperature.

The chief factor concerned in the formation of broad and narrow, or summer and winter rings was the abundance or scarcity of food and not the rise and fall of temperature. Temperature variations might possibly have an indirect effect by causing variations in the production, consumption or assimilation of food by the fish.

It was clear from these observations that although it was difficult, if not impossible to determine from the examination of individual scales the effect of the rich or the poor food supplies on the formation of the scale rings, the measurements of the width of rings of a large number of scales obtained from a large surface of the body showed collectively the food effects in quite an obvious manner.

A rich nutrition produced on the scales comparatively wide rings, while a poor nutrition resulted in the formation of narrow rings. It was possible that the excessive nutrition obtained by the fish in one case and its deficiency in the other were not greatly marked from the hitherto normal consumption of food in the hatchery, so that the scales did not show, except in a few cases, a distinct broadening out or narrowing down of the rings as they did in nature where the discrepancy between the summer and winter food supplies was obviously very great.

As a result of these observations one was led to believe, therefore, that in nature the annual zones of broad and narrow rings on the fish scales are formed as a result of a rich or poor nutrition obtained during summer or winter respectively independent of the temperature variations.

In the discussion which followed Mr. Malpas spoke of the lack of variation in the scales of fishes found in the tropics and Mr. Burt discussed the formation of Liesegang rings artificially and compared them with the rings of fish scales.

The meeting closed with a hearty vote of thanks to the lecturer which was carried with acclamation.

Ninety-third General Meeting

The Ninety-third General Meeting of the Society was held on Tuesday, 14th October, at 5.30 p.m. in the Reading Room of the Colombo Museum Library.

The President, Dr. Nell, took the Chair, and there were 10 members and 10 visitors present.

The following new members were elected :—

Dr. W. C. O. Hill and Dr. H. G. Bogle, proposed by Dr. Andreas Nell and seconded by Mr. Burt.

The Chairman called on Mr. D. R. R. Burt to give his lecture on "The Natural History of South Africa."

Mr. Burt gave an account, illustrated by lantern slides, of photographs taken on a tour in South Africa during the summer of 1929 at the time of the South African meeting of the British Association for the advancement of Science. Starting from Cape Town, the Cape Peninsula and the surrounding district, he described the journey through the great Berg and Hex River Valleys to Kimberly and Johannesberg, thence to the Kruger Game Reserve in North-east Transvaal, and through Pretoria, the Kalahari Desert, Bulawayo and the Matopos country to the Victoria Falls, whence returning to Bulawayo, continuing east to Fort Victoria, the Great Zimbabwe Ruins and Salisbury.

The flora of the Cape Peninsula is richer in species of flowering plants than any other part of the world, but conspicuous are the Ericaceae, Proteaceae, Monocotyledons, Pines, Silver trees and yellow woods. Among the heaths the bird-heaths are most remarkable in that the corolla is just the length of the bill of the honey bird of the same curvature. The fauna consists of baboons and coneys among the rocks, insects, centipedes, scorpions and snakes under the rocks, and among the trees, under dead and decaying logs, specimens of Peripatus are fairly plentiful. On the one side of the Peninsula is the Atlantic, and on the other side the Indian Ocean, and the difference in temperature of 10° to 15° F. between the two shores accounts for a marked difference in the fauna. From the Rhodes Memorial on the spur of a mountain on the east of the Peninsula one has a view claimed by Rhodes himself to be the finest in the world. One sees from Table Bay on the west to False Bay on the south, and ahead over the Flats, French Hoek Mountains, and Dal Jehosephat with their fertile valleys to the Drakenstein mountains and Hottentot Hollands under snow on the horizon some 60 miles away.

The Karoo Desert, a high inland plateau, sheltered from the coast by high ranges of mountains, is an arid region with less than 10 inches of rain per year. In this region Cotyledons, Mesembryanthemums, Aloes, Crassulas, and Stapelias retain their moisture in succulent leaves and roots, to blossom forth once a year after rain.

The lecturer described the formation of the Diamond Mine at Kimberly and the Wetwatersrand with its gold mines, and, at the village Deep Mine at Johannesberg, the performance of a Zulu War Dance.

The Kruger Game Reserve, one of the largest game reserves in the world, supports thousands of head of game in the wild state—Zebras, Wildebeest, Sable Antelopes, Kudus, Lion, Oryx, Giraffes, Rhinoceros, Hippopotamus, Elephants, and many varieties of small antelopes.

Through the grass-land transition of the Kalakari one arrives at the Matopos country, the home of the Matabeles. In this rocky district, where among the gigantic boulders plants find an almost miraculous existence, baboons are plentiful. In the many caves in the district can be seen some of the best examples of pre-historic art,—cave-paintings of the bushmen. These paintings are, for the most part, like those in France and Spain, reproductions of animals of the chase,—in this case Kudus, Buffaloes, Elephants and Wildebeest.

The Victoria Falls and the surrounding country were described with the aid of an aerial view of the falls, and of the chasm and gorge.

The Zimbabwe Ruins, the greatest ruins of the chain which stretches across Southern Rhodesia (presumably an old caravan route), consist of (1) an Acropolis, (2) an Elliptical temple, (3) Valley of Ruins. The method of building is unique, and the date of these buildings and the nature of the builders is unknown. There are two theories, either that they are not older than 600 years and were built by Bantus, or that they are at least 2,000 years old. Recent excavations lend support to the former view, but as £75,000,000 gold is estimated to have been taken from the gold workings, one has in accepting the former view, to account for this treasure.

If the second view is held, then the gold may have found its way to India to form part of the hoarded treasures of the Rajahs, or it may have been extracted by King Solomon from the Queen of Sheba.

The lecturer finished by describing a native Kraal in the vicinity of Zimbabwe.

There being no discussion the Chairman terminated the Meeting by proposing a hearty vote of thanks to the lecturer, which proposal was carried.

Ninety-fourth General Meeting

The Ninety-fourth General Meeting of the Society was held on Thursday, 20th November, at 5.30 p.m. in the Reading Room of the Colombo Museum Library.

The President, Dr. Nell, took the Chair, and there were 11 members and 4 visitors present.

The minutes of the previous meeting were read and confirmed.

The Chairman called on the Hon. Mr. W. E. Wait, C.M.G., to give his paper on "Oceanic Bird Wanderers to Ceylon."

Mr. Wait drew attention to the salient features of Ceylon's Geographical position and the seas and oceans from which we might expect wanderers to arrive. The position of Ceylon, as the southern termination of the Indian Peninsula is comparatively favourable to the occurrence of storm-driven stragglers.

The term "Oceanic Birds" is defined to include members of the following orders:—1. Tubinares (Petrels); 2. Longipennes or Laro-Limicolae (Gulls, Terns and Skuas); 3. Impennes (Penguins); 4. Alcae (Auks and Guillemots); 5. Steganopodes (Pelicans, Cormorants, Gannets, Frigate-birds and Tropic-birds); 6. Limicolae (sub-family Phalaropinae only) (Phalaropes). Of this list, Impennes and Alcae (Penguins and Auks) are unknown anywhere near Ceylon and their occurrence as wanderers is highly unlikely. Phalaropinae have not yet been recorded from Ceylonese waters, but as they have been recorded from India their occurrence here is probable. Our Oceanic bird wanderers are, therefore, confined to those orders of which Tubinares are strictly oceanic, while Laro-Limicolae and Steganopodes contain members which are strictly oceanic and others which frequent inland waters. Each species has its definite breeding range to which the birds repair annually, but in the non-breeding season birds range far and wide, which fact accounts for their occasional appearance in unexpected localities, often in another quarter of the globe from the breeding-range.

For present purposes oceanic wanderers were divided into—1. Casual marine migrants, *i.e.*, oceanic birds which breed in the far north but winter in the Arabian Gulf, occasionally continuing southwards as far as Ceylon. 2. Habitual frequenters whose breeding-range is far from Ceylon. 3. Rare storm-driven stragglers from the Arctic or Antarctic. The lecturer then surveyed each of the three orders from which our oceanic birds are drawn and described each of the recorded species.

Laro-Limicolae—Families. *Laridae* (Gulls), *Sternidae* (Terns), *Stercorariidae* (Skuas). *Laridae*—Three species, of which one, the brown-hooded gull is a regular winter visitor. Great Black-headed Gull, *Larus ichthyaetus*, breeds in Central Asia and winters in the northern part of the Indian Ocean. It occurs occasionally in the north-east monsoon. *Larus fuscus taimyrensis*—The Dark-backed Herring Gull, breeds in N. Europe and Sibera and winters in the northern part of the Indian Ocean like the previous species. All the specimens so far recorded have been immature.

Sternidae.- Three terns, the Panayan Tern (*Sterna anaetheta*), the Sooty Tern (*Sterna fuscata*), and the Philippine Noddy (*Anous stolidus pileatus*) are visitors, the first fairly regular, but the other two only occasional.

Stercorariidae—Stercorarius antarcticus maccormickii—McCormick's Skua, *S. antarcticus antarcticus* the Antarctic Skua, and *Stercorarius pomarinus pomarinus* - the Pomatorhine Skua are all unexpected visitors. The breeding range of the first two is the Antarctic, and of the third the Arctic, and their occurrence is probably due to stormy conditions.

Steganopodes The Frigate-birds, *Fregatidae*, the most completely aerial of water birds, usually roost on trees near shore in the Pacific Islands. The three species found are : *Fregata ariel iredalei*—Iredale's Frigate-bird, *Fregata andrewsi* —The Christmas Island Frigate-bird, and *Fregata minor aldabrensis*—The Western Lesser Frigate-bird. Of the Gannets and Boobies, *Sulidae*, three species breed in the Indian Ocean but only two have been captured in Ceylon. *Sula leucogaster plotus*, the brown booby, breeds off the east coast of Australia. *Sula dactylatra*, the Masked Booby, has two forms in the Indian Ocean—the Western and Eastern. The single Ceylon record belongs to the race which breeds in tropical Australian waters and ranges through the Malayan Archipelago to the coast of Indo-China and occasionally westwards to the Bay of Bengal (*Sula dactylatra personata*).

The tropic birds, *Phaethontidae*, comprise a few species of which *Phaethon lepturus lepturus* is the only one so far recorded. Several specimens have been obtained near Chilaw and Colombo.

Tubinares –Three families are recognised. *Diomedeidae*, *Puffinidae* and *Procellariidae* - Albatrosses, Petrels and Shearwaters, and Stormy Petrels.

Albatrosses are practically confined to southern seas. Four species of Shearwaters have occurred :—

(1). *Puffinus pacificus hamiltoni*—the Wedge-tailed Shearwater, (2). *Puffinus carneipes carneipes*—the Pink-footed Shearwater, (3). *Puffinus leucomelas* the White-fronted Shearwater, and (4). *Daption capense*—the Cape Pigeon, an Antarctic Petrel of striking colouration.

Of the Stormy Petrels, one, *Oceanites oceanicus* –Wilson's Storm Petrel, is a fairly constant stormy-weather visitor, although it never comes ashore. The other species, *Oceanodroma homachroa socorrensis* the Ashy Storm-Petrel, breeds on the N. Pacific. One specimen has been obtained.

In concluding Mr. Wait suggested probable reasons for the large number of stragglers, and indicated that the existence of the shipping routes probably directly influences the question.

There being no discussion, the President called for a hearty vote of thanks to the lecturer.

The President then exhibited a bust of the late Dr. Kelaart, one of Ceylon's pioneer Naturalists, which had been presented to the Colombo Museum by his descendants.

Mr. Holsinger announced that Mr. E. P. H. Kelaart was preparing a memoir of Dr. Kelaart's life and work, and suggested that the Society might assist in its publication. Mr. Wait suggested that probably the best way would be to offer the memoir to the Ceylon Journal of Science for publication in Spolia Zeylanica and Dr. Pearson said that he would be pleased to confer with Mr. Kelaart with a view to publishing it if suitable. Mr. Kelaart returned thanks and the meeting then terminated.

Ninety-fifth General Meeting

The Ninety-fifth General Meeting of the Society was held at 5.30 p.m. on December 18th in the Reading Room of the Colombo Museum.

In the absence of the President Dr. Pearson took the Chair and there were 15 members and 4 visitors present.

The minutes of the previous meeting were read and confirmed.

Proposed Amendment of the Rules of the Ceylon Natural History Society

Rule 3. *To be amended as follows* :—

The business of the Society shall be conducted by a Council consisting of a President, five Vice-Presidents, an Honorary Secretary, an Honorary Treasurer and six other Ordinary or Life Members and one Student Member.

Rule 5. *To be amended as follows* :—

The Council shall be elected by ballot at the Annual General Meeting. The Student Members of the Council shall be elected by the Student Members of the Society and the remainder of the Council shall be elected by the Life Members and Ordinary Members. Vacancies arising during the year shall be filled by the Council.

New Rule 9. Members shall be classified as :—

(*a*) Ordinary Members.
(*b*) Life Members.
(*c*) Foreign Members.
(*d*) Student Members.

New Rule 10. (*a*) *Ordinary Members.*—Ordinary Members shall pay an annual subscription of Rs. 5/- which falls due on 1st January of each year. Ordinary Members shall have the privilege of voting on all questions brought up before the Society and shall be eligible for election to the Council of the Society.

(*b*) *Life Members.*—Ordinary Members may become Life Members by compounding for a sum of Rs. 50/-. They shall enjoy the privileges of an Ordinary Member and shall not be called upon for further subscriptions after their subscription as a Life Member has been paid. Ordinary Members who are in arrears in respect of their annual subscriptions cannot become Life Members until such arrears have been paid.

Replaces Rule 21. (*c*) *Foreign Members.*—Non-residents of the Island who are distinguished men of science and who have made important researches in Natural History, particularly of Ceylon and India, may be elected on the recommendation of the Council as Foreign Members without payment of fee or subscription. Such Foreign Members shall have all the privileges of an Ordinary Member except that they shall not be eligible to serve on the Council of the Society. Ordinary Members of the Society shall be eligible for election as Foreign Members after having given up residence in Ceylon but no part of a Life Member's subscription shall be refunded.

(*d*) *Student Members.*—Students of recognised Educational Institutions may become Student Members on payment of an annual sum of Rs. 2/-. Such subscription will entitle them to membership for one calendar year from date of election. Student Members shall have all the privileges of Ordinary Members except that they shall not have the power to vote on questions brought before the Society and shall not be eligible to serve on the Council of the Society. But such Student Members shall have the privilege of electing one member from their own number to sit on the Council of the Society.

New Rule 11. In the case of New Members (Ordinary, Life and Student Members) the subscription shall fall due on the date of election and such election shall not be considered complete until the first annual subscription or Life Membership subscription has been paid.

Old Rule 11 will become *Rule* 12, and so on.
Old Rule 21 will be replaced by Rule 10 (*c*).

In proposing the above amendment of the rules of the Society, which proposed amendment had been circulated to members, Dr. Pearson pointed out that the object of the amendment was the regularizing of the position of Student Members of the Society. Professor N. G. Ball seconded the motion and it was put to the meeting. The Chairman declared the motion carried.

The Chairman called on the Rev. Percy T. Cash to give his paper on "Spiders."

Mr. Cash explained that although everywhere abundant, and very numerous in Ceylon, spiders were a neglected group of animals. The relative neglect was partly due to lack of importance economically, and from a medical standpoint. Spiders are closely allied to scorpions, harvestmen and ticks, known collectively as Arachnida. Spiders are distinguished from other Arachnida by the waist, a narrow constriction between cephalothorax and abdomen, and by the presence of spinning organs. The salient features in the structure of spiders are the two divisions of the body; the cephalothorax and abdomen; the mandibles or jaws or chelicerae; the maxillae or pedipalps which are greatly modified in the male: four pairs of legs in contradistinction to the three pairs of insects; and the absence of wings. The eyes, which furnish useful taxonomic features, are usually eight in number but some families possess six, some four, and one genus two. The jaw is perforated by the orifice of a poison tube at the tip, and the poison produced is sometimes very powerful as in the Tarantulas, but in the smaller types of spiders it has but little effect on man. In the legs there are seven joints, the terminal joint having two or three claws. The metatarsus of the leg possesses very often a comb-like organ or calamistrum for drawing silk out of the abdominal spinning organ or cribellum. Mr. Cash showed lantern slides dealing with the external structure and demonstrating the different types of head parts and the structure of feet. The lecturer then described the internal organs of the spider; the alimentary canal; book-lungs; heart; and spinnerets. There are upper, lower and median paired spinnerets present, in the special spinning organ the cribellum, found only in a few families, there are 9,600 spinning tubes.

The web of the orb-weaving spiders is formed of strong outer bounding lines, fine radial lines and a viscid spiral which surrounds the hub in a concentric circle. The viscid spiral is the true snare and possesses many thousands of droplets of a viscid nature upon its course. Near the hub is often seen an extra mass of entangling silk which is ready for use and may be thrown upon a large and troublesome victim further to entangle it. The Theridiidae, a well-represented family in Ceylon, build irregular untidy webs, the Argiopidae construct beautiful and symmetrical webs *Argiope* has always an accessory swathing band on the hub of its web. One of the most interesting webs of all is that of the Ceylon " Dome spider " (the name is the lecturer's). The silken dome is the size of a large inverted finger bowl. Beneath the dome is a horizontal sheet of silk and above it an irregular pyramid of silken threads from which is sometimes suspended a central line carrying green cocoons from which later the young will emerge.

The spider herself is usually found in the dome at the top of it. The web is common on telegraph wires and aloes.

The dome spider is *Cyrtophora cicatrosus*. Silk enables spiders to hang from their nest when danger threatens, for ants cannot travel down the thin drag line. The silk is used also to construct the egg cocoons, familiar objects as white blotches in inaccessible places on wooden beams and rafters. Many spiders carry their egg cases about with them. Silk from the spider has been used in the same way as silk worm silk, as in the case of the gloves made for the Empress of France, but the process is too expensive to be anything but a curious luxury. Spider lines are, however, used for micrometer eye-pieces of telescopes and species of *Nephila* are used at the Colombo Observatory for this purpose. Silk also enables the young to travel at the end of a gossamer thread. A long thread of silk may be carried across a stream and so enable a spider to build its web in an otherwise inaccessible position.

Mr. Cash then dealt with a number of spiders in detail. *Uloborus*, common in Ceylon, builds horizontal orb snares. *Stegodyphus sarasinorum*, another cribellate form is colonial and builds on the Acacia. Pholcid spiders are common everywhere and are recognised by their long legs and habit of vibrating vigorously. *Ariamnes flagellum* has a long thread-like abdomen and belongs to a family the members of which possess a comb of spines on the tarsus of the third leg, for flinging silk over their victims. *Latrodectus* has a bad reputation for being poisonous, but no story has been absolutely established as to its poison being fatal to man. In the Argiopidae the discrepancy in size between male and female is very marked; in *Nephila* the female is sometimes 1,000 times the size of the male. In the untidy web of *Cyclosa* is found a line of the remains of its victims and among these the spider often hides.

The Attidae is the largest family of hunting spiders— it includes the familiar spider which stalks flies even on the dining table : many are beautifully coloured and others display mimicry. One member is very like the common red ant *Oecophylla smaragdina*.

The lecturer concluded with an account of the life and habits of the Avicidae and Lycosidae. In the discussion following the lecture Messrs. Henry, Burt, Goonewardene and Dr. Hill took part.

Dr. Pearson brought the meeting to a close by calling for a hearty vote of thanks to the lecturer and expressing the hope that he would give another paper before long.

Ninety-sixth General Meeting

The Ninety-sixth General Meeting of the Society was held at 5.30 p.m. on January 14th in the Reading Room of the Colombo Museum.

The President, Dr. Nell, took the Chair and there were present 25 members and 5 visitors.

The minutes of the previous meeting were read and confirmed.

The Chairman then called on Professor F. O'B. Ellison, M.D., B.Ch., B.A., to deliver his lecture on "Satellites."

Professor Ellison opened his lecture by discussing the possibility of other stars having families of planets similar to those of our own sun. We know one thousand million stars, two million spiral nebulae, many irregular or gaseous nebulae, a few annular planetary nebulae and globular clusters, but only one planetary system. As planets only shine by reflected light from the sun, planetary systems even in the nearest stars would be invisible, but there are reasons why other planetary systems must be very scarce.

Our planetary system has probably arisen through tidal action, through the near approach, long ago, of some other star to our sun. Stars are so widely scattered that such an approach must be extremely rare ; but when this does happen the attraction of the two stars tends to draw out an elongated mass of gas in the direction of attraction. The amount of gas would be greatest at the nearest approach and in the smaller star ; the thick middle part would condense to form larger planets, and the two thin ends smaller ones. Hence we have the big planets Jupiter and Saturn in the middle, and the small ones Neptune and the Earth, Venus and Mercury at the ends. Satellites might be formed from planets in a similar way by disturbances due to the sun on each other. The big planets would remain hot and gaseous for a long time and the gas pulled out of them would form many satellites with big ones in the middle and small ones at each end as in the case of Jupiter and Saturn. The small planets would soon cool and liquefy and would undergo a different process. A rapidly revolving liquid mass tends to split in two and this is what probably happened to Neptune and Earth. There is some ground for the belief that Mercury was originally a satellite of Venus and that the sun pulled him away afterwards into an independent orbit.

Jupiter's moons were the first to be discovered after our own, and the four bright ones were the first discovery made in 1610 with the newly invented telescope. They can be seen through an opera glass or moderate sized telescope and are everlastingly fascinating. They revolve in nearly the plane of Jupiter's orbit and equator and nearly in the plane of the earth's orbit, so that they continually pass back and forward, crossing in front of Jupiter and passing behind him into his shadow undergoing eclipses at every revolution.

The transits are especially interesting, the satellite and its shadow being seen on Jupiter's face, the shadows always but the satellites seldom as they differ so little in brightness from Jupiter. They may be seen bright against a dark belt and dark against a bright belt, the latter especially with the third satellite. Very rarely all four moons are invisible either being on or behind the disc. This occurred on August 1st, 1857, and will occur again in February 14/15th, 1931, at 2.21 a.m. Colombo time. Two will be eclipsed and two in transit. This is a very rare occur-

rence. With a large telescope the four moons show little discs on which markings have been seen. In shape they are often oval in irregular directions due probably to the tidal action of Jupiter's large mass. Jupiter's five other moons are very tiny and only one of them has ever been seen, the others were discovered photographically.

In the photographs which the lecturer put on the screen they were readily visible. The outer satellites revolve round Jupiter in a direction opposite to the others. This, and their small size, less than 100 miles in diameter, leads to the theory that some are asteroids or minor planets, which, approaching very close to Jupiter, were pulled out of their orbits and caught as moons by him.

Saturn also has nine moons in addition to the rings composed of multitudes of small moons revolving round him. These appear to be the fragments of a moon which got too close to Saturn and was pulled in pieces by his tidal attraction. It was shewn mathematically by Roche that a small body cannot revolve in an orbit round a large one at a distance of less than 2.45 radii of the larger. Nearer than this tidal action causes the smaller to break up. Saturn's outer ring is well within " Roche's limit " and his inner moon well outside it.

The plane of the rings, and orbits of the satellites of Saturn, and of his equator is inclined to the Earth's orbit at an angle of 28°, so that the plane only passes through the Earth twice in thirty years, the period of Saturn's revolution round the sun. The rings then appear edgewise and are so thin as to become invisible. Only at this time do Saturn's satellites appear in line with his equator as Jupiter's always do, but owing to his distance these phenomena are not nearly so startling. At other times they are difficult to distinguish. Saturn's ninth moon Phoebe, is very tiny and takes over two years to revolve once round Saturn, which it does in the reverse way to the others. This suggests that it was originally not born of Saturn but was a stray asteroid picked up by the planet from outside.

Uranus has four satellites which revolve in orbits almost perpendicular to the plane of his orbit. His equator is similarly tilted, so that the Arctic circle comes almost down to the equator and day and night each last half a year—about forty of our years.

Neptune's single satellite is probably the largest moon in the solar system. Its orbit and motion resemble those of Uranus's satellites being steeply inclined to the ecliptic and retrograde in movement. The fact that the satellites of the two outer planets have the same two-fold peculiarity has suggested the theory that all the satellites had originally retrograde movements, that the nearer ones had their orbits pulled head over heels by the attraction of the sun, but that Saturn has not yet reached this final state, and that Uranus's and Neptune's moons are not yet half way over owing to the pull of the sun being less at the greater distance.

Mars has the two oddest moons in the solar system. They are less than 10 miles in diameter, and the nearest Phobos is so close that it revolves in a little over seven hours. Mars spins on his axis in about 24½ hours and this is the only case known of a satellite revolving round a planet in less than its own day. Hence to the Martians it would rise in the West, cross the sky in a little over three hours, and do this three times in the course of the day. The other Deimos behaves equally oddly. Its revolution takes thirty hours, so that it takes nearly three days between rising and setting, and goes through all its phases from new to full moon twice over during that time. These were discovered in 1877 by Asaph Hall at Washington, but Dean Swift about 100 years before gives his astronomers of Laputa in " Gulliver's Travels" more powerful telescopes than our own and they discover two moons of Mars, one of which has a period less than the planet's day—one of the most amazing coincidences on record.

The lecturer concluded with a detailed account of our own moon illustrating its topography with many excellent photographs, those of Puiseaux at Paris, those taken by the Hooker 100-inch telescope at Mt. Wilson, California, and his own. The phases of the moon, and the relation of the sun, moon and earth in eclipses of the sun and moon were demonstrated with a model. As the moon's orbit is tilted about 5° half is above and half below the earth's orbit so that it is only near the nodes that an eclipse can occur. The nodes revolve round the moon's orbit in the opposite direction to the moon once in 18½ years, hence eclipses occur in nearly

exactly the same manner after a period of 18 years 11⅓ days called the saros, the odd ⅓ day causing the corresponding eclipse to be visible in a longitude 120° more west each time. After three saroses eclipses come back nearly to the same place. The eclipse of June 29th, 1927, visible in Lancashire and Yorkshire will be repeated on August 11th, 1999, four saroses later. The third just misses England, being visible in Norway. Eclipses tend to occur in groups of three at intervals of a fortnight about six months separating the groups. There can be either the whole of two groups and one of a third, making two total lunar and three partial solar eclipses in a year, or there may be only two of a group at the beginning and end of the year and all three in the middle making still seven but composed of three total lunar and four solar eclipses, of which the first can be total or annular and all the others partial.

Finally as an important effect of our satellites we have the tides, but a whole lecture would be necessary to deal with that abstruse subject.

Dr. Pearson paid a tribute to Professor Ellison not only for the subject matter of the discourse but also for the remarkable presentation of the subject.

The Chairman called for a hearty vote of thanks to the lect 'er which was carried with acclamation.

The meeting then terminated.

Notes on Ceylon Tettigoniidae, with descriptions of new species. Part I

BY

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WITH EIGHT PLATES

In the following paper I desire to place on record observations on local distribution, habits, etc., of Ceylonese Katydids and Longhorned Grasshoppers exclusive of the Gryllacrinae and Stenopelmatinae, which are being worked out by Prof. Dr. H. Karny of Buitenzorg, Java. I must express my indebtedness to Dr. B. P. Uvarov, of the Imperial Institute of Entomology, without whose kindly assistance and advice the more technical part of this paper could not have been undertaken by me.

Sub-family COPIPHORINAE

Euconocephalus incertus (Walk.)

In addition to the locality records given by Uvarov[1] the Colombo Museum possesses specimens from Wellawaya, Rakwana, Kotte, and Mousakande, Gammaduwa.

I am provisionally determining all our specimens, 19 in number, as *Eu. incertus* Walk., although some 8 of them possess a narrow black line on the extreme anterior margin of the tegmina and would therefore appear referable to Redtenbacher's *pallidus*. This black line varies so greatly in density, however, that it seems to be worth little as a diagnostic character, and I am of opinion that colour characters, unless reinforced by definite structural differences may easily be given too much weight in specific discrimination in this genus. The male genitalia throughout our series show no distinct differences. I hope, however, to be able to breed from both varieties and so settle the question once for all. There are of course two colour varieties, brown, of various shades, and green.

1. Spolia Zeylanica XIV, p. 91.

Homorocoryphus sp.

Three specimens, from Bibile 19–vii–29 (green variety) and Anuradhapura 7–xii–16 (brown variety).

This genus is in great confusion and it is impossible to be certain to which species these belong. They are not, however, *H. lineosus* Walk. a Chinese insect, with the type of which I have compared them.

Sub-family AGRAECIINAE

Acrodonta subaptera Redt. (Plate XLIII, figs. 1-4)

Fourteen specimens (six immature). The only new locality is Ohiya, 6,500 feet, where it was found to be fairly common. The specimen recorded from Colombo by Uvarov (Spol. Zeyl. XIV, p. 91) belongs to the next species ; it is almost certainly wrongly labelled, as both forms are entirely montane in habitat.

As the male of this species does not appear to have been described I offer the following description :—Shining almost throughout ; head and pronotum rugulose. Pronotum rounded and slightly sinuous in front, evenly rounded behind, the posterior lobe much longer than in the female. In profile the middle of the pronotum is slightly concave, the transverse sutures scarcely distinguishable. There is a small ill-marked tubercle at the anterior angle of the lateral lobes, which are somewhat bulged at their ventral extremity. This bulge, which covers the prothoracic spiracle, is closed in posteriorly by an inwardly-directed flange which may be seen if the insect is viewed from behind. The tegmina are much longer and broader than in the female, rounded-truncate behind. Small wings are present but quite concealed in dorsal view. The fore femora have 3-6 (average 4) anterior spines and 3-6 (average 5) posterior ; fore tibiae with 8 anterior and 7 posterior. Intermediate femora with 4-5 anterior spines and two or three small posterior spinules near the base. Posterior femora with 7-10 spines on the lower external carina, the internal carina having only a few minute spinules.

The abdomen is short and narrow. Supra-anal plate transverse, somewhat triangular, semi-circularly excavated on each side to fit the bases of the cerci, the margins of these excavations being thickened. The apex is slightly deflexed, medially sulcate. The cerci are short, stout, somewhat tapering, swollen at middle of inner margins, with rounded tips which bear a minute inwardly-directed spinule on their ventro-internal surface. The sub-genital lamina is scoop-shaped, rounded posteriorly except where the short cylindrical styles are inserted.

Colouration. This varies within wide limits, from dull castaneous to olive green, and it therefore affords unreliable diagnostic characters, but a well-coloured specimen shows the following colouration: Olive-green, mouth-parts various shades of ferruginous to stramineous; tarsi and genicular regions of legs infuscated with dark brown, a brown mark below tympanal organ on fore tibiae. The proximal part of costal field of tegmina is orange, the radial field is bright green with black mottling between the veins, and the remainder of the tegmen is opaque, very pale, stramineous. The stridulatory area of tegmina is completely covered by the posterior lobe of pronotum.

In life, the abdominal sternites are dull crimson.

The above description has been drawn up from four adult males taken at Ohiya, Nuwara Eliya and Maskeliya. There are also four adult females from Ohiya and Nuwara Eliya, from which the measurements given below have been taken.

Measurements:

	♂ mm.	♀ mm.	
Length	19·0 to 22·0	26·0 to 31·0	(including ovipositor)
Length of fastigium, from median ocellus ..	2·3 to 2·75	2·1 to 2·7	
Greatest width of head ..	3·3 to 3·5	3·1 to 3·4	
Length of pronotum ..	7·0 to 8·0	5·3 to 6·0	
Greatest width of pronotum	5·0 to 5·2	5·0 to 5·5	
Length of tegmina ..	4·0 to 6·8	2·0	
Length of posterior femur	10·0 to 10·2	10·0 to 11·0	
Length of ovipositor ..	——	9·5 to 11·0	

Acrodonta hakgallae sp. nov. (Plate XLIII, figs. 5-8)

Very like *A. subaptera* Redt. with which, for some time, I have confused it. It is, however, easily distinguishable by the following features:

Habitus considerably stouter, fastigium of vertex much shorter, face below eyes considerably swollen especially in the males. Sculpturing of head and pronotum coarser.

Tegmina, in male, half to one-third longer on the average, in the female twice as long and twice as broad as in *A. subaptera*. The ♂ cerci are very stout, not tapering. There is a small inwardly-directed spinule on the inner side of the tip as in the other species. The sub-genital lamina in the ♀ is of a different shape and much more deeply cleft in the middle. (See Plate XLIII where the main differences between the two species are illustrated).

The fore femora in both sexes normally bear 4 anterior and 5 posterior spines, the fore tibiae 8 anterior and 7 posterior. The mid

femora bear 5 anterior and 2 or 3 small posterior spines. The hind femora bear from 5 to 8 spines on the ventro-external carina and a few small spinules on the internal carina.

Colouration. The new species appears to be generally of a lighter green than *A. subaptera*. The tegmina of the males are coloured much as in that species, but none of the specimens before me show any of the black mottling between the veins that characterises most males of *A. subaptera*. The ♀ tegmina are nearly as large as those of the average ♂ of *A. subaptera* and are coloured green with an orange costal area and a broad, pale-stramineous band on the inner margin. Anteriorly, this stramineous band is bounded by a rusty-brownish spot. Some specimens are yellowish or light brown throughout, but whether this is due to post-mortem discolouration, or is a definite colour variety, I am unable to say.

Measurements:

	♂ mm.	♀ mm.
Length of body	17·5 to 19·0	26·5 to 29·8
Length of fastigium, from median ocellus	1·75 to 2·1	1·7 to 2·0
Greatest width of head	4·8 to 5·0	4·0 to 4·5
Length of pronotum	7·3 to 8·4	6·0 to 6·3
Greatest width of pronotum ..	5·0 to 6·0	5·5 to 5·6
Length of tegmina	6·0 to 6·6	4·3 to 4·5
Length of posterior femur ..	9·6 to 10·5	11·0 to 11·3
Length of ovipositor (measured laterally from centre of base)	——	9·9 to 11·2

Material examined. *Type* and four other males and 7 females (one immature) taken at Hakgalla in jungle at night, 20 to 30-viii-29. One ♀ taken at Haputale 4,700 feet 19-vi-26; one ♀ "Colombo" (?) 18-viii-23.

The *type* ♂ and a *paratype* ♀ will be deposited in the British Museum (Natural History); the remaining paratypes are in the Colombo Museum.

This species differs from Bolivar's *A. nigrospinosa* (which I have not seen), in being much smaller, differently coloured, and in the ♂ genitalia, as well as in other details of structure. It seems probable that it is the species from Ceylon mentioned by Bolivar as being "voisine de *subaptera* Redt. mais distincte." (Ann. Soc. Ent. de France LXVIII, 1899, p. 777).

The distribution of this species, as at present known, is peculiar compared with that of *A. subaptera*, and I hope that further collecting will enable me to delimit their respective boundaries.

Gonatacanthus werneri Karny

Three specimens (determined from description) of this species were taken from burrows of the digging wasp, *Sphex nigripes* at Balangoda

on 12 and 17-iv-26. They comprise a ♂ (rather badly damaged) one adult ♀ and one immature ♀.

Ischnophyllus viridipennis Redt. (Plate XLIV, figs. 3 and 4)

One male and two females were retrieved from a burrow of *Sphex nigripes* on a jungle path at Kitulgala on 9-iv-27. The wasp was observed commencing its burrow and the exact spot was marked by means of straws laid in such a way as to afford " cross bearings " of the entrance. Some hours later the place was visited and the burrow was found to be filled up with earth and its entrance obliterated, but the straws indicated its location and a little digging soon revealed the *cache* of paralyzed grasshoppers, one of which bore the egg of the *Sphex* on its meso-sternum.

The marking down and subsequent rifling of burrowing wasps' nests would appear to be a good method of obtaining rare specimens of Tettigoniidae.

Ischnophyllus crassus sp. nov. (Plate XLIV, figs. 1 and 2)

This species was recorded by Uvarov[1] as *I. viridipennis* Redt., with which it is closely allied. *I. crassus*, however, is a stouter and larger insect with much shorter tegmina and wings. Redtenbacher described only the male of *I. viridipennis*, while I have only females of the new species, but as our series of *I. viridipennis* includes a male which agrees closely with his description in all respects, I have no doubt of the correctness of the determination.

Fore femora each with 5 anterior, and 3 or 4 posterior spines ; fore tibiae with 7-10 anterior and 3-4 posterior spines. Mid femora with 5 anterior spines only ; mid tibiae with 8-9 anterior spines. Hind femora with 8-12 spines on lower external carina.

Lateral pronotal lobes much less produced posteriorly than in *I. viridipennis* ; their antero-lateral angles bearing a small, blunt tooth.

Tegmina not reaching the apex of ovipositor (in *I. viridipennis* they surpass it by nearly a quarter of their length).

Anal tergite slightly notched in the middle of its distal margin. Supra-anal lamina small, forming an almost equilateral triangle but with its apex somewhat tuberculately produced, slightly sulcate in the middle line near the base. Cerci short, sharply tapering, curved, with the concave side dorsal, setose. Ovipositor shorter and much broader than in *I. viridipennis*.

1. Spolia Zeylanica XIX, P. 91, 1927.

Colouration. Green (inclining to dirty yellowish brown in the dry specimens). Distal rim of first antennal joint and most of the second, black. Front margin of dorsum of head, including the dorsal surface of fastigium, black ; sides of fastigium mostly occupied with large, pale yellow, ocellar fenestrae. Labrum and labium dull reddish brown. Mandibles stramineous with dark brown tips. Pronotum with a small black spot in the middle and with its posterior border dark crimson. Tarsi dull reddish brown and auditory area of fore tibia suffused with black and pink. Tegmina with irregularly scattered, black, depressed spots, larger and more numerous than in the genotype. A small, ill-defined black blotch at the middle of base of each tegmen. The veins of the wings are apparently not crimson as they are in *I. viridipennis*. Ovipositor stramineous with the margins of its valves broadly suffused with brown.

Measurements:

	I. crassus sp. nov. ♀ mm.	*I. viridipennis* Redt. ♀ mm.
Length of body	24·0	21·0
Length of pronotum	5·0	4·7
Greatest width of pronotum	4·5	4·2
Length of tegmen	17·0	22·0
Length of posterior femur	9·0 to 9·5	9·0
Greatest breadth of posterior femur ..	2·7	2·4
Length of ovipositor	7·2	7·0
Greatest width of ovipositor .. .	2·1	1·7

Material examined. *Type* female collected at Woodside Estate, Urugalla, on 25-iv-24, and *paratype* female taken at the same locality on 22-iv-24. No male specimen has yet been taken, but I give a drawing of the ♂ genitalia of *I. viridipennis*, as well as one of the female of that species, so as to facilitate its discrimination from *I. crassus*.

The *type* will be deposited in the British Museum (Natural History). The one paratype is retained in the Colombo Museum. (Registered No. Orthoptera 1273).

SCYTOCEROIDES gen. nov.

In both Redtenbacher's [1] and Karny's [2] keys, this new genus runs to *Subria* Stal. It differs, however, from all hitherto described species of that genus in the extraordinary length of the ovipositor, as well as in the shape of the pronotum and in other features. With *Aethiomerus*

1. Verh. der K. K. Zool.-bot. Gesellsch. in Wien XLI. 1891. P. 327, et seq.
2. Gen. Insect., Fasc. 141. P. 3, et seq.

Redt. it agrees in most points, but the tegmina considerably surpass the end of the abdomen, and here again, the long ovipositor distinguishes it. On the whole, it seems to form a connecting link between the genera *Scytocera* Redt. and *Macroxiphus* Pict. with one or the other of which it may eventually be merged, but, as I have not been privileged to examine specimens of any of these genera, I think it advisable to erect a new genus to accommodate the remarkable insect described below. To *Macroxiphus*, it is allied by the form of the ovipositor, but it differs in having an unarmed prosternum, vertex much shorter than the first antennal joint, no tubercle at base of vertex, head and pronotum smooth not "rugulose-punctate," meso-sternal lobes not "acutely produced."

The new genus is characterised as follows: Habitus similar to *Macroxiphus* Pict. Antennae very long, their first joint slightly swollen inside, a small, blunt tooth on the inner distal margin. Vertex shorter and narrower than the first antennal joint, conical, compressed, at tip in dorsal view roundedly pointed, in profile obliquely rounded; neither sulcated nor provided with a tubercle dorsally, ventrally wedge-shaped, concave, separated from the facial fastigium by a sinuosity. Large ocellar fenestrae on the sides of the vertex and on the facial fastigium between the antennal scrobes. Frons and genae smooth and shining, faintly punctured. Eyes not very prominent.

Pronotum smooth, broadly rounded in front, roundedly truncate behind; its lateral lobes not very deep, rounded in front, obliquely emarginate below, a slight humeral sinuosity.

Prosternum unarmed (a pair of minute tubercles can be detected under a fairly high-power binocular microscope); mesosternal lobes obtusely angled behind, metasternal lobes similar but closer together, with the angles more rounded, bearing a small tubercle at each of their antero-lateral corners (see Plate XLV, fig. 4).

Fore coxae with a long, acute, anterior spine; mid coxae with a short, thick, antero-dorsal spine, and a large, postero-ventral, conical tubercle; hind coxae with a postero-ventral tubercle.

Fore femora sulcate beneath, slightly compressed, spinose anteriorly and posteriorly; their anterior (inner) knee-lobe only spinose. Fore tibiae spinose on both sides below the auditory bullae, which are very much inflated and have their foramina in form of broad slits.

Mid femora slightly compressed, beneath spinose only on the anterior (outer) margin (in some cases with a single minute spine on the postero-distal margin); their posterior (inner) knee-lobe only spinose. Mid tibiae slightly incrassated, spinose on both sides beneath.

Hind femora spinose on outer ventral carina, one or two small spinules on inner ventral carina near the distal end ; both its knee-lobes spinose.

Tegmina considerably surpassing the abdomen, narrow, tapering from base, rounded at apex, slightly longer than the wings (*e.g.*, when folded).

♂. Anal tergite transverse, deeply excavated at mid margin, forming an angulated lobe at each side ; supra-anal plate transverse, downwardly directed, deeply medially sulcate ; cerci short, longly setose, nearly globular, with a dorso-internal apophysis and a distal process ; sub-genital lamina deeply incised medially, with comparatively long, exserted styles.

♀. Ovipositor longer than the body, straight, nearly parallel-edged but slightly broader near the tip than near the base, its upper valves surpassing the lower, its tip bluntly pointed. Cerci rather stout, curved, very setose, tapering suddenly near the tip. Sub-genital lamina with small, rounded lateral lobes at the base, sides then steeply converging, median edge deeply, roundly excavated.

Genotype : *Scytoceroides ceylonensis* sp. nov.

Scytoceroides ceylonensis gen. et sp. nov. (Plate XLV, figs. 1-9)

The main features of this insect have been given in the generic diagnosis ; the following points seem to be of specific value merely : occiput with a series of shallow sulci, of which the chief are a median sinuous pair extending from the base of the vertex, and a lateral pair bowed outwards from the interno-posterior margin of the eyes ; both extending to the back of the head.

Frons in profile reclinate, its outline very slightly sinuous. Maxillary palpi with third and fourth joints nearly equal, fifth slightly longer, clubbed, almost squarely truncate at tip ; terminal joint of labial palpi slightly shorter than fourth maxillary, club-shaped and obliquely truncate at tip.

Fore coxal spine long, acute, slightly curved and downwardly directed ; fore femora with 4-5 anterior (internal) and 3-4 posterior (external) spines. Inner knee-lobe spinose, the outer smooth. Fore tibiae with 5-6 spines on each side (not counting the small terminal spurs). As remarked already, the auditory bullae are very much inflated, their foramina being in the form of elliptical slits (see Plate XLV, fig. 5).

Mid femora with 7-8 rather irregularly-placed spines on the anterior (outer) ventral carina, a minute distal spine occasionally on the posterior (inner) ventral carina (which is very feebly developed) ; mid tibiae with

7 anterior (external) and 4-5 posterior (internal) spines (not counting the terminal spurs).

Hind femora with 9-11 spines on the ventral external carina and a single small sub-apical one on the inner ventral carina. Both knee-lobes spinose. The hind tibiae bear the usual four rows of spines, the internal ventral row being confined to the distal half.

The tarsi call for no special remark.

Pronotum smooth, its greatest depth equal to the width of its anterior half, but less than its greatest width which is immediately above the fore coxae. The transverse sulci are obsolete and its dorsal profile is merely slightly sinuous; the antero-ventral margin of the lateral lobes is gently rounded, the ventral margin is obliquely concave, the humeral sinus is present but not very pronounced; humeral ridges very slight and rounded.

The tegmina are long, narrow, tapering, rounded at tip, with costal margins nearly straight. Tympanal area of male small, partly concealed by the posterior lobe of the pronotum. Wings not quite reaching the tips of the tegmina.

♂ *genitalia.* The anal tergite is transverse, with its posterior margin broadly W-shaped; beneath it the supra-anal plate is a transverse structure directed downwards nearly at right angles and deeply sulcated medially so that it appears to be in two lobes. Each cercus is nearly globular, with a dorso-internal peg, and distally bearing a projection with a sharp tooth inwardly- and upwardly-directed; the lateral edges of the supra-anal plate appear to be grasped between this peg and tooth. The cerci are clothed with long setae. The titillator, which is just visible in the specimen before me, is in the form of two club-shaped, strongly chitinised, black organs, set with numerous short, stout, recurved spines. The subgenital lamina is deeply bilobed, each lobe bearing at its tip a somewhat long cylindrical style; the lobes and styles are hirsute (see Plate XLV, figs. 6, 7, 8).

♀ *genitalia.* Unfortunately, in the process of evisceration of the only specimen of this sex available, the supra-anal plate and cerci, etc., have been retracted into the abdomen in such a way that the shape of the former cannot be made out, but the cerci can be seen to be short, stout, slightly upwardly-curved, very hirsute, and tapering suddenly near their tips. The ovipositor is longer than the body by nearly half the length of the latter; in profile it is perfectly straight except at the base, nearly parallel-edged but very slightly broader just before the tip than just behind the base. The dorsal valve surpasses the ventral by a millimeter or so and its tip is sharply rounded. The sub-genital lamina has a small rounded lobe at each side, posterior to which its sides converge so that

they would meet in something less than a right angle; the medial margin, however, is deeply and roundly excised so that the sides terminate in sharp, almost spinous, points (see Plate XLV, fig. 9).

Colouration. In both sexes, the ground colour is tawny brown, slightly olivaceous dorsally. The following blackish brown marks are present: vertex (except the large ocellar fenestrae on the sides, which are pale yellow), distal rim of first antennal joint and a ventro-basal spot on the same; ventral sides of antennal scrobes and the frontal area between them (except the median ocellus which is pale yellow); base and rim of second antennal joint; eyes; all the leg-spines and a spot at the base of each; the distal extremities of all the femora (including the greater part of the knee-lobes), and tibiae; spots proximal and distal to the auditory organs on fore tibiae and one between the auditory foramina; diffuse spots on fore and mid tibiae tending to form a dark band along their dorsal surfaces; an irregular demi-ring, just distal to knees, on dorsum of mid and hind tibiae; a line between the two dorsal carinae on hind tibiae; parts of third tarsal joints; indistinct irregularly scattered spots between venules on tegmina.

The file-bearing vein in the male stridulatory organ is pale opaque yellow; the extreme costal margin of tegmina is also pale opaque yellow, forming a narrow line; all these markings are rather less defined in the female than in the male; the ovipositor is castaneous, paler at the base.

Vestiture. Almost the whole insect, except the abdominal tergites, is shortly and sparsely setose in both sexes.

Measurements:

	♂ mm.	♀ mm.	
Length of body	28·0	37·0	(excluding ovipositor)
Length of antennae—at least ..	84·0	115·0	
Length of pronotum ..	7·0	8·5	
Length of tegmina	26·0	33·0	
Length of fore femur ..	8·0	10·0	
Length of hind femur ..	19·0	24·0	
Length of fore tibia ..	8·5	10·0	
Length of hind tibia ..	20·0	25·5	
Width of head, including eyes ..	3·3	4·0	
Width of pronotum ..	4·5	5·7	
Greatest depth of pronotum ..	3·5	4·1	
Length of ovipositor ..	—	51·0	
Width of ovipositor	—	1·8	

Material examined. The *type* male was captured in jungle at Labugama on 21-i-30 by my Assistant, Mr. T. R. Sandrasagara. It will be deposited in the British Museum (Natural History). A *paratype* female was taken by me, at night, in heavy forest at Kitulgala on 11-iv-27; it is retained in the Colombo Museum.

LABUGAMA gen. nov.

In Karny's[1] key, this genus runs near *Pseudoliara* Karny, but it differs in the shape of the pronotum and in the genicular armature. While I am reluctant to erect another new genus, there seems to be no other course open pending a thorough revision of the Agraeciinae, which appears to be considerably overdue and which it is hoped some student of the sub-family will shortly undertake. Such a revision is of course only possible to one who has the opportunity of examining the rich historic material housed in the great museums of Europe ; not to mention the indispensable advantage of access to the complete literature of the subject. In my opinion such a revision, to form a stable foundation for future work, must be *lavishly* illustrated, and such illustrations should include adequate figures of the facies of every genotype, together with complete detail-figures of such structures as sternal armature, knee-lobes, auditory organ, pronotum, head, etc. Without such figures, it is impossible for workers, who have not access to the type specimens, to be certain to which genus any given specimen should be referred. Descriptions, however elaborate, in no way supersede the necessity for good illustrations, and one of the greatest desiderata in Systematic Entomology is the provision of really accurate and ample illustrations of the types of genera. I would go so far as to say that no proposed generic name should be accepted as valid, unless its description is accompanied by such complete illustration that, if the type series were to be completely destroyed, the determination of the insect from the figures need be subject to no reasonable doubt.

The new genus *Labugama* is described as follows : Female unknown. ♂ : form comparatively slender ; brachypterous, the tegmina not much longer than pronotum in the genotype, and less than half the length of the abdomen ; wings present and nearly as long as the tegmina. Vertex shorter and narrower than first antennal joint, not conspicuously compressed, slightly carinate below, separated from frontal fastigium by a sinuosity and slight notch. Its tip bluntly pointed, dorsally non-sulcate, non-tuberculate. First antennal joint tumid internally, with a small blunt tooth on its inner distal margin ; flagellum of antennae long. Eyes not very prominent. Frons and genae smooth, shining, very faintly punctured.

Pronotum rounded in front, roundedly truncate behind, semicylindrical, smooth, the transverse sulci scarcely marked, the sides in dorsal view deeply sinuous about the middle ; lateral lobes not very deep, gently rounded antero-ventrally, the ventral border emarginate and

1. Gen. Insect. Fasc. 141. P. 3, et seq. (1913)

slightly oblique, postero-ventral lobe not much developed, humeral sinus very slight.

Prosternum armed only with a pair of minute tubercles, mesosternal lobes very obtusely and roundedly triangular, metasternal lobes rounded, with a small blunt tubercle at each of their anterior corners.

Fore coxae with an acute antero-dorsal spine ; mid coxae with a minute antero-dorsal spinule and a small ventro-distal tubercle ; hind coxae with small dorso-external and ventral tubercles. Fore and mid femora rather strongly compressed ; fore femur spinose on both sides disto-ventrally, its anterior (inner) knee-lobe spinose, the other rounded ; mid femur spinose only antero-ventrally (outer side) its posterior (inner) knee-lobe spinose, the other bluntly pointed ; hind femur spinose on the outer ventral carina, a single small sub-apical spine on the inner ventral carina, both its knee-lobes strongly spinose. Fore tibiae spinose on both sides beneath, the auditory bulla somwhat inflated (but not so much as in *Scytoceroides*) its foramina in the form of broad longitudinal slits ; mid tibiae somewhat incrassate-compressed, spinose on both sides beneath ; hind tibiae with the usual four rows of spines of which the two ventral ones are confined to the distal half. The tarsi call for no special remark.

As the genitalia are rather complicated and evidently strongly characteristic of the individual species, no useful purpose will be served in dealing with them here. A full description will be found under the specific diagnosis.

Genotype : *Labugama pearsoni* sp. nov.

Labugama pearsoni gen. et sp. nov. (Plate XLVI, figs. 1-8)

This insect superficially suggests a micropterous form of the preceding—*Scytoceroides ceylonensis*—and it is a coincidence that the unique type was captured at the same time and place as the type ♂ of the latter ; that the resemblance is but superficial is at once apparent, not only by the abbreviated tegmina but by the structure of the auditory organs and genitalia, etc.

Occiput slightly convex, curving gently upwards into the vertex ; face strongly reclinate, its outline in profile nearly straight, 3rd and 4th joints of maxillary palpi sub-equal and about 1/3rd of their length shorter than the 5th, which is incrassated apically and slightly obliquely truncate ; terminal joint of labial palpi very little longer than the third maxillary, apically incrassate and obliquely truncate.

Fore femora sulcate beneath with 3 anterior (internal) and 3 posterior (external) ventral spines situated in the distal half ; it is somewhat strongly compressed, particularly proximally ; fore tibiae with 6 an-

terior (internal) and 5 posterior (external) spines (terminal spurs do not appear to be differentiated); the auditory bulla is fairly inflated but not so much as in *Scytoceroides*.

Mid femora with 4-5 anterior (external) ventral spines only; mid tibiae somewhat incrassate-compressed, with 6 anterior (external) and 5 posterior (internal) spines (terminal spurs not differentiated). Hind femora with 8 spines on ventro-external carina and a single small sub-apical one on ventro-internal.

Tegmina longer than the pronotum but not reaching the middle of the abdomen, their apices obliquely rounded; the venation well developed, tympanal area small but only partly covered by the pronotum. Wings nearly as long as the tegmina.

The anal tergite is transverse, with sides convexly converging, distal margin broadly, roundly excavated; the supra-anal plate is in form of two stout projections separated by a deep, wide furrow; their form is best indicated by a diagram (figs. 7 and 8). Each cercus is a stout, short cylinder, longly hirsute, with a long, dorso-internal flange-like lobe; below the distal end of this lobe, a long inwardly and upwardly curved spine is attached; but here again, the form can only be adequately conveyed pictorially (see figs. 6 and 8). The sub-genital lamina is longly W-shaped, with straight, cylindrical styles exserted from the distal apices (see fig. 5).

Vestiture: Almost the whole insect is shortly and sparsely setose. The cerci are longly hirsute and the sub-genital lamina and styles are rather densely clothed with short setae.

Colouration. Tawny brown or testaceous; eyes dark brown; vertex (darkest dorsally), first and part of second antennal joints, antennal scrobes, a longitudinal band on upper half of frons, dark brown; femoral and posterior tibial spines, with a diffuse spot at the base of each, brown; diffuse brown marks above and below the auditory bulla and also between the foramina; indistinct brown dots on dorsum of mid tibiae; the tegmina have indistinct brown spots between the venules.

Measurements:	♂
	mm.
Length of body—about	32·0
Length of antennae—at least	106·0
Length of pronotum	7·0
Length of tegmina	8·75
Length of fore femur	8·0
Length of hind femur	17·4
Length of fore tibia	7·3
Length of hind tibia	18·2
Width of head, including eyes	3·3
Greatest width of pronotum	4·4
Greatest depth of pronotum—about	2·75

Material examined. The *type* male is unfortunately the only specimen available. It was captured at Labugama on 22-i-30 by my Assistant, Mr. Sandrasagara, who reports that he took it in jungle at night. It will be deposited in the British Museum of Natural History.

It gives me very great pleasure to dedicate this interesting insect in honour of my esteemed Chief, Dr. Joseph Pearson.

Sub-family CONOCEPHALINAE

Conocephalus (Xiphidion) signatus (Redt.)

This is probably the commonest and most widely distributed Tettigoniid in Ceylon, being found in lush herbage everywhere. The Museum possesses 65 specimens (some immature) from the following unrecorded localities : Arugam Bay, Balangoda, Bandarawela, Battaramulla (W.P), Bibile, Bintenne, Colombo, Haputale, Horton Plains (7,000 feet), Kalkudah, Kandy, Ohiya, Rakwana, Ratnapura, Trincomalee, Wellawaya. It is a very alert and active insect.

I am treating the whole series as *X. signatus* Redt., although many of the specimens might be placed in *X. trifasciatus* Redt. so far as colouration is concerned, as they have three more or less well-marked dark longitudinal bands on the abdomen. These bands show so much variation, however, that I consider them worthless for separating species, and I am quite unable to find any structural differences to warrant the separation of our series into two species. While an examination of the types is of course necessary for certainty, it seems more than probable that *X. trifasciatus* will eventually fall as a synonym to *X. signatus*, more especially as the latter was described from the female only.

Conocephalus (Xiphidion) longipennis (Haan)

Nineteen specimens, from Arugam Bay, Battaramulla (W.P.), Maha Oya, Mihintale and Ratnapura as additional locality records. One of these is a dwarf male from Ratnapura (No. 2267) and is only about two-thirds the normal size, but it agrees in all essentials with the other males, and especially in the shape of the genitalia.

Conocephalus (Xiphidion) maculatus (Le Gouill.)

Twenty-nine specimens, giving the following unrecorded localities : Bandarawela, Battaramulla (W.P.), Belihuloya, Bintenne, Cheddikulam, Kallar (N.P.), Kandy, Wellawaya.

Sub-family LISTROSCELINAE

Phisis pectinata Guer-Méne.

Dr. Uvarov informs me *in epistola*, that the specimen from Ceylon in the British Museum collection recorded by Walker is a larva, apparently of *Décolya* sp., and as this appears to be the only definite record of *P. pectinata* from Ceylon, it may be removed from our list.

Phisis kelletti sp. nov. (Plate XLVII, figs. 1-5)

Fastigium of vertex medially, longitudinally sulcate, narrow in profile, not extending beyond the gibbosity on inner side of first antennal joint. Face below antennae transversely gibbous, then somewhat flattened to clypeus. Eyes prominent, in diameter about $\frac{3}{4}$ of the distance between them. Maxillary palpus long, its terminal joint longest, third and fourth nearly equal. Labial palpus also long, its terminal joint slightly longer than that of the maxillary palpus. Antennae without nodes.

Pronotum truncate anteriorly and posteriorly, a slight medial elevation at the anterior border. In profile, the dorsum is concave. the posterior border somewhat sharply elevated. The transverse sutures are well marked. Prosternum with two divergent spines.

Fore coxae with the usual spine, fore femora with 4 anterior, 5 posterior, long, cylindrical spines ; fore tibiae with 7 anterior and 7 posterior spines, each spine being equal in length to its opposite fellow and the whole series diminishing evenly in size distally. The auditory organs are normal for the genus.

Mid trochanters with a small ventral spine, mid femora with 4 or 5 anterior spines, and 3 posterior spinules in the proximal half. Mid tibiae with 6 anterior and 6 posterior spines (not counting the terminal spurs) as well as a small dorsal one near the distal extremity.

Lower external carina of posterior femora armed with about ten small spines, the spaces between which are occupied by pale-coloured setae. All genicular lobes armed with a spine on each side as usual in the genus.

Tegmina about twice the length of the abdomen, wings extending a little beyond them.

Anal tergite large and broad, extended on each side into a long, cylindrical, incurved process. Its medial edge is produced and sharply up-curved to form a lip like that of a jug. Supra-anal plate invisible in the unique type. The titillator forks into two long, slender, cylindrical, tapering rods, which curve first upward, then outward and slightly

ownward. Each cercus is a broad, flattened plate with a deep dorsal concavity near the tip over-arched by a small, inwardly-directed tubercle. The sub-genital lamina is broad, with its margin between the short styles obtuse-angularly excavated, the margin of the whole resembling a somewhat splayed-out W (see Plate XLVII, figs. 3, 4, 5).

Colouration. The type specimen was bright green in life and has faded to greenish stramineous. There is a rose-pink longitudinal band, with two diverging "horns" at its anterior end, on the pronotum, and superimposed on this pink band there are two dense black lines more or less broken at the transverse sulci. The tympanal membrane on the tegmina is smoky brown.

Measurements:	♂
	mm.
Length of body—about	14·0
Width of head	2·75
Length of pronotum	3·0
Greatest width of pronotum	3·0
Length of tegmina	17·5
Length of hind femur	10·0

Material examined. The *type* male captured 8-iv-28 at Ougaldowa Estate, Belihuloya, the residence of Mr. F. G. Kellett, whose guest I was at the time and in whose honour I am naming this species. It will be deposited at the British Museum of Natural History.

A last instar female larva, taken at the Nitre Cave, Medamahanuwara on 15-iv-30, also belongs, almost certainly, to this species, as, making due allowance for sex and immaturity, it agrees in all important points with the type.

Genus **DECOLYA** Bolivar

Ceylon seems to be very rich in species of this genus, originally described by Bolivar, from Kodaikanal in S. India. It is certainly very closely allied to *Phisis* Stål, almost the only points of difference, that I am able to discover, being the slightly more depressed pronotum and the abbreviated tegmina and wings in *Decolya*. It is also very closely related to the genus *Estrinia* Karny ("Treubia," Vol. VII, 1926, p. 194) but differs in the form of the pronotum, in the number of spines on the fore and mid lsgs, in possessing dorsal spines on the mid tibiae, in the armed fore coxae and in other particulars.

Three new species are herein described, and I have two more of which further material is awaited before remarking on them. One of these seems very close to *D. visenda* Bol. the genotype, but examination of S. Indian material (which I have not been able to obtain) of the latter is necessary before one can be certain.

Decolya uvarovi sp. nov. (Plate XLVIII, figs. 1-4)

Allied to *D. roseopicta* Uvarov, with which it agrees in habitus but differs in measurements, markings, and in the genital armature.

♂. Head almost exactly as in *D. roseopicta* but narrower and rather more swollen below eyes. Pronotum similar but very nearly as broad as long. Sternal armature as in that species.

Fore coxa armed with a straight spine, shorter than in *D. roseopicta*. Fore femora with 4 anterior and 5 posterior spines ; fore tibiae with 7 spines on each side ; intermediate trochanters with a small spine on their ventral surface ; intermediate femora with 4 anterior and 2 posterior, sub-basal ones in series with the one on the trochanter ; intermediate tibiae with 6 anterior, 5 posterior, and 2 dorsal of which the first is set near the second anterior and the other near the distal end ; hind femora with 7 sharp, recumbent spines on the lower external carina ; the hind tibiae bear four rows of sharp spines, and four strong terminal spurs, of which the internal dorsal is the longest. It will be seen that this spine-formula agrees very closely with that given for *D. roseopicta* (Spol. Zeyl. XIV, p. 92).

Anal tergite transverse, rectangular, with the posterior angles broadly rounded, its posterior margin deeply emarginate for the reception of the small, nearly circular, supra-anal plate. Cerci somewhat thickened and slightly compressed at base, tapering distally and expanded for about their terminal quarter into semi-spatulate, inwardly concave, gutter-shaped structures. Each cercus is rather strongly bowed, particularly at the base, but it is not nearly so recurved as in *D. roseopicta* and completely lacks the inward expansion found in the latter. The sub-genital lamina is broad, transverse, strongly excavated on its posterior margin and bearing a comparatively long, somewhat inwardly-directed style at each side of the excavation. The titillator is in the form of two slender, slightly compressed, curved rods projecting upwards from below the supra-anal plate. I present a figure of the ♂ genitalia of *D. roseopicta* for comparison with those of this species (see Plate XLVIII, figs. 3 and 5).

Colouration. In life a beautiful, delicately-varied, translucent green ; in the dry specimens dirty yellowish brown. Eyes dark brown. Anterior face of auditory bulla on fore tibia smoky brown.

One specimen has a number of crimson-pink spots arranged as follows : A ring on second antennal joint, a trace on inner side of first antennal joint, a pair on front margin of pronotum, another pair just behind anterior sulcus and a third pair at middle of posterior margin. A large indefinite blotch on disc of stridulatory area of tegmen, and a

spot on terminal margin. Two rows of spots on abdominal tergites. A spot at base of anterior coxal spines, one at base of fore femora, one at the apex of each tibia. The femoral and tibial spines also have a tendency to be pink and there are indistinct pinkish spots in other situations as well.

The other specimen has no pink or crimson but has a large smoky-brown blotch on the disc of the stridulatory area of the tegmen and a slight spot of the same colour on its terminal margin.

The above description refers to the males, but it applies to the females also in most respects. They, however, lack the smoky-brown marks on the auditory bullae and are uniform dirty yellowish-brown. Their tegmina are very vestigial (more so in one specimen than in the other), being much less than half the length of those of the males. The ovipositor is very bulbous at the base in dorsal view, sabre-shaped, very minutely serrated on both edges near the tip. Owing to shrinkage in drying, the precise form of the anal tergite is a little difficult to make out, but it appears to be like that of the male on a small scale but with the median emargination acutely angled. The shape of the sub-genital lamina cannot be satisfactorily made out.

Measurements:

	♂ mm.	♀ mm.
Length of body—about ..	.. 11·0	about 20·0
Length of pronotum ..	.. 2·8 to 2·9	2·8
Length of tegmina ..	.. 4·0	1·3 to 1·7
Length of anterior femur ..	.. 5·5 to 6·0	5·8 to 6·0
Length of posterior femur ..	.. 9·0 to 9·5	9·6 to 10·0
Length of anterior tibia ..	.. 6·2 to 6·9	6·9 to 7·0
Length of posterior tibia ..	.. 10·6 to 11·0	11·6 to 11·75
Length of ovipositor ..	.. ——	9·0 to 10·2
Breadth of ovipositor ..	.. ——	1·1 to 1·2

Material examined. Type male taken at Hakgalla 24-viii-29; *paratype* male, Hakgalla 1-ix-29; *paratype* female, Hakgalla 30-viii-29; *paratype* female, Kandapola 21-ix-26.

The *type* male and a *paratype* female will be deposited in the British Museum of Natural History; the remaining paratypes are in the Colombo Museum.

All the specimens were taken in jungle undergrowth at an elevation of 5,500 to 7,000 feet. As with the other species of this genus herein described, they hide during the day, clinging to the underside of leaves with their long legs fully extended, and in this position they are very inconspicuous, their bright green colouration forming no contrast with the green light transmitted by the leaf. When disturbed they move very

rapidly and excitedly and lose no time in scrambling into concealment beneath another leaf.

I have pleasure in naming this species in honour of Dr. B. P. Uvarov who has done so much to further our knowledge of the saltatorial Orthoptera.

Decolya splendens sp. nov. (Plate XLIX, figs. 1 to 5)

In general facies somewhat resembling the preceding species but larger and much longer limbed.

♂. Head as in *D. uvarovi* but less swollen below eyes. Eyes large and prominent; antennae very long and slightly nodose, the nodes being marked with dark brown; the first occurs at about the 16th joint, the second at about the 25th, the third at about the 43rd, after which a secondary series of annulations of a paler brown appears between the primary ones, which, moreover, tend to lengthen. The maxillary palpi are very long, their third and fourth joints sub-equal, fifth longest. Labial palpi also very long, their terminal joint longer than the fifth maxillary.

Pronotum truncate in front and behind, nearly as broad as long; its transverse sulci fairly well marked, the lateral lobes horizontally expanded, and the posterior margin raised to form a well marked rim.

Tegmina considerably longer than pronotum, rather suddenly narrowed on the inner margin immediately behind the stridulatory area. The file-bearing vein in the left tegmen is thick, raised and shining. Wings very small and obsolescent.

Prosternum armed with two long, blunt spines; mesosternum with two pronounced, semi-pedunculate round tubercles; metasternum produced at the sides into conical tubercles.

Spines on anterior coxae narrow and nearly straight. The spine formula of the two anterior pairs of legs is the same as in *D. uvarovi*. The posterior femora bear 12 small, oblique spines on the outer ventral carina which is deep and compressed. Posterior tibiae with four series of dark tipped spines and with four terminal black spurs, of which the internal dorsal is the longest and the external ventral is the smallest.

Abdomen probably nearly cylindrical in life, but strongly compressed proximally in the dry specimen. Sides of margin of ninth tergite lobately produced. Anal tergite not at all rectangular, its sides converging from base, then lobately produced, a very deep and broad median concavity between the lobes. The supra-anal plate very small, rounded, medially sulcate, retracted into this concavity. Apparently from its lower surface there arise two long prongs which curve outward,

hindward, and downward, nearly reaching the edge of the sub-genital lamina. Their precise nature is obscure and could only be ascertained by dissection which is precluded by paucity of material.

The titillator takes the form of a pair of nearly straight, slightly diverging rods which emerge from below the prongs just described and project obliquely upwards. The cerci are very strongly bowed outwards near their bases, then gently curved to the apex. Near the base they are broad and deeply hollowed on the inner side with the dorsal margin thickened, then somewhat tapering, with the terminal third very slightly expanded. The sub-genital lamina is broad, somewhat lobed laterally below the bases of the cerci, its posterior margin concavely truncate and with a short cylindrical style inserted at each side of the truncation. The cerci, anal tergite and sub-genital lamina are clothed with long erect setae (which are omitted from the figures for the sake of clearness).

Colouration. In life, the general colour was delicate apple green, but unfortunately no detailed notes of it were made at the time of capture. The dry specimen is dirty brownish yellow. The dorsal surface of the file-bearing vein on the left tegmen is black and shining and there is a triangular black patch extending across the tympanal area to its inner edge. The proximal dorsal portion of the auditory bulla on fore tibia is dark brown, as are also all the third tarsal joints with their pulvilli; the distal extremity of the posterior tibiae; the ventral surface of the fore femoral and tibial spines; and the antennal annulations already mentioned.

The following crimson-pink marks are present: a pair of converging lines on prozona of pronotum, a pair of parallel ones on mesozona; a large blotch on the tip of each tegmen; the bases of the leg spines and the proximal ends of the tibiae tend to be pink, also the ventral surface of the mid femoral and tibial spines; a pair of marginal spots in the middle of the ninth tergite.

The female agrees with the male in most characters, spine-formula, etc., but she is very much more slenderly built; her antennae show hardly any trace of nodes and completely lack the dark annulations; her tegmina are only half the size of those of the male and are more or less elliptical in shape. In colour she completely lacks all the dark brown and crimson-pink markings except for traces of brown shading on the ventral surface of the spines on the fore leg.

The ovipositor resembles that of *D. uvarovi* but it is relatively narrower, more gradually curved, and with comparatively coarse serrations on the distal half of the dorsal edge, finer ones on the distal quarter of the ventral. The supra-anal plate and sub-genital lamina are

too shrunk for satisfactory description, but the penultimate tergite bears a curious, stout, rounded, somewhat hook-like lobe on its postero-ventral margin ; this is a very distinctive character (see Plate XLIX, fig. 3).

Measurements :

	♂ m m.		♂ m m.
Length of body	14·0	about	23·0
Length of pronotum	3·9		3·7
Breadth of pronotum	3·5		2·9
Length of tegmina	5·7		3·0
Length of anterior femur	9·3		9·3
Length of posterior femur	15·2		15·7
Length of anterior tibia	10·8		10·8
Length of posterior tibia	18·8		19·8
Length of ovipositor	—		10·2
Breadth of ovipositor	—		0·95

Material examined. *Type* male taken at Labugama, 10-ix-26 ; *paratype* female from the same locality, 22-i-30 ; and several immature specimens of both sexes, all from Labugama, preserved in spirit. The *type* will be deposited in the British Museum of Natural History and the remaining specimens are in the Colombo Museum.

Habits, etc. On 19-ii-31 and 9-iii-31, visits were made to the Labugama forest reserve mainly for the purpose of obtaining material of this species. No adults were captured, but several larvae in different stages of development were taken by sweeping amongst the wild bamboo, which forms the major item in the jungle undergrowth in that damp locality. These were brought alive to Colombo and placed in cages with bamboo leaves, etc., and supplied with an assortment of small insects. They all succumbed early, however (the smaller ones, I believe, to cannibalism on the part of their elders), except a single $\frac{3}{4}$ grown male taken with five others on 9-iii-31. This was taken home, where its habits could conveniently be studied, and it lived for nearly a month. It was strictly nocturnal and usually assumed the resting position even at night, when artificially lighted. In the day-time its eyes were pale yellow but changed to deep red at night. It never ate the bamboo leaves with which it was kept supplied and for a long time its food was a mystery, but at last it was observed eating small insects (of which a promiscuous collection was swept from herbage daily and introduced into its cage) ; tiny moths seemed to be most usually taken. The feeding position was peculiar : it clung upside-down to the roof of its cage and supported the prey on its sternum while the mouth-parts manipulated it. I was never lucky enough to observe the method of capturing prey but am inclined to think that it uses the fore limbs, with

their spiny armature, as a kind of clap-net. The resting attitude was on the underside of a leaf (or of the cage-roof, etc.), with the fore-legs and antennae stretched out straight in front of the head, the hind legs similarly stretched out behind and the mid femora laid back along the body with their tibiae usually projecting laterally almost at right angles.

Unfortunately it seemed very finnicky about its food and died before becoming adult.

Labugama forest reserve is the catchment area for the Colombo water supply, and lies among low hills about 30 miles inland from the city. Its average elevation is somewhere about 700 feet above sea level and it possesses a high rainfall.

Decolya petiyagallae sp. nov. (Plate XLIX, figs. 6 and 7)

Very close to the last species (*D. splendens*) of which I should consider it a mere variety but for the very different genitalia.

The head and its attached structures offer no points of distinction, the antennae are similarly noded, the nodes being annulated with dark brown as in the other species. The pronotum is considerably narrower, particularly in front, and rather more compressed, its anterior margin being distinctly concave with a small median projection.

The anterior coxal spine is rather stouter and more curved than that of *D. splendens*, but this, in my opinion, is a character of very small value. The spine formula of the legs is the same as in *D. uvarovi* and *D. splendens* except that the posterior femora have 10 spines on the lower external carina (in the unique specimen available).

The post-tympanal area of the tegmina is considerably shorter than in *D. splendens*, but otherwise they are of much the same shape as in that species.

Genitalia. The ninth tergite is slightly lobed at the sides of the posterior margin as in *D. splendens*. The anal tergite is roughly rectangular with the posterior corners concavely cut off and the middle excavated. The supra-anal plate cannot be distinguished, but the titillator is in the form of a trough, bifurcated distally, and with the two prongs, which are slightly spatulate, twisted inwardly and convergent so that their tips nearly meet; the sides of the whole organ being almost parallel. The large curved prongs which are so conspicuous in *D. splendens* are represented by a pair of small, flattened, inwardly-directed hooks which can only be seen in posterior view (not shown in the figures).

The cerci are tapering, cylindrical, inwardly-curved rods with their distal ends spatulately expanded. When examined from anteriorly,

the lower side of the spatula is seen to be expanded and strongly folded inward, and this produces a small "nick" in the extreme tip of the cercus. In profile, the cerci are curved downwards (*i.e.*, the convex surface is dorsal) whereas in *D. splendens* the main curvature is upwards, only the tips being slightly deflexed.

The sub-genital lamina follows, in the main the lines of that of the latter species but its sides are more convergent distally, the lateral lobular expansions are less pronounced, and the median excavation is much deeper and narrower. The genitalia are hirsute, as described in the other species.

Colouration. In general as described for *D. splendens*; the auditory bullae, third tarsal joints, etc., are dark brown, and the same crimson marks are present. The file-bearing vein in the left tegmen is not however black, but dirty crimson for about its proximal half, and the black triangle on the tympanal area is replaced by two indefinite marks of dull crimson. The apical crimson blotches are very deep in colour and comparatively well defined.

Measurements:	♂
	mm.
Length of body	13·4
Length of pronotum	3·5
Breadth of pronotum	3·0
Length of tegmina	4·5
Length of anterior femur	8·5
Length of posterior femur	14·0
Length of anterior tibia	10·0
Length of posterior tibia	17·5

Material examined. The *type* ♂ is unfortunately the only specimen of this species that has so far come to hand; it was captured in jungle undergrowth on Petiyagalla, a mountain near Balangoda, at an approximate elevation of 3,500 feet, on 21-iv-26. It will be deposited in the British Museum of Natural History.

Hexacentrus unicolor (Serv.)

Sixteen specimens (8 males and 8 females) from Anuradhapura, Battaramulla (W.P.), Bibile, Rakwana (Morningside, ca. 4,000 feet), Ratnapura and Wellawaya, in addition to the localities given by Uvarov (Spol. Zeyl. XIV, p. 91).

Hexacentrus sp.

The Museum possesses a single ♂ specimen of a probably new species of *Hexacentrus*, but as it is in bad condition and unlabelled, further material must be collected before it can be described.

Genus **XIPHIDIOPSIS**

The Colombo Museum possesses 23 specimens of this genus but as there are only 4 males among them and females are very hard to discriminate, the collection of further material is necessary before remarking further on them.

In Hawaii, parthenogenesis has been found to occur in the case of *X. lita* Hebard (see Proc. Hawaiian Entom. Soc., Vol. VII, p. 279), and it seems very probable that it occurs also in some of the Ceylonese species, as females are very much commoner than males.

Sub-family MECONEMINAE

Nicephora hakgallae sp. nov. (Plate L, figs. 1-5)

Closely related to *N. forficulata* Carl, but differing markedly in the ♂ genitalia.

♂. Fore-part of head, without eyes, fastigium of vertex, etc., almost hemispherical. Fastigium of vertex short, rounded at tip, concave in profile beneath, distinctly medially sulcate dorsally. Face short, rather bulbous. Eyes somewhat prominent and forwardly-directed, separated dorsally by twice their diameter. First antennal joint stout, slightly depressed, tumid internally ; second joint about half the length of the first but less than half its breadth ; flagellar joints sparsely pubescent and parallel-sided so that their divisions are hard to distinguish. (In all the specimens available the flagella are broken rather short so that it is not known whether they are darkly noded towards the apex as in other species of the genus). Maxillary palpi with 3rd and 4th joints nearly equal and longest, 5th short, incrassated, truncate at apex, of similar shape to the terminal labial.

Pronotum semi-cylindrical, roundedly truncate in front, elliptically rounded behind, entirely covering the tympanal area of tegmina ; sides slightly lobed above fore coxae ; dorsal profile nearly straight ; margin of lateral lobes, in profile, very slightly sinuous but with no pronounced angles or emarginations.

Prosternum unarmed. Fore coxal spine short and blunt ; all femora unarmed, fore and mid femora nearly cylindrical ; fore and mid tibiae with 3 longish spines anteriorly, 2 shorter ones posteriorly, and a pair of small apical spurs. Auditory tympana oval, quite exposed on both sides. The mid tibiae are slightly incrassated. Hind tibiae spinose on the two dorsal carinae only.

Tegmina extending nearly to the end of the body but not surpassing the genitalia, obliquely rounded at apex ; the stridulatory area

quite covered by the pronotum; venation well developed. Wings very minute.

The anal tergite is very large and broad, its sides straight and almost parallel, the hind margin for its whole length broadly, angularly excavated; cerci similar in type to those of *N. forficulata*; they are stout, nearly cylindrical rods curving inwards and downwards, and slightly outwards near the tip, which is acute; at the base there is a dorso-internal flange which is produced disto-internally into a long upward- and inwardly-directed process; the distal half of the cercus is provided with another flange on the inner side, the proximal end of which is produced into a flattened, recurved process, so that the cercus resembles a somewhat splayed-out fish-hook with its barb.

As in *N. forficulata*, there is a "sub-anal lamina," but it is of a very different shape. It consists of a broad plate with converging sides and broadly rounded end, its disto-dorsal surface elevated into a stout, roundedly conical process; ventrally it is concave.

The sub-genital lamina is a narrow tapering process, channelled dorsally and slightly expanded and swollen at the tip; just proximal to the tip, on the ventral side there is a pair of fairly long, cylindrical, slightly recurved styles which diverge strongly and project at almost right angles to the sub-genital lamina (see Plate L, figs. 1, 3 and 4).

♀. The female resembles the male in all essentials but her fastigium of vertex is rather shorter and more bluntly rounded; the 4th maxillary joint is distinctly longer than the 3rd; her tegmina are shorter, extending only about $\frac{3}{5}$ths of the length of the abdomen (exclusive of ovipositor).

The penultimate tergite is lobularly produced laterally, emarginate with thickened rim on the sides above this lobe, depressed and broadly emarginate medially. The anal tergite is deeply excavated in the middle for the reception of the nearly circular, medially sulcate supra-anal plate. The cerci are short and conical. The ovipositor is short, gently curved and evenly tapering (see Plate L, figs. 2 and 5). The sub-genital lamina forms almost a rounded right angle.

Colouration. In life, both sexes were of a delicate pale green, quite un-marked. The dry specimens are dirty yellowish brown.

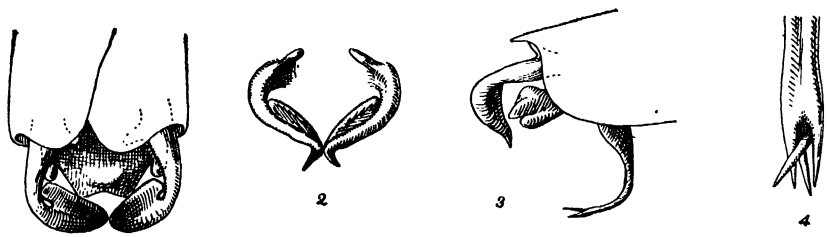
Measurements:	♂	♀
	mm.	mm.
Length of body	8·0	12·5 (including
Width of head, including eyes	1·9	2·0 ovipositor)
Length of pronotum	3·5	3·0
Width of pronotum	2·2	2·25
Length of tegmina	4.3	3·1
Length of fore femur ..	2·4	2·5
Length of hind femur ..	6·1	6·6
Length of ovipositor	—	5·75
Breadth of ovipositor ..	—	1·0

Material examined. 1 male (*Type*) Hakgalla ca. 5,500 feet, 28-viii-29; 3 females (*Paratypes*) taken at Hakgalla on 27-iv-27; 14-viii-29; and 26-viii-29. They were all captured by sweeping amongst jungle herbage.

The *type* ♂ and a *paratype* female will be deposited in the British Museum (Natural History); the remaining paratypes are in the Colombo Museum.

Nicephora forficulata Carl

This species was described by Dr. Carl in the "Revue Suisse de Zoologie" 28, 1921, p. 308, from an adult ♂ and 2 larvae collected by Dr. E. Bugnion in "Ceylon" (no precise locality given), and preserved in alcohol. It is of interest to record that a ♂ specimen was captured by me at Nuwara Eliya on 14-v-27 and was provisionally determined from description as Dr. Carl's species, but to make sure, the accompanying drawings were made and submitted to Dr. Carl who kindly compared them with his type and pronounced them to be conspecific. As his figure (*loc. cit.*) was made from a spirit specimen it is thought desirable to offer the drawings made from the dry specimen for comparison with those of the last species.



Nicephora forficulata Carl

1. ♂ *genitalia*, dorsal view.
2. ♂ *cerci*, posterior view.
3. ♂ *genitalia*, lateral view.
4. ♂ *sub-genital lamina*, dorsal view.

The measurements of our specimen are as follows:

	♂ mm
Length of body	8·0
Width of head, including eyes	1·8
Length of pronotum	3·5
Width of pronotum	2·1
Length of tegmina	4·75
Length of fore femur	2·5
Length of hind femur	6·1

EXPLANATION OF PLATES

Plate XLIII

Fig. 1 *Acrodonta subaptera* Redt., ♂, body × 3
Fig. 2 ,, ,, ,, ♂, head and pronotum × 3
Fig. 3 ,, ,, ,, ♂, genitalia × 6
Fig. 4 ,, ,, ,, ♀, sub-genital lamina × 6
Fig. 5 *Acrodonta hakgallae*, sp. nov. ♂, body × 3
Fig. 6 ,, ,, ,, ,, ♂, head and pronotum × 3
Fig. 7 ,, ,, ,, ,, ♂, genitalia × 6
Fig. 8 ,, ,, ,, ,, ♀, sub-genital lamina × 6

Plate XLIV

Fig. 1 *Ischnophyllus crassus* sp. nov. ♀, × $2\frac{1}{2}$
Fig. 2 ,, ,, ,, ,, ♀, profile × $2\frac{1}{2}$
Fig. 3 *Ischnophyllus viridipennis* Redt. ♀, profile × $2\frac{1}{2}$
Fig. 4 ,, ,, ,, ♂, genitalia, posterior view × 10

Plate XLV

Fig. 1 *Scytoceroides ceylonensis* gen. et., sp. nov. ♂, body × $2\frac{3}{7}$
Fig. 2 ,, ,, ,, ,, ,, ♀, profile × $1\frac{5}{7}$
Fig. 3 ,, ,, ,, ,, ,, ,, ♂, face × $2\frac{4}{7}$
Fig. 4 ,, ,, ,, ,, ,, ,, ♂, meso- and meta-sterna × 8
Fig. 5 ,, ,, ,, ,, ,, ,, ♂, left fore-tibia, * dorsal aspect × $5\frac{5}{7}$
Fig. 6 ,, ,, ,, ,, ,, ,, ♂, genitalia, dorsal aspect × $5\frac{5}{7}$
Fig. 7 ,, ,, ,, ,, ,, ,, ♂, supra-anal plate and cerci,* posterior aspect × $5\frac{5}{7}$
Fig. 8 ,, ,, ,, ,, ,, ,, ♂, genitalia, *profile × $5\frac{5}{7}$
Fig. 9 ,, ,, ,, ,, ,, ,, ♀, sub-genital lamina × $5\frac{5}{7}$
*N.B.—In these figures the setae are omitted for the sake of clearness.

Plate XLVI

Fig. 1 *Labugama pearsoni* gen. et., sp. nov. ♂, dorsal aspect × $2\frac{2}{3}$
Fig. 2 ,, ,, ,, ,, ,, ,, ♂, profile × $2\frac{2}{3}$
Fig. 3 ,, ,, ,, ,, ,, ,, ♂, face × 3
Fig. 4 ,, ,, ,, ,, ,, ,, ♂, meso- and meta-sterna × 7
Fig. 5 ,, ,, ,, ,, ,, ,, ♂, sub-genital lamina × 7
Fig. 6 ,, ,, ,, ,, ,, ,, ♂, right cercus, postero-lateral aspect × 13
Fig. 7 ,, ,, ,, ,, ,, ,, ♂, genitalia, dorsal aspect × 7
Fig. 8 ,, ,, ,, ,, ,, ,, ♂, genitalia, posterior aspect × 7

Plate XLVII

Fig. 1 *Phisis kelletti* sp. nov. ♂, fore-part of body, dorsal aspect × 7
Fig. 2 ,, ,, ,, ,, ♂, fore-part of body, profile × 7
Fig. 3 ,, ,, ,, ,, ♂, genitalia, posterior aspect × 14
Fig. 4 ,, ,, ,, ,, ♂, genitalia, ventral aspect × 14
Fig. 5 ,, ,, ,, ,, ♂, genitalia, lateral aspect × 14

Plate XLVIII

Fig. 1 *Decolya uvarovi* sp. nov. ♂, × $5\frac{1}{7}$
Fig. 2 ,, ,, ,, ,, ♂, profile × $5\frac{5}{7}$
Fig. 3 ,, ,, ,, ,, ♂, genitalia, ventral aspect × $11\frac{3}{7}$
Fig. 4 ,, ,, ,, ,, ♀, ovipositor × $5\frac{4}{7}$
Fig. 5 *Decolya roseopicta* Uvarov ♂, genitalia, ventral aspect × $11\frac{4}{7}$

Plate XLIX

Fig. 1 *Decolya splendens* sp. nov. ♂, × $2\frac{7}{9}$
Fig. 2 ,, ,, ,, ,, ♀, fore-part of body × $2\frac{7}{9}$
Fig. 3 ,, ,, ,, ,, ♀, ovipositor × $5\frac{4}{9}$
Fig. 4 ,, ,, ,, ,, ♂, genitalia, posterior aspect × $8\frac{1}{3}$
Fig. 5 ,, ,, ,, ,, ♂, genitalia, ventral aspect × $8\frac{1}{3}$
Fig. 6 *Decolya petiyagallae* sp. nov. ♂, genitalia, dorsal aspect × $8\frac{1}{3}$
Fig. 7 ,, ,, ,, ,, ♂, genitalia, ventral aspect × $8\frac{1}{3}$

Plate L

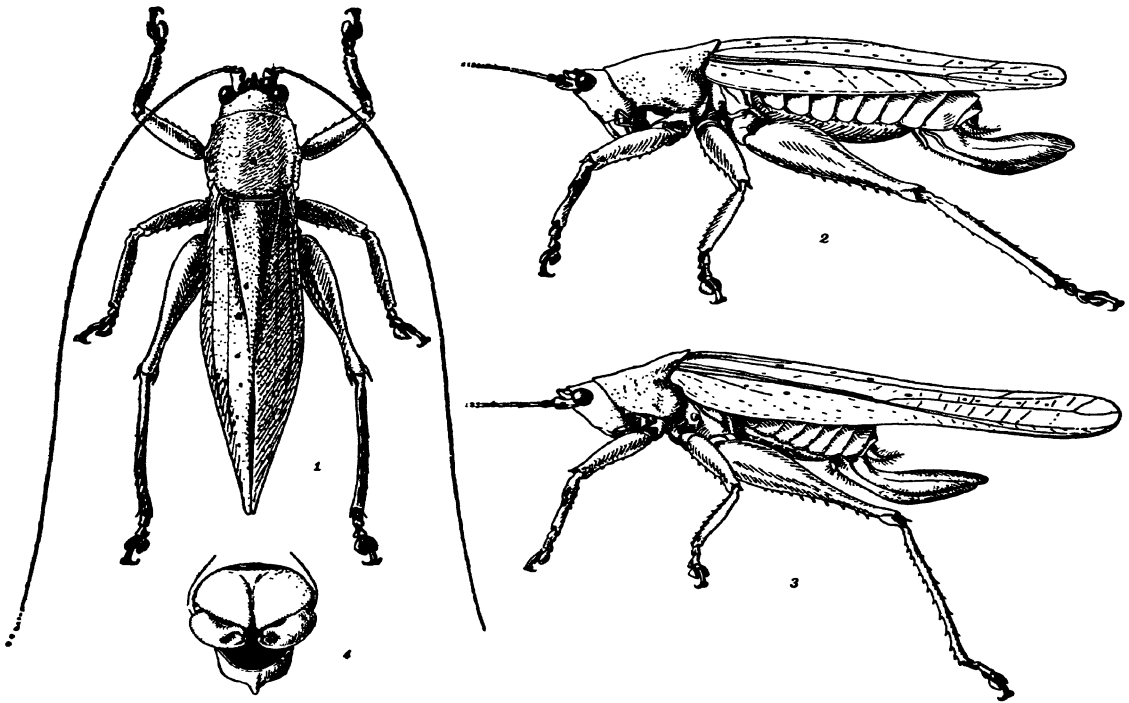
Fig. 1 *Nicephora hakgallae* sp. nov. ♂, × 7
Fig. 2 ,, ,, ,, ,, ♀, profile × 7
Fig. 3 ,, ,, ,, ,, ♂, genitalia, posterior aspect ×
Fig. 4 ,, ,, ,, ,, ♂, genitalia, lateral aspect × 9
Fig. 5 ,, ,, ,, ,, ♀, genitalia, dorsal aspect × 7

PLATE XLIII

G. M. Henry del.

1—4 Acrodonta subaptera

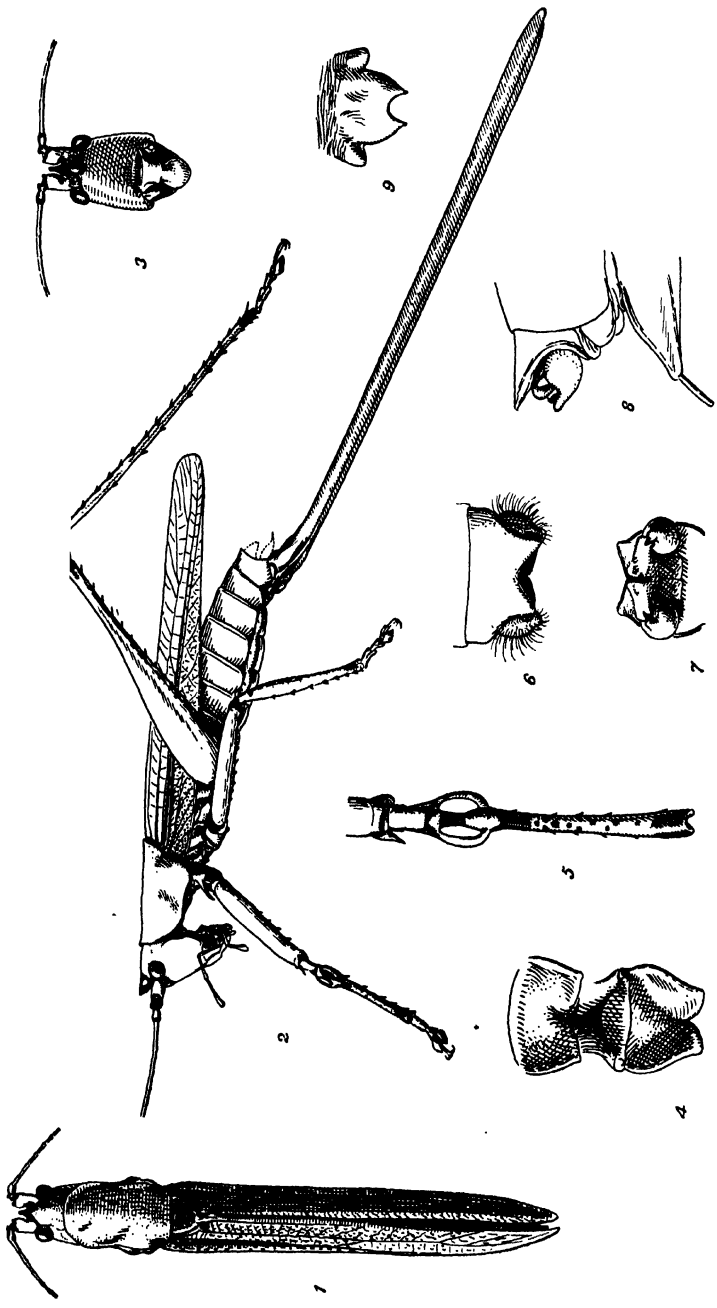
5—8 Acrodonta kakgallae sp. nov.



G. M. Henry del.

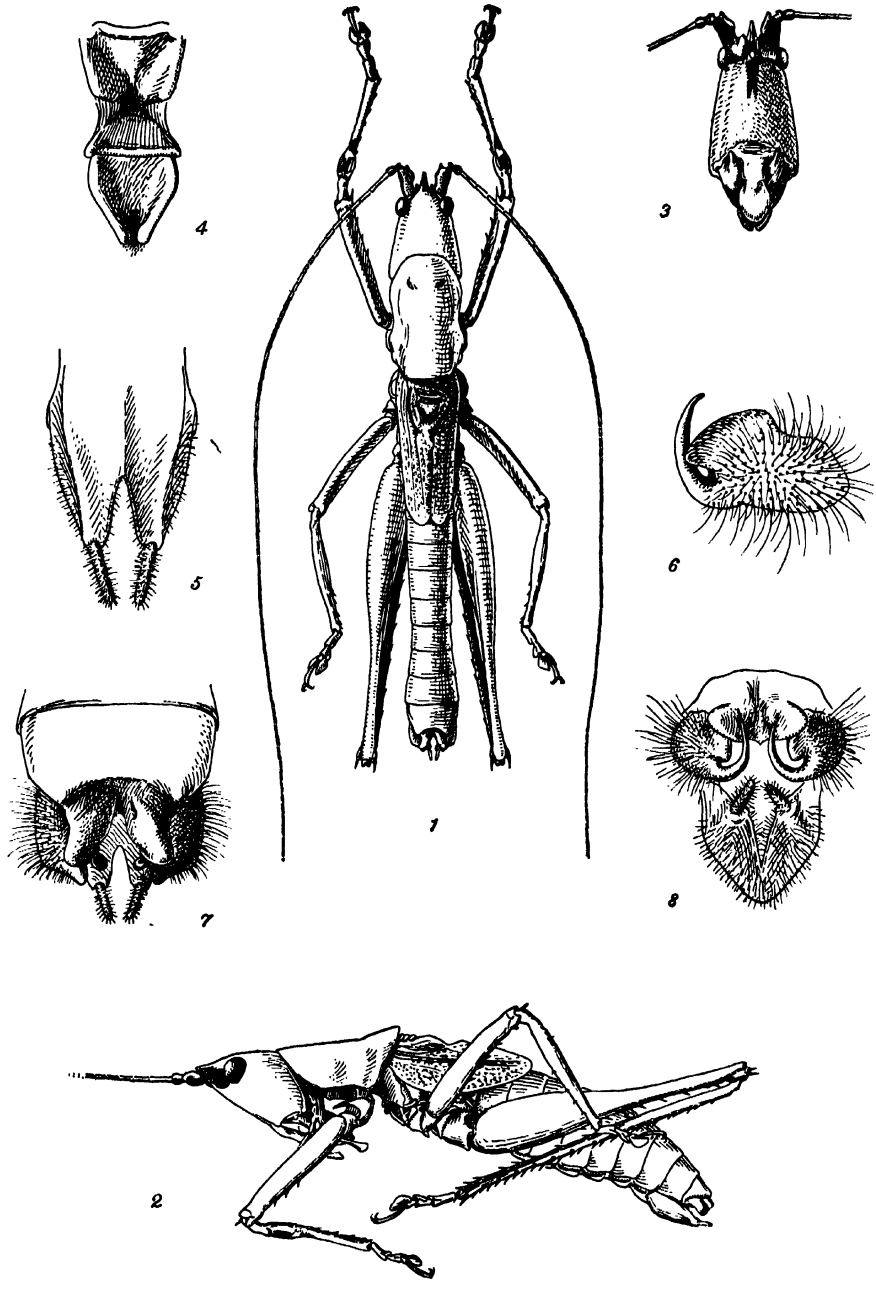
1 and 2. *Ischnophyllus crassus* sp. nov.

3 and 4. *Ischnophyllus viridipennis*



Scytoceroides ceylonensis gen. et sp. nov.

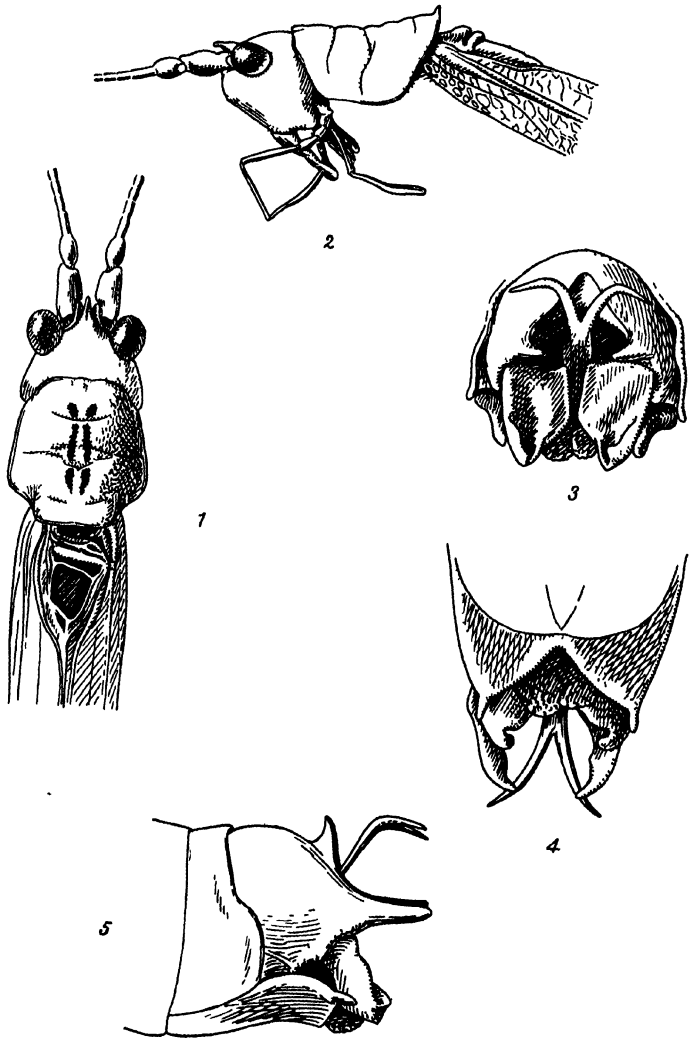
G. H. Henry del.



G. M. Henry del.

Labugama pearsoni gen. et sp. nov.

PLATE XLVII

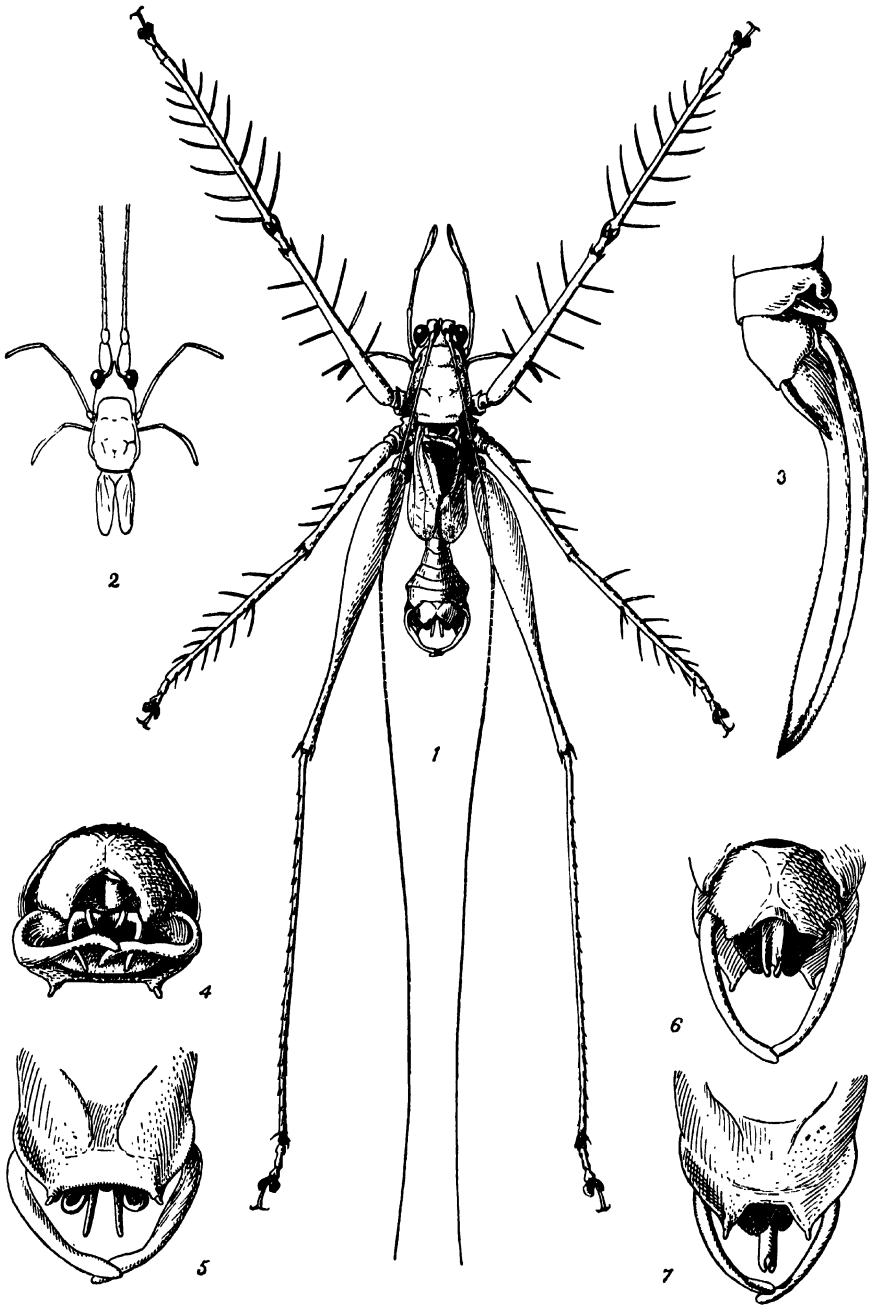


G M. Henry del.

3a *Phisis kelletti* sp. nov.

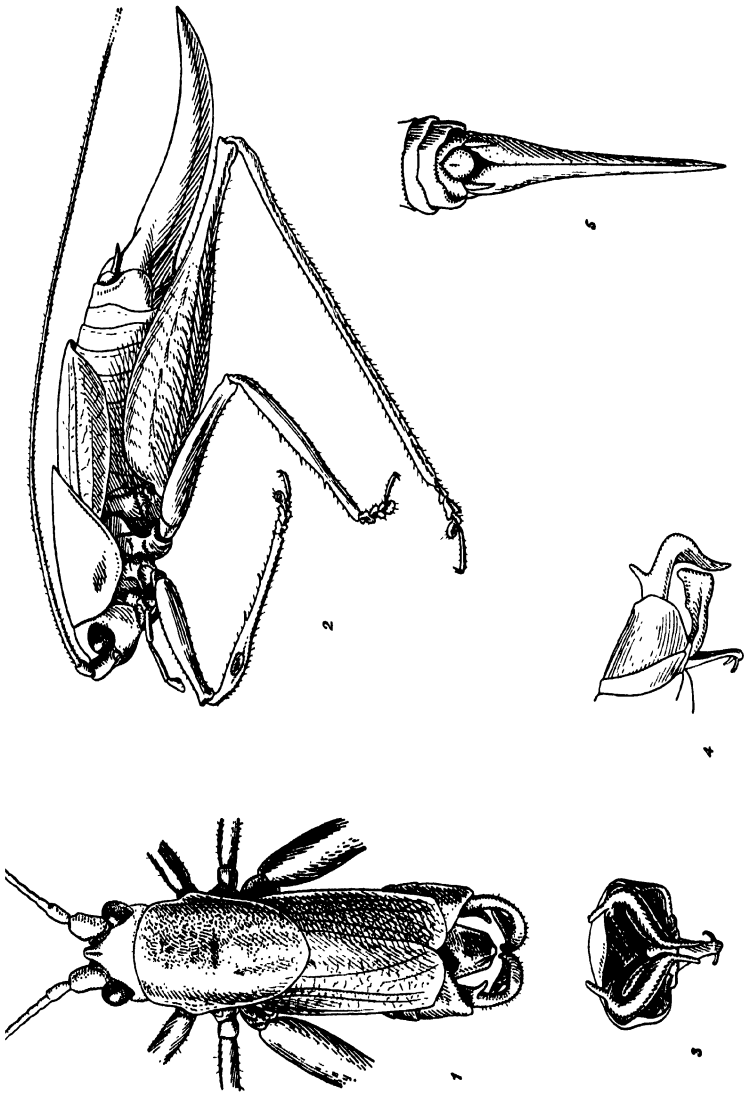
1—4. *Decolya uvarovi* sp. nov. 5. *Decolya roseopicta.*

G. M. Henry del.



G. M. Henry del.

1—5. *Decolya splendens* sp. nov. 6—7. *Decolya petiyagallae*



Vicephora hakgallae sp. nov.

G. M. Henry del.

The barnacles Stephanolepas and Chelonibia from the turtle Eretmochelys imbricata

BY

C. A. Nilsson-Cantell, Ph. D. (Vänersborg), Sweden

WITH THREE PLATES

The following genera and species of barnacles have been recorded from turtles :

Chelonibia testudinaria (Linné, 1758)
Chelonibia manati Gruvel, 1903.
Chelonibia caretta (Spengler, 1790).
Platylepas hexastylos (O. Fabricius, 1798).
Platylepas decorata Darwin, 1854.
Cylindrolepas darwiniana Pilsbry, 1916.
Stomatolepas elegans (O. G. Costa, 1838) (probably from turtle).
Stomatolepas praegustator Pilsbry, 1910.
Stomatolepas transversa Nilsson-Cantell, 1930.
Stephanolepas muricata P. Fischer, 1886.

Some of the above, *e.g.*, *Platylepas hexastylos* and *Chelonibia manati* also live on other animals such as manatees and fishes.

As no exact study has been made regarding the hosts and places of fixation of these parasites, our knowledge of their biology is still incomplete. *Platylepas hexastylos* is recorded by Richards (1930) from the skull of a turtle *Chelonia mydas*. Some, such as *Stephanolepas* are not only fixed in the skin, but are deeply embedded. A curious place of fixation for *Stomatolepas praegustator* is mentioned by Pilsbry, namely, the upper end of the gullet of *Caretta caretta*.

The small collection [1] here dealt with contains only two species *Chelonibia testudinaria* and *Stephanolepas muricata* from a female turtle *Eretmochelys imbricata* from the Indian Ocean (Bentota, Ceylon). *Stephanolepas* is of especial interest as it was only imperfectly known before.

1. See P. Deraniyagala, 1930 in "Testudinata of Ceylon," Ceylon Journal of Science, Section B, Vol. xvi, pp. 65, 74, 76.

Genus **CHELONIBIA** Leach, 1817

Chelonibia testudinaria (Linné, 1758)

Several specimens of different sizes ranging from 2·5 mm. to 30 mm. in carino-rostral diameter were obtained from the horny scutes of the turtle *Eretmochelys imbricata*.

New locality. Bentota, Ceylon.

Distribution. Tropical and temperate seas.

Genus **STEPHANOLEPAS** P. Fischer, 1886

Complementary diagnosis. Compartments six, outer layer porous, having radii, except the carina. Alae on all compartments, except the "rostrum." Sheath leaving one-third of the wall free. Shell nearly cylindric with large orificium and smaller basal opening, basis membranous. The six spinous areas ("areas epineuses" Fischer) of the shell are distinct from the median longitudinally ridged part of the compartments ("areas lisses" Fischer) and have horizontally flattened projections somewhat irregularly arranged, but with a tendency to be placed in transverse rings. The margins of the compartments with alae secondarily cover the radii. Opercular valves well developed but not distinct, articulated. Labrum with few teeth on each side of the deep middle notch. Palpus club-shaped. Maxilla II with mentum.

Stephanolepas muricata P. Fischer, Plates LI-LIII

Stephanolepas muricata P. Fischer, 1886.
Stephanolepas muricata Gruvel, 1903, 1905.

Discussion. This interesting cirriped was first described by Fischer (1886), and later mentioned and figured by Gruvel (1903, 1905). The type specimens were only young individuals which may partly explain the differences in the external shape from those of this collection. The descriptions given by the authors mentioned above are so incomplete that I first thought the specimens of this collection, taken from the same kind of sea turtle, were new species of the genus erected by Fischer. A closer comparison with the incomplete figures given by the authors makes it quite clear that this genus, like other room parasites, *e.g.*, *Tubicinella* and *Xenobalanus* only includes one species.

This genus is held by Fischer to be intermediate between *Tubicinella* and *Platylepas*. The affinity with the later species seems to me, however, not to be greater than with any other genus except *Tubicinella* of the sub-family Coronulinae. In my opinion it is most related to *Tubicinella* but quite distinct from this genus; closer study will make this evident.

Because of the incomplete and partly erroneous description of the genus, Pilsbry (1916), when he brought this sub-family into order,

placed it together with *Stomatolepas* in the so-called platylepadid series, thus widely separating it from the nearly related genus *Tubicinella* belonging to the coronulid series. He notes, however, that he has not seen specimens of *Stephanolepas*.

A study of this form is difficult, as the whole animal is embedded deeply in the skin of the turtle. It was not possible to dissect it out of the embedding tissue on account of the long projections from the wall; but by boiling in natron lye for one or two hours, it was possible to destroy the embedding tissue and get the shell free and undamaged.

As the shell offers so many interesting features, for instance the manner of junction of the compartments not found so far in any other cirriped, a detailed description of the whole animal, especially of the wall, is given below:

Complementary description. According to Fischer the cirriped is fixed between the plates of the epidermis. Judging from this material the fixation also seems to be possible in the horny scutes of the turtle (Pl. LI, fig. 2). The external shape of the wall is also variable, probably due to age. Thus the younger specimen figured by Fischer is globuloconic ("subspherique") while those of the collection are older and of a more cylindrical shape (Pl. LI, fig. 1). The orificium in one specimen has a diameter of 8·5 mm. and a basal opening of 6 mm.

Measurements of two specimens (in mm.) are: (1) carino-rostral diameter 10, height 20; (2) carino-rostral diameter 11, height 22.

All the six parietes are porous in the outer layer as mentioned in the diagnosis of the sub-family Coronulinae. According to Fischer they are non-porous. As in the nearly related genus *Tubicinella*, a sheath is developed on the inside of the compartments, but leaving the lower third of the valves free. In Gruvel's figure (fig. 2, Pl. 2, 1903) the lower boundary of the sheath is not distinctly indicated. This lower edge is not free from the rest of the compartments, but distinct as in Pl. LII, a-d. The lower margins of the compartments are provided with smaller teeth. The upper margins are more or less destroyed, as the wall is rather fragile. Externally, every compartment has a median lower lying area ("area lisse" Fischer) with fine longitudinal ridges. The sideparts of the compartments constitute what I term the six spinous areas of the wall ("areas epineuses" Fischer). According to Fischer, the median parts are smooth and not ridged as in reality here found. By the possession of these fine ridges the genus corresponds well with the genus *Tubicinella*, it is also striated longitudinally. Traces of transverse lines are also seen on this median part. (Text-fig. 1 and Pl. LII). Instead there are several ridges in Tubicinella.

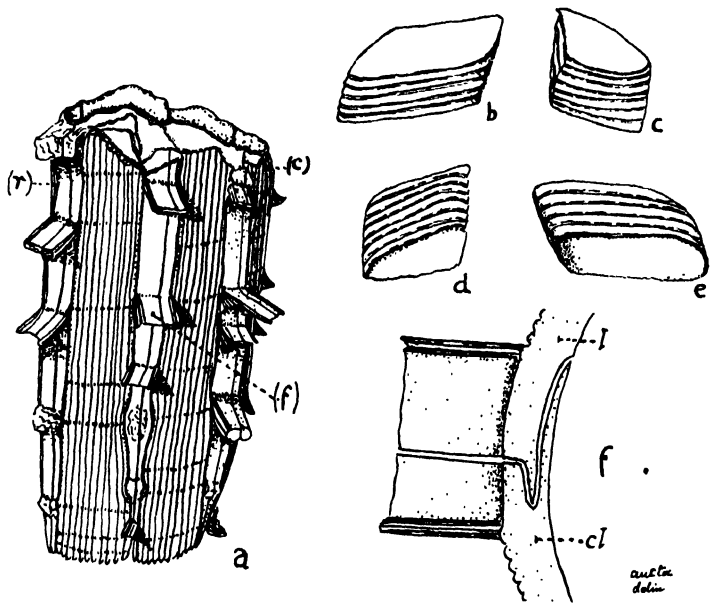


Fig. 1. *Stephanolepas muricata* Fischer
a. A specimen showing lateral aspect, (*c*) carina, (*r*) " rostrum ;" *b*. left scutum, external aspect ; *c*. left tergum, external aspect ; *d*. left tergum, internal aspect ; *e*. left scutum, internal aspect ; *f*. horizontal section through the articulating areas between the carino-lateral and lateral compartments, with the valves partially disarticulated ; *l*. lateral compartment, *cl*. carino-lateral compartment.

The six spinous areas of the wall are of the greatest interest as it is not possible to ascertain the details from the earlier descriptions. These areas are smooth with a distinct suture on each showing the limits between the compartments and dividing the area into a broader and a narrower part, broadest at the radial side. They have the horizontally flattened projections figured by Fischer. Each of these is also composed of two parts belonging to different compartments. Some of the projections are longer than here figured (Text-fig.1 and Pl. LII). Judging from Fischer's figures these projections are very regular in shape and arranged in rings. Whether this is a wrong observation or is due to age, is not possible for the present to decide. In both the specimens figured (Text-fig. 1 and Pl. LII) the projections are placed at varying distances from each other, but there seems to be a tendency most evident in the lower part of the wall to arrange themselves in rings.

Regarding these spinous areas, Fischer merely says the following (1886, p. 194) " Cette aréa épineuse des *Stephanolepas* est placée au-

dessus des radii des valves." Thus no study was made respecting the articulation. By disarticulating the compartments it was possible to ascertain the finer details.

The alae are thin and internally not limited from the rest of the compartment reaching as far down as the lower limit of the sheath, and obliquely cut off as in *Balanus* (Pl. LII, f).

The radii are thicker, internally distinctly limited from the median part of the sheath. Externally, the radius is composed of two parts ; the smooth area with projections and the transversely ridged marginal part, which extends down to the base. These ridges serve as teeth for uniting the compartments and correspond to deepenings in the covering part of the nearest compartment, provided with alae. Thus the smooth areas with projections situated on the outside of the alae, must have arisen secondarily as covering bands over the marginal part of the radii. By this means the compartments are very solidly united (Text-fig. 1 f). Such a secondary covering of the radii is not seen earlier in any cirriped genus. Both these smooth areas together form one band (the spinous area) with a line marking the coalescence. All compartments are of about the same width. The details are :

The carina (Pl. LII, d,h) is provided with alae distinctly marked externally. The furrows under the covering bands on both margins are not seen in the figures.

The carino-lateral compartments (Pl. LII, e,g) have radii against the carina and alae on the lateral margins.

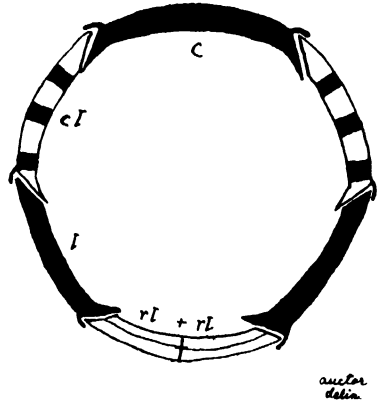


Fig. 2. *Stephanolepas muricata.*
Diagram showing the secondary covering of radii produced by the overlapping of the neighbouring compartments.

The lateral compartments (Pl. LII, b.f) are of the same shape with radii against the carino-lateral compartments and alae against the "rostrum." The "rostrum" (Pl. LII, figs. a,e) with alae on both margins and also with both the covering bands over the radii of the lateral compartments.

In diagram (Text-fig. 2) the agreement with genus *Balanus* is shown, but also the dissimilarity due to the secondary covering of the radii by the small bands mentioned above. The base is membranous. The opercular valves are rather well developed and agree with many other genera of this sub-family.

The scutum (Text-fig 1, b.e) is larger than the tergum and transversely elongated.

The tergum (Text-fig 1, c.d) of about the same length and height. Sometimes the valves are higher, depending on how many layers are formed. As in other genera of this sub-family, *e.g.*, *Platylepas* the upper layers usually scale off, the scuta and terga touch each other, but there are no distinct articular ridges. Descriptions are here given of internal parts not studied earlier.

Mouth-parts : (Pl. LIII) Labrum with a wide notch in the middle, with three teeth on one side and two on the other in the specimen dissected, fig. a.

Palpus club-shaped, with bristles round all margins and on the sides near the margins. Those along the upper margin are feathered, fig. b.

The mandible with five main teeth, of which the fourth and fifth are smaller and have a pectinated inner angle. Between tooth two and tooth three an additional tooth. Some of the teeth, *e.g.*, two and three teeth, are double, fig. c.

Maxilla I has a straight front edge with a distinct notch under the upper stronger spines, fig. d.

Maxilla II with a pointed spinous lobe and a mentum as in *Tubicinella*. The mouth-parts agree well with what is known of the sub-family Coronulinae, but they are in many points quite distinct from those of the related genus *Tubicinella*, fig. e.

The number of segments of the cirri of a specimen of carino-rostral diameter 10 mm. and height 20 mm. are :—

Cirri.	I	II	III	IV	V	VI
Segments.	10-16	10-10	13-15	18-25	25-26	26-27

Cirri I-III are shorter than those following. Cirrus I with very unequal rami (the shorter ramus less than half of the longer). Cirrus II with unequal rami by about 4 segments in the specimen dissected.

Cirrus III also with unequal rami by about two segments. The longer cirri with nearly equal rami.

Cirrus IV has in this specimen on one side a ramus shorter by five segments. Cirrus VI with four pairs of spines on the front edge of the segments. The cirri also differ in many points from those of genus *Tubicinella*. Cirrus I has in genus *Tubicinella* a smaller difference between the rami. All segments of the cirri of *Tubicinella* have a more protuberant front edge and the spines situated close together at the top of the margin. Also the number of segments, for instance, in the longer cirri, is smaller in *Tubicinella* (in cirrus VI, 19 segments against 27 of *Stephanolepas*).

Penis long and annulated.

Old locality. Cochin China, Pulo Condor from *Eretmochelys imbricata.*

New locality. Bentota, Ceylon, 17. 2. 1928. Some specimens in the carapace and plastron of *Eretmochelys imbricata* ♀ captured when she came ashore to deposit her eggs.

Distribution. The genus is thus only known from Ceylon and Cochin China, but the distribution ought to be larger and coincident with the only host known, *Eretmochelys imbricata* cosmopolitan in tropical seas.

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EXPLANATION OF PLATES

PLATE LI

Stephanolepas muricata

Fig. 1 View from the left side (approx × 6.)

Fig. 2. Five specimens embedded in the plastron of a turtle, *Eretmochelys imbricata* ♀ (approx × 1).

Plate LII

Disarticulated compartments of *Stephanolepas muricata*.

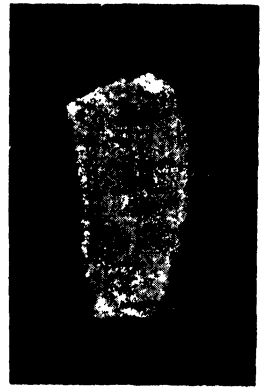
a. " Rostrum "
b. Lateral compartment
c. Carino-lateral compartment
d. Carina
} Internal aspect.

e. Rostrum
f. Lateral compartment
g. Carino-lateral compartment
h. Carina
} External aspect

Plate LIII

Mouth parts of *Stephanolepas muricata*.

a. Labrum
b. Palpus
c. Mandible
d. Maxilla I
e. Maxilla II, (*m* mentum).



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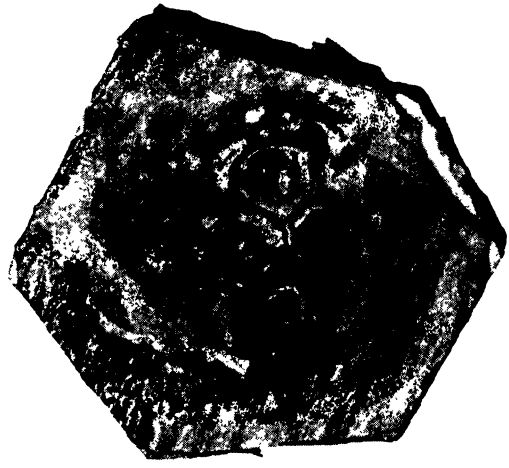

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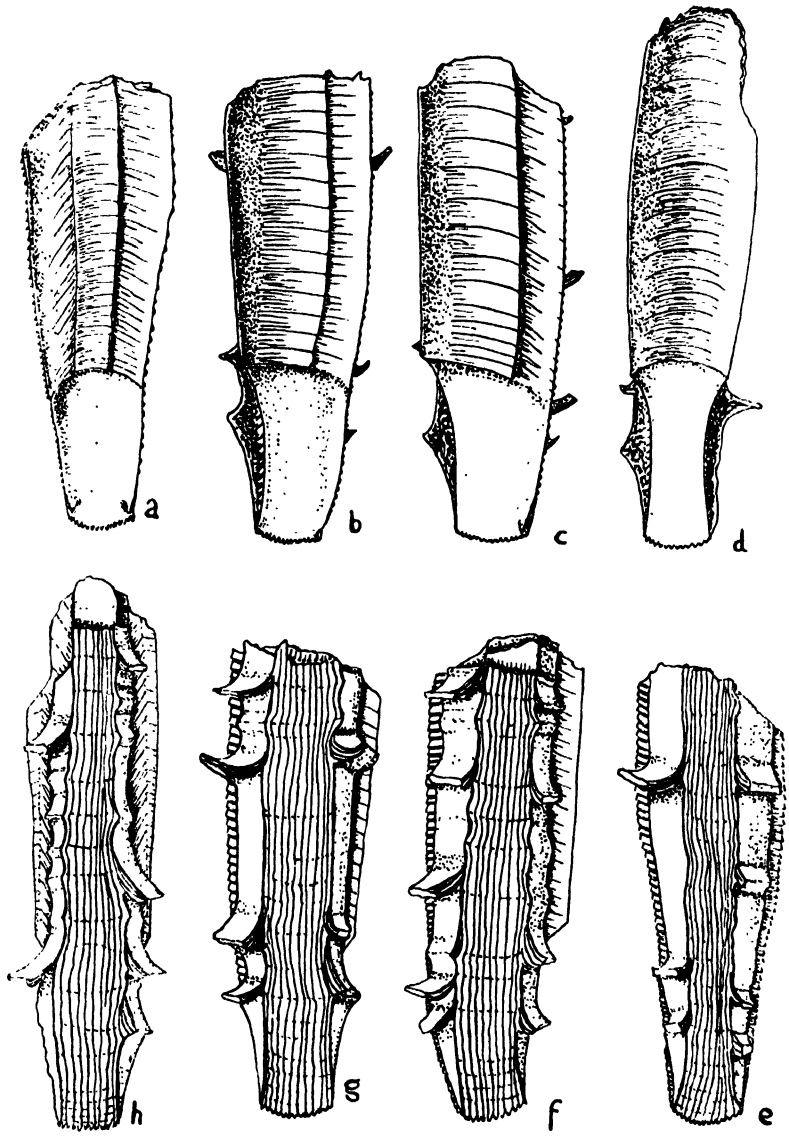
Stephanolepas muricata



C. A. Nilsson-Cantell del.

Stephanolepas muricata

C. A. Nilsson-Cantell del.

Stephanolepas muricata

The Opisthomi of Ceylon

BY

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WITH ONE PLATE

The order Opisthomi consists of a single family the *Mastacembelidae* which are fresh water, eel-like, spiny fishes of uncertain relationships. The presence of dorsal and anal spines, normal ovisacs, oviducts and the habit of spawning in fresh water, excludes them from the Apodes, although there is a resemblance in the pectoral girdle, which is attached to the vertebrae and not to the skull. This, however, may be a case of convergent evolution for the Synbranchidae show a similar structure. Another Apodal feature is the absence of ventral fins, which again is common to the Synbranchidae and some genera of Aulostomi and Labyrinthici, while both the last named possess families with fin spines.

The *Mastacembelidae* are of Asiatic origin, for although Asia has only twelve species as against the thirty known from Africa the former show a greater variety, some being primitive with a free caudal fin. The African forms all have the caudal confluent with the dorsal and anal. This condition is a case of secondary reversal from the free state as denoted by the well developed hypural bones. The prominent projection of the caudal in the young of *M. armatus* supports this view.

Order OPISTHOMI

Physoclist. Opercle well developed, embedded in skin. Parietals separated by supraoccipital which is contiguous with frontal. Pectoral arch remote from skull, no mesocoracoid. Ventrals absent, dorsal and anal long and with strong, short spines. Ovisacs and oviducts well developed. A single family.

Family Mastacembelidae

Anguilliform, with minute scales. Caudal free, or confluent with dorsal and anal. Lateral line distinct, complete, descending gradually to midbody. Snout elongated into a rostrum which is grooved ventrally. Anterior nostrils tubate, near tip of rostrum and remote from posterior ones. Mouth small, sub-ventral. Upper jaw fixed and bordered by inter-maxillaries. Teeth villiform ; on jaws, vomers and at times in rostral groove. Gills four, gill rakers and pseudobranchiae absent. Branchiostegals six, gill slits inferior and reduced. Precaudal vertebrae with transverse processes bearing ribs. Air bladder undivided and as long as body cavity. The large mouth cavity with its reduced external openings and absence of palatal teeth appears to be employed for transpiration of oxygen from atmospheric air. Reproduction oviparous, eggs small and numerous. Fresh and brackish waters of Ceylon, India, Burma, Malay Archipelago, China and Africa.

Key to Ceylon genera of Mastacembelidae

1. Rostral groove dentigerous ... ...*Macrognathus.*
2. Rostral groove edentulous ....*Mastacembelus.*

Genus MACROGNATHUS Lacépède

Postlabial groove on lower jaw only. No preorbital spine, preopercle with smooth outer edge. Teeth villiform ; on jaws and as transverse patches in rostral groove. Caudal fin distinct from dorsal and anal. Dorsal with 13 to 20 spines.

Macrognathus aculeatus (Bloch)

Ophidium aculeatum Bloch, Ausland. Fische taf 159, Fig. 2. 1795.
Bata kola theliya (S.)

D XIII-XVII. 50-54. A II-III. 50-52. P. 22-25. C 15

Gape ends far in front of posterior nostril. Upper surface of head and snout without scales. Lateral line descends to mid body below anterior quarter of soft dorsal ; 19-23 scales from lateral line to origin of soft dorsal. Spinous dorsal begins a little more than a head length behind gill opening, the posterior spines are longer than the anterior. Origin of soft dorsal above that of anal, the latter with three spines of which the second is strongest and the last vestigial. Pectoral rounded and contained 12-15 in length or 2·8-3 in head ; caudal distinct with rounded posterior margin and contained 12 to 14 in length. Specimens in which the caudal had been removed through injury appeared to re-

generate new caudal fin rays ; the new fin confluent with the dorsal and anal. Bases of the single fins covered with small scales. Scales of head somewhat larger than those on body. Eye 10-13, interorbit 1, snout 4-5 orbits, head 4·9-5 or 1·9 in tail, depth 6·2-7·8. Teeth villiform on jaws and also in 20-26 cross bands in rostral groove, none on palate. Length of fish 255 mm.

Colours. Not subject to much variation in Ceylon. Dorsally a reddish brown or olive with a median light stripe and a yellow lateral band from eye to tail above the lateral line. An indistinct row of light spots between these two light bands, which fade with age. In some young there is a faint light band from pectoral to tail. Sides greenish yellow ventrally salmon pink, yellow or white. Single fins usually dusky brown, dorsal with three to nine yellow or orange rimmed ocelli along its base above which is a longitudinal yellow stripe. The number of ocelli is not influenced by age, sex or locality. Anal often a uniform orange, or yellow, or with a yellow longitudinal band occasionally with one or two ocelli on its base. Caudal with short bars and spots of yellow. Pectorals orange or yellow.

Food. Earthworms, insects, organic matter.

Reproduction. Oviparous, eggs pale green, numerous, small, 1·28 mm. in diameter, laid in fresh water. Sexually ripe males and females were taken at Narammala ela near Yakvala (W.P.), March 9, 1931. Females with mature eggs taken at Piliandera (W.P.), September 20, 1927, and at Kurunegala (N.W.P.) and Nawala Canal, May 8, 1931.

Distribution. Common in low-country streams, ponds and tanks with muddy bottom. According to villagers it comes ashore during showers following the flow of rain water. Yakvala, Kelaniya, Hanvalla, Tebuvana, Piliandera, Dummala modera ela (W.P.), Katupotha, Kurunegala (N.W.P.) Anuradhapura (N.C.P.).

Ceylon, India, Burma, Borneo, Moluccas.

Genus **MASTACEMBELUS** Scopoli

Postlabial groove on both jaws. Preorbital spine present or absent. Teeth villiform, on jaws only. Caudal fin distinct or confluent with dorsal and anal ; the former with 7 to 39 spines.

Mastacembelus armatus (Lacépède) Plate LIV

Macrognathus armatus Lacépède, ii. P. 286. 1843.
Gan theliya, oya theliya, (S).

D XXXIV-XXXVII. 64-80. A II-III. 64-78. P 25, C 20

Gape ends under posterior nostril. Top of snout naked, its side scaly at base. A single suborbital spine and three at preopercular

angle. These, of which the upper is the strongest, diminish with age; lateral line descends from shoulder and runs along mid body. 28-30 scales from lateral line to origin of soft dorsal. Spinous dorsal begins over middle or posterior third of pectoral fin; its spines are longest posteriorly; in old specimens the anterior ones are reduced. Origin of soft dorsal above or a short distance behind origin of anal. The latter with three spines of which the second is the longest, the last being often vestigial. Pectoral bluntly truncate and contained 2·8-3·2 in head; caudal elongate, bluntly lanceolate and projecting considerably beyond dorsal and anal in young; short, truncate and more or less completely confluent with dorsal and anal or bounded by a slight notch in adult. Bases of single and paired fins covered with small scales. Scales on head about equal to those on body. Eye 9·5-10·5, interorbit 1, snout 3·7-4·5 orbits, head 5·8-7·8 or 3·6-4·5 into head and trunk, depth 10·5-14. Head of very young usually 4·5-4·9 in length. Teeth pluriserial, villiform, on jaws only. Length of fish 640 mm. (an adult male).

Colours. Subject to considerable variation with age and habitat, specimens from flowing water being lighter than those from sedentary waters. A black median frontal band runs from between eyes to nape of neck. Behind this band is a single dorsal row of 7-9 yellow blotches extending to origin of soft dorsal which has another row of seven along its base. A double lateral band of black or brown runs from snout through opercle and extends for about a head length past pectoral. The upper then breaks into 12-15 black spots along base of dorsal; the lower follows the lateral line to form large spots or reticulations. A finer brown lateral band runs below this and forms a reticulation posteriorly which anastamoses with the one above. Base of anal with 12-18 black or brown spots. Some specimens show traces of "W" shaped marks posteriorly on tail. Ground colour greenish yellow, yellow ochre or reddish brown. Single fins have orange margins with longitudinal dark lines, reticulation or spots. All dark bands break up with age into fine reticulation and spots which are eventually obscured by the darkening ground colour, giving old specimens at first glance a uniform dark olive brown appearance.

Food. Usually earthworms, and frequently taken on rod and line with this bait or shrimps.

Reproduction. Oviparous. Numerous small eggs. A male 640 mm. long taken at Thabbova tank (N.W.P.) on December 10, 1928, extruded milt. The dorsal spots and reticulation was indistinct, the pectorals were strongly spotted and there was a chain of elongate spots from throat to cloaca, while there were numerous small spots ventrally.

Ovigerous females with mature eggs taken at Gampaha (W.P.), November 5 and December 5, 1925, and October, 1926. Numerous young under 50 mm. taken at Levälla in Mahavilli Ganga, February 17, 1926. Two young 68 and 70 mm. long taken at Bibile (E.P.) 22-7-28.

Distribution. Flowing and still water. Up to elevation of 4,000 feet at Gammaduva (C.P.), rivers, lakes, ponds preferring the neighbourhood of rocks under which they shelter in mud. When held in the hand the fish wriggles backward, and its short dorsal spines act like the teeth of a saw, inflicting a nasty slash in the palm of the inexperienced fisherman.

Batuluoya, Thabbova väva (N.W.P.), Veyangoda, Gampaha, Hanwella, Colombo, Kelaniya, Baduruеliya (W.P.), Mahaoya river near Rambukkana, Levälla, Gammaduva (C.P.), Bibile (E.P.), Vakvälla (S.P), Nachchikudda (E.P.).

Ceylon, India, Nepal, Siam, East Indies, China.

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EXPLANATION OF PLATE

Plate LIV. *Mastacembelus armatus*

PLATE LIV

Mastacembelus armatus

P. Deraniyagala del.

The Nematognathoidea of Ceylon. Part I

BY

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WITH THREE PLATES

Cat-fishes are largely nocturnal in habit and several fresh water and estuarine forms are reputed to come ashore to forage, especially during rain. As they are essentially mud dwellers, they possess barbels which are generally supplied with taste buds to enable them to locate food in water, where vision is greatly restricted. All cat-fishes are devoid of scales, although some, not found in our waters, possess bony scutes. Each pectoral fin has a sharp spine which when set in a horizontal plane falls into an immovable lock from which it can be released by upward and backward pressure. In some forms, these spines are poisonous and wounds from them are very painful and subsequently suppurate. Several genera possess in addition, two dorsal spines, of which the first is vestigial. Some fresh water forms have the air bladder strongly modified and partly encased in bone and two such genera have accessary organs for aerial respiration, while several species produce a harsh grating sound, when out of water, by friction of different sets of bones with the air bladder. Eight fresh water forms are known from Ceylon, one of which is endemic, while another which is absent from Indian waters recurs in the East Indies, thus suggesting a former land connection. The *Nematognathoidea* are fresh water, estuarine and marine. Of the former, the family *Clariidae* are air breathing; while of the two latter, several genera of the family *Tachysuridae*, which are generally gregarious, are anadromous and lay a few very large eggs which are carried in the mouth of the male until incubated. During this period the parent fish starves, the palatine teeth become partially overgrown by mucous membrane and the buccal cavity is enlarged by the bones diverging. This family shows a decided tendency to repress the barbels.

Cat-fishes, especially the fresh water forms, regenerate a destroyed caudal fin. The new organ lacks the hypural bones and is confluent with the anal and at times with the dorsal according to the genus. They reach a large size, one form being the second largest Ceylon fresh water fish. The large proportion of meat to offal and the fat, well flavoured flesh make them valuable food fishes but their barbels, scaleless slimy bodies and omnivorous habits are viewed with disfavour by many. I here take the opportunity to extend my thanks to Drs. Seymour Sewell and S. L. Hora and Mr. Mukerji of the Indian Zoological Survey for information concerning several allied Indian forms and to Messrs. J. R. P. Perera, D. A. Obeyesekere and Dr. P. E. Pieris for help in collecting specimens.

Order OSTARIOPHYSI

Sub-order **NEMATOGNATHOIDEA**

Body naked or with bony scutes. Subopercle and symplectic absent; jaws fixed, with intermaxillaries forming upper oral border. Maxillary reduced and forms base of a barbel. Barbels one to four pairs. No pseudobranchiae. Second, third and fourth vertebrae ankylosed. Air bladder physostome, often reduced and invested in bone; when developed has an internal partition. Pectoral fins with spines. Adipose dorsal fin present or absent.

Key to Ceylon families of Nematognathoidea

1. Anal as long as tail.
   - A. Caudal not forked
     - (*a*1) Two dorsals, first with a spine ..... *Plotosidae*
     - (*a*2) One spineless dorsal ..... *Clariidae*
   - B. Caudal forked ..... *Siluridae*
2. Anal shorter than tail.
   - A. Eight barbels ..... *Bagridae*
   - B. Six barbels or less ..... *Tachysuridae*

Family Plotosidae

Head subconical or depressed, eye free, body subcylindrical, mouth wide, subterminal with thick lips. Gill membranes united or more or less separated from each other and free from, or more or less united with isthmus, branchiostegals 9-12. Nostrils widely separate; bar-

bels four pairs, nasal, maxillary, mandibular, mental. Teeth conical or obtuse. Air bladder large, free. First dorsal short with a spine anteriorly and is separate from the long spineless second dorsal which is confluent with caudal and anal. Pectorals with spines ; ventral rays 10-16. A dendritic organ usually present between cloaca and anal fin.

PLOTOSUS Lacépède

Head wider than deep with two anterior close-set fontanels, of which the posterior is very small and a narrow occipital fontanel. Snout which has ampullary structures subdermally, is as wide as rest of head. Mouth subterminal, transverse ; lips thick and crenulate perforated by the tubate anterior nostrils, close to which lie the slit-like posterior nostrils on snout but remote from eye. Eye small, free and located dorsally. Barbels, nasal, maxillary, mandibular and mental. Teeth pluriserial ; caninoid on jaws, molariform and in a crescentric band on vomers. Gill membranes partially confluent but free from isthmus. Body subcylindrical, tail compressed. Two dorsal fins, the first short and with a spine, the second a short distance behind, long and confluent with caudal and anal. Ventrals behind first dorsal. A well developed dendritic organ between cloaca and anal fin. Branchiostegals 9-12.

Key to Ceylon species of Plotosus

Colours uniform ; Anal rays 108-110 ..... *P. canius*

Longitudinal stripes ; Anal rays 70-77 ..... *P. anguillaris*

Plotosus canius Ham. Buch.

Plotosus canius Ham. Buch., Fishes of Ganges, 1822.
Sinhalese : *Kalapu magura, Kana magura.* Tamil : *Keduthal.*

Fins. ID. II. 4-5. II. D. 127-136. A 108-110. PI. 11-12. V 13. C 12.

Barbels. Eight. Nasals reach two orbits beyond eye, maxillaries do not quite reach pectoral, mandibulars reach division of gill membranes ; mentals shorter.

Measurements. Head 4·5-5·5, eye 11-15, interorbit 4-5, snout 3·5-5 orbits, depth 6-10. Pectoral rounded, equal to or a little longer than first dorsal, its spine serrate on both edges and as long as half or three-quarters of postorbital head. Origin of first dorsal far in advance of ventrals, its spine as long as pectoral spine and serrate. The second dorsal originates about a snout length behind the first and slightly in advance of ventrals, which have partially united bases and may, or

may not, reach anal. Single fins confluent, caudal pointed. Branchiostegals 11-13, gill rakers 16, somewhat shorter than branchial filaments. Lateral line midlateral. A dendritic organ consisting of two tufts of small fleshy lamellae with villiform structures, arises from a single stem and lies between cloaca and anal fin. Head depressed, eye in anterior half and dorsilateral ; snout as broad as rest of head ; mouth wide, subterminal, rounded. Lips thick, crenulate ; posterior nostrils an orbit length behind the anterior ones which are tubate and on lips. The anterior cephalic fontanel narrow and long and ends nearly level with hind edge of orbits. The small posterior one is close behind and is remote from the weak, flat, occipital process which is twice as long as broad and reaches basal bone of dorsal spine. A narrow fontanel, which disappears in adult, is present at base of occipital process. Teeth pluriserial, caninoid on jaws and smallest on intermaxillaries where there are two contiguous ellipsoid or subrectangular patches. Vomerines a crescentric band of large molariform teeth in four rows. Length of fish 930 mm.

Colours. All shades of olive green, lighter ventrally. Fins reddish brown with darker margins to unpaired ones ; dendritic organ dull crimson.

Food. Mollusca, crustacea and debris. Specimens from Puttalam lagoon contained an abundance of *Lingula* shells.

Reproduction. Numerous greenish brown eggs. Ovigerous specimens from Puttalam, July 2nd, 1928.

Distribution. Common in lagoons and estuaries, abundant in Puttalam lagoon where the delicate flesh is in considerable demand.

Chilaw, Mundal lagoon, Puttalam lagoon (N.W.P.), Negombo, Colombo, Panadura, Kalutara (W.P.), Bentota, Galle(S.P.), Jaffna(N.P.).

Ceylon, India, Burma, Singapore, Andaman Islands, Malay Archipelago, New Guinea.

Plotosus anguillaris (Bloch)

Platystacus anguillaris Bloch, Ausland. Fische VIII., 1794.
Sinhalese : *Mudhu hunga.* Tamil : *Kadal sungan.*

Fins. ID. II. 4-5. II D 80-110. A 70-77. PI. 10-12. V 11-12. C 10-12.

Barbels. eight ; short, subequal, each about as long as two orbit lengths. Nasals reach orbit in adolescents, not as far in adult.

Measurements. Head 4·4-5, eye 5-7, interorbit 1·7 -2·5, snout 1·7-3, orbits, depth 6-8. Pectoral rounded, equal to or a little longer than first dorsal, or head minus snout. Dorsal and pectoral spines

subequal, half as long as their fins, weak, serrate on both margins; strongest serration is along posterior edge of dorsal spine.

Second dorsal originates a snout length behind first and above ventrals, which have free bases and reach as far as anal. Single fins confluent, caudal pointed. Branchiostegals 11-12, gill rakers 21, as long as branchial filaments. Lateral line mid lateral. A bifid dendritic organ consisting of two tufts of small, comparatively smooth, fleshy lamellae between cloaca and anal fin. Head gently depressed, snout as broad as rest of head curving downward from the nasal barbels. Numerous small tubercles generally present on snout and above eyes. Dorsal profile subconvex, rising to dorsal spine. Eye dorsilateral, almost in middle of head length, its lower rim free, its upper edge fixed. Mouth wide, subterminal, crescentric when shut. Lips thick, strongly crenulate with a double row of fleshy papillae along inner margin. Anterior nostrils short tubes just behind upper lip and half an orbit in front of posterior nostrils. Three cephalic fontanels; the anterior elongate and ends in line with mid orbit, a small one is close behind and in line with hind edges of orbits. A narrow fontanel nearly as long as orbit remote from these and at base of occipital process, which is weak and connected to basal bone of dorsal spine by a strong ligament. Teeth bi-, or triserial narrowing to a single row laterally. Caninoid on jaws, molariform on vomers where they form a crescentric band. Length of fish 210 mm.

Colours. Dark brown dorsally with a white lateral band as wide as eye, from nasal barbel to caudal fin. A less distinct band from maxillary barbel to caudal. Light brown ventrally. Single fins with a darker edge. Old specimens said to lose the white lateral bands.

Reproduction. A shoal of fry collected by Willey (1908) at the mouth of the Periya Palampat-aar in Lake Tamblegam were examined. Willey said that the dark shoal of fry kept moving together in unison and that two white longitudinal stripes ran from between the eyes posteriorly, one along each side of the dorsal. The specimens which are in the Fisheries collection are 18 to 20 mm. long. The nasal barbel reaches front of orbit. The anterior part of the second dorsal is without visible fin rays, the caudal is rounded and there is a slight constriction between it and the anal which has all its rays developed. The dendritic organ consists of two fleshy lamellae, feebly convoluted.

Distribution. Marine and estuarine. A gregarious form. Colombo Harbour (W.P.), Gulf of Mannar (N.W.P.), Lake Tamblegam (E.P.).

Ceylon, India, Siam, East Indies, Australia, New Guinea, Fiji, South Sea Islands, Philippines, Formosa, Tonkin, China, Andamans, Red Sea, East Coast of Africa, Madagascar.

Family Siluridae

Head subconical or depressed ; eye free or subcutaneous ; body compressed. Mouth wide, terminal or superior, gill membranes overlapping, free from each other and isthmus, branchiostegals 9-20. Anterior nostrils tubate, posterior ones holes or tubate. Barbels two pairs, maxillary and mandibular. Teeth depressible or fixed, villiform. Air bladder well developed, free. Dorsal spineless, short, vestigial, or absent ; anal spineless, long ; each pectoral with a spine. Ventral rays 6-14. Caudal deeply emarginate or rounded ; free or confluent with anal.

Key to Ceylon genera of Siluridae

Mouth subterminal, ends behind eye ..... *Wallago*

Mouth superior, ends in front of eye ..... *Ompok*

Genus WALLAGO Bleeker

Head and snout depressed. Mouth subterminal and ends behind eye which is free. Gill rakers short and stiff. Ventrals behind or below dorsal. Caudal free and strongly emarginate or forked.

Wallago attu (Bloch et Schneider) Plate LV

Silurus attu Blochet Schneider, Syst. Ichth. 1801.
Sinhalese: *Maha Valeya, Valeya.*

Fins. D1·4. A 80-90. PI. 13-14. V 10. C 18.

Barbels. Two pairs. Maxillaries reach tip of pectoral in adult, to anal fin in young. Mentals 2·5-3 times orbit length.

Measurements. Head 4-4.5, eye 7-11, interorbit 4·5-5, snout 3·5-4, gape 1·9, depth 4·9-6. Pectoral as long as head minus snout, or twice ventral fin ; its spine weak, with a few indistinct teeth on its posterior margin, distal half soft. Dorsal in advance of anal and over posterior third of pectoral. Ventrals reach up to sixth anal ray. Anal long and separate from caudal, which is deeply forked with rounded spatulate lobes of which the upper is longer and contained 7·7 in length. Branchiostegals 18-20, gill rakers 21-25, sharp, tooth-like, much shorter than branchial filaments. Lateral line distinct, running in upper half of body and giving off short tubules downward. Head depressed, with spatulate snout ; lower jaw prominent; dorsal view of head ellipsoid, profile oblique. Nostrils remote from eye ; the anterior is one orbit

from the posterior. Mouth subterminal, gape wide and extends beyond eye. Distance from snout tip to dorsal contained 2·3 in distance from dorsal to caudal.

Teeth villiform, acute, depressible, larger internally. Vomerines in two small separate oval patches. Length of fish 800 mm. and said to reach 1,500 mm. The largest Ceylon cat-fish, weighs 12700 gms. or 28 lbs. (Willey, 1909).

Colours. Dorsally greyish brown, head purplish, sides leaden or silvery white with a broad purple reflection under lateral line of abdomen. Belly white. Fins pale yellow. After death, yellowish.

Reproduction. A female with nearly mature eggs from Kelaniya 25.2.27. Eggs numerous, small.

Distribution. Chiefly found in deep flowing water. An active, predatory fish which readily eats garbage. When taken on a hook snaps viciously at its captor. In rivers and tanks of the hills and low-country. Kelaniya (W.P.), Batulu Oya, Chilaw (N.W.P.), Nambapana, Ratnapura (Sab.P.), Levella (C.P.).

Ceylon, India, Burma, Siam, Java, Sumatra.

Genus **OMPOK** Lacépède[1]

Head broad, snout depressed. Mouth superior and ends anterior to eye which is subcutaneous. Gill rakers few, short. Ventrals below or anterior to dorsal. Caudal strongly emarginate, free or confluent.

Ompok bimaculatus (Bloch)

Silurus bimaculatus Bloch, Ausl. Fische. VIII. 1794.
Callichrous ceylonensis Günther, Catalog. Fishes Brit. Mus. Vol. V, 1864.
Sinhalese : *Pena Vallepotha, Vallepotha, Kokussa.*

Fins. D1. 3-4. A 61-66. PI. 12-15. V 6-8. C 18.

Barbels. Two pairs. Maxillaries reach tip of pectoral or up to sixth anal ray. Mentals 0·5-2 times orbit.

Measurements. Head 4·5-5·5, eye 5·5-7, interorbit 3·5-5 orbits, snout 1·8-2, orbits, depth 4-4·5. Pectoral fin reaches tip of ventral, its spine, usually with a soft tip, is as long as postorbital head length and has a serrate hind edge, which varies, and is more pronounced in specimens from some places, *e.g.*, Marichchukkadde (N.P), than in others as from Levälla (C.P.) and the Menik Ganga (S.P.). Origin of dorsal a head length behind head, is as high as postorbital head length. Ventrals small, reach origin of anal which is long and separate from caudal. Caudal as long as head, deeply forked with spatulate, rounded

1. Replaces *Callichrous* Ham. Buch.

lobes, the upper usually slightly the longer. This fin is at times found to be regenerated and is then confluent with anal. Branchiostegals 12-13; gill rakers 8-13 and about one-third length of branchial filaments. Lateral line complete and mid lateral.

Head broad, bluntly rounded; mouth superior, gape ends some distance before eye and in line with mid orbit. Dorsal profile of head gently concave. Distance from snout tip to dorsal is 2-2·15 in distance from dorsal to caudal. Teeth villiform as a continuous band on jaws, in two small separate patches on vomers. Length of fish 400 mm.

Colours. Dorsally a pale bluish olive, sides dull silvery white, a yellow shoulder patch which becomes brown after death. Opercles shot with gold, chest pink, fins yellow, lower caudal lobe silvery, base of anal purplish.

Reproduction. Numerous small eggs of a pale chocolate brown colour. Two ovigerous females taken at Yakvala (W.P.), August 31, 1930. Young taken at Maha Oya (E.P.), April 25, 1931.

Variation: Frequently the entire fish is mottled with brown. The pectoral fin at times has two contiguous spines.

Distribution. In tanks, ponds and rivers, Yakvala, Veyangoda, Athidiya, Baddurueliya (W.P.), Marichchukkadde (N.P.), Batulu oya, Chilaw, Puttalam, Murungan (N.W.P.), Levälla (C.P.), Anuradhapura, Rämbäva (N.C.P.), Nambapana, Ratnapura (Sab.P.), Vakvella, Menik Ganga (S.P.), Maha Oya (E.P.).

Ceylon, India, Burma, Siam, Java, Sumatra, Borneo.

Family CLARIIDAE

Head strongly depressed; eye free lateral; body subcylindrical or compressed. Mouth wide, terminal, gill membranes partially united and free from isthmus, branchiostegals 7-9. Anterior nostrils short tubes, posterior ones holes behind nasal barbels. Barbels four pairs, nasal, maxillary, mandibular and mental. Teeth villiform. Cranial bones expanded and partly, or completely, cover a pharyngeal diverticulum for aerial respiration, which may possess a dendritic organ. Gill filaments in upper parts of all four gill arches coalesce to form valves, which regulate air circulation in this chamber. Air bladder physostome, developed in young, vestigial in adult, and is enclosed in a bony capsule formed from the fourth and fifth vertebrae. Dorsal spineless, its base long or short; anal spineless, base long. Each pectoral with a pungent spine. Ventral rays six. Caudal subtruncate or rounded, free or confluent with dorsal and anal. Although many observers consider that these fishes aestivate in mud, however as is the case with the Labyrin-

thici, they appear to congregate in the one or two deep pools unaffected by the drought and there await the advent of the rains, by which time they are ovigerous. When the pools overflow, the fishes repopulate a considerable area and spawn in a few days, hence in a few months the tanks abound with fishes.

Key to Ceylon genera of Clariidae

Dorsal with 70 rays ..... *Clarias*
Dorsal with 7-8 rays ..... *Heteropneustes*

Genus **CLARIAS** Gronov

Head depressed, suprabranchial chamber with two dendritic respiratory organs arising from upper part of gill arches for aerial respiration. Dorsal longer than or as long as anal which extends along tail, at times confluent with rounded caudal. Ventrals behind origin of dorsal. Branchiostegals seven to nine. Body subcylindrical.

Clarias teysmanni Bleeker Plate LVI

Clarias Teysmanni Bleeker, Nat. Tijdscher Ned-Ind. XIII, 1857.
Sinhalese: *Magura, Vel Magura, Kaha Magura.*

Fins. D 70. A 60. P I. 8. V 6. C 21.

Barbels. Four pairs; nasals shorter than, maxillaries equal to, head length. Mandibulars reach axilla, mentals not as far.

Measurements: Head 4·3, eye 12, interorbit 5·5 orbits, snout 3, orbits, depth 6·7. Pectoral rounded, nearly half head length, its spine shorter, weak and feebly serrate anteriorly. Ventrals rather small, rounded and reach anal, no axillary pore. Caudal rounded posteriorly and contained 7 in length of fish. Specimens are frequently found with a regenerated caudal, which is then confluent with the dorsal and anal and lacks the hypural bones. Branchiostegals 8-9, gill rakers shorter 16-18. Lateral line runs slightly below the mid lateral. Head broad, depressed, with an ellipsoid outline when viewed from above and wider posteriorly than at eyes which are small and free; mouth subinferior, skull with two dorsal fontanels, the bones faintly rugose and expanded to roof a suprabranchial chamber containing two dendritic organs for aerial respiration. Frontal fontanel begins on a line joining front margins of eyes and is midway between snout tip and occipital fontanel, which is one-third of the former and begins above a line joining bases of pectoral spines. Occipital process bluntly rounded, its breadth at base equals three times its length, while its distance from origin of

dorsal is contained 2·5 in head length along mid dorsal line. Distance from snout tip to dorsal contained twice in base of dorsal.

Lips and bases of barbels with granular dermal folds. Teeth villiform pluriserial, in subquadrangular patches on jaws ; with age the intermaxillary bands are confluent when the band is four times as long as broad. The vomerines lie just behind in a single crescentric patch nearly as long. Each mandibular patch pointed posteriorly. Length of fish 305 mm. Willey (1909) records one of 3628·6 gms. (8 lbs.)

Colours. Olive green, brown or yellow with small irregular dark spots as large as eye. Young a dark brown or copper red.

Food. Small fishes, worms, decaying organic matter.

Reproduction : Numerous small yellow eggs. Ovigerous females with mature ova from Kalutara, March 21, 1927, and Yakvala, March 25, 1928.

Variation. Specimens coloured a uniform yellow ochre (*Kaha maguro*) are common and this tint is probably assumed on sexual maturity, as no young ones have been noticed.

A specimen 125 mm. long taken at Ratnapura had the single fins confluent. The head was 4·1, eye 10·5, D 76, A 58 and head length [1] equal to twice distance from occipital to dorsal ; colour normal.

Distribution. A hardy, air-breathing cat-fish common in muddy streams and ponds of the low-country and hills. Erroneously supposed to aestivate under baked mud, it is well-known to come on land during rain or at night. Its firm, well flavoured flesh and numerical abundance make it a food fish of considerable importance. Although very common in Ceylon it is absent from India but recurs in the East Indies.

Colombo, Kelaniya, Kalutara, Yakvala, Veyangoda (W.P.), Ratnapura, Kahavatta (Sab.P.), Maha Oya (E.P.), Vakvella (S.P.), Levälla (C.P.).

Ceylon, Malacca, Java, Sumatra, Borneo.

Genus **HETEROPNEUSTES** Müller [2]

Head strongly depressed. An elongated pharyngeal, aerial respiratory sac, which is external to the ribs, extends posteriorly under muscles of back to above cloaca. Dorsal very short, its origin anterior to ventrals ; anal as long as tail and partially or completely united with the rounded caudal. Pectorals with poisonous spines. Ventrals under, or slightly anterior to, dorsal. Branchiostegals seven or eight. Body subcylindrical anteriorly, compressed posteriorly.

1. Head length is from tip of snout to top of gill cleft.
2. Replaces *Saccobranchus* Cuv. et Val.

Heteropneustes fossilis (Bloch)

Silurus fossilis Bloch, taf 370, fig. 2. 1801.
Sinhalese: *Hunga, Kaha hunga.*

Fins. D 7-8. A 67-78. PI. 7. V 6. C 17-23.

Barbels. Four pairs, nasals and mentals reach tip of pectoral spine, maxillaries reach beyond pectorals but not as far as ventral fins, mandibulars are shorter and reach just beyond pectorals.

Measurements. Head 4·8-6, eye 7, interorbit 4, snout 2, depth 6-7. Pectoral rounded as long as postorbital head length, its spine as long, pungent and serrate along inner edge. Origin of dorsal slightly in advance of ventrals. Ventrals reach anal which has a long base and is separated from caudal by a deep notch. Caudal rounded posteriorly and 7·25-12 into length of fish. Specimens with regenerated caudals as in *Clarias* are not uncommon. Branchiostegals 8-9, gill rakers 23-28, shorter than branchial filaments. Lateral line mid lateral. Head depressed, narrowest at snout and widest above insertion of pectoral spines, dorsal view subtriangular, mouth terminal. Skull with two dorsal fontanels, the bones faintly rugose and expanded to roof two suprabranchial chambers into which open two elongate pharyngeal diverticula used for aerial respiration. Each diverticulum lies under the dorsal muscles and extends half way down tail. It consists of a strong sheath of connective tissue protecting a vascular sac, which is supplied with venous blood usually by the fourth branchial artery which lies ventrally. Both diverticula generally have a similar venation, but at times it varies considerably. A low adipose fold dorsally on posterior third of tail. Frontal fontanel from a line joining front margins of orbits and is midway between snout tip and occipital fontanel, which is smaller and begins on a line joining bases of pectoral spines. Occipital process acute and slightly longer than the fontanel. Distance from occipital process to dorsal is somewhat less than a head length. Distance from snout tip to dorsal contained 2-2·15 in distance from origin of dorsal to caudal. Teeth villiform, pluriserial, in subquadrangular patches on jaws, the intermaxillary patches coalesce with age. Vomerines form a "V" shaped band nearly as long as latter, or two separate patches. Interspace between premaxillaries and vomerines as wide as premaxillary band. Mandibular patches distinct and taper off posteriorly into acute processes. Length of fish 245 mm.

Colours. Copper red in young. Dark brown in adult with two lateral yellow bands. Ventrally lighter.

Reproduction. Eggs 1·42 mm. in diameter, numerous and green in colour. Spawning occurs all the year round.

Variation. Specimens of a uniform yellow colour (Kaha hunga) are common and this tint is probably assumed on sexual maturity, as no young ones have been noticed. These two genera of the family Clariidae are the only Ceylon cat-fishes which show a uniform yellow variation, although several marine forms, such as *Osteogeneiosus*, show conspicuous yellow areas during certain seasons.

Distribution. Low-country ponds and tanks, and at times slightly brackish water. A common fish much dreaded for the painful stings inflicted by its pectoral spines, which cause oedema and subsequent suppuration and at times ankylosis of a finger joint if stung there. The flesh is well flavoured and fat.

Colombo, Yakvala, Veyangoda, Bolgoda, Kalutara, Baduruelia (W.P.), Galle, Vakvella, Bentota, Tissamaharama (S.P.), Marichchukaddai (N.W.P.), Maha Oya (E.P.), Anuradhapura, Rämbäva, Medavachchiya (N.C.P.), Chilaw, Puttalam (N.W.P.).

Ceylon, India, Burma, Cochin China.

Heteropneustes microps (Günther) Plate LVII

Saccobranchus microps Günther, Catalog. Fishes Brit. Mus. Vol. V. 1864.
Sinhalese: *Lai hunga, Vel hunga.*

Fins. D 6-8. A 62-63. PI. 8. V 6. C 18-23.

Barbels. Four pairs. Nasals and mentals reach as far as or just beyond tips of pectorals. Maxillary barbels reach insertion of ventrals, mandibular barbels not so long.

Measurements. Head 6-6·5 in length or 3·85-4 into tail, eye 7-8, interorbit 3·5-4, snout 1·8-2, depth 6·5-6·8. Pectoral fin contained 10 in length as long as post orbital head length, its spine as long and faintly serrate distally. Origin of dorsal in advance of ventrals. Ventrals reach anal which has a long base and is confluent with the caudal. The caudal is bluntly truncate and contained 8-9 in length of fish. Branchiostegals 8, gill rakers 23 slightly shorter than branchial filaments. Head depressed, dorsal view rather narrow and subquadrangular or subtriangular. Mouth terminal. Skull as in *H. fossilis*. Distance from occipital process to dorsal as long as 0·9 head length; distance from snout tip to dorsal contained 2-2·25 times in distance from dorsal to caudal. A low adipose fold dorsally along posterior half of tail or further. Teeth in villiform subquadrangular patches. A single premaxillary band with two transversely elongate ellipsoid patches on vomers, which are close set. Mandibulars distinct and with pointed posterior angles. Length of fish 140 mm.

Colours. Reddish to reddish brown with two parallel yellow lateral bands on each side narrower than interspaces ; ventrally lighter.

Distribution. In muddy ponds. Dikkanda and Dambuva estates near Yakvala (W.P.).

Ceylon.

Family Bagridae

Head subconical or depressed ; eye free or subcutaneous ; body subcylindrical ; mouth subterminal, moderate ; gill membranes widely separate or united and free from isthmus ; branchiostegals 7-13. Nostrils widely separate with a nasal barbel. Barbels four pairs ; nasal, maxillary, mandibular and mental. Teeth villiform. Air bladder large, free. Dorsal short, with a pungent spine ; pectorals with a spine ; adipose fin well developed. Ventral rays 6. Anal with less than 20 rays, caudal forked, free.

Genus AORIA Jordan[1]

Eye free. Gill membranes free from isthmus and almost entirely separate. Dorsal above or anterior to ventrals.

Key to Ceylon species of Aoria

1. Two distinct cephalic fontanels.
   - *a.* Fontanels equal.....*A. keletius*
   - *b.* Posterior fontanel small.....*A. vittatus*
2. One cephalic fontanel.....*A. gulio*

Aoria vittatus (Bloch)

Silurus vittatus Bloch, Ausland Fische, 1785.
Sinhalese: *Iri ankutta, Hiri ankutta.*

Fins. DII. 7-8. A 2-3. 7-8. PI. 8. V 6. C 17-18.

Barbels. Four pairs. Nasals reach hind edge of preopercle or at times middle of opercle. Maxillaries reach middle of anal, mandibulars the tip of pectoral, mentals the insertion or middle of pectoral.

Measurements. Head 3·6-3·8, eye 4·5-5·1, interorbit 1·6-2, snout 1·25-1·5, depth 4-4·75. Pectoral does not reach ventral, its spine strong, flattened and strongly denticulate posteriorly. Dorsal fin, as long as head minus snout, anterior to ventrals, rounded and higher than its spine, which is weak and smooth or faintly serrate distally. Anal fin remote from ventrals and caudal, which is deeply forked and

1. Replaces *Macrones* Dumeril

has broad acute lobes of which the upper is the longer. It is contained 3-3·4 in length. Adipose fin remote from dorsal and ends above base of anal. Its base as long as that of dorsal. Branchiostegals 10, gill rakers 25-29, the anterior ones faintly spinose along inner edge, the longest being somewhat shorter than branchial filaments. Head faintly depressed with a convex profile; the occipital process meets basal bone of dorsal spine. Fontanels close set, the anterior long and ending above hind margin of orbit; the posterior ending far in advance of base of occipital process. Length of shoulder bone behind gill cleft equals postorbital head length. Distance from snout tip to dorsal contained 2·6 in length of fish.

Teeth villiform, in crescentric continuous bands on jaws and vomers. The junction of the vomerine patches at times narrow and of one or two rows of teeth only. Length of fish 100 mm.

Colours. Dorsally olive brown, with a dark shoulder patch and three dark brown lateral bands, at times a blotch on caudal peduncle. Sides yellow, belly white, fins pale yellow.

Food. Insect larvae, earthworms, garbage.

Reproduction: Numerous yellow eggs. Ovigerous females taken at Yakvala (W.P.) August 19, 1930.

Distribution. Ponds and small streams up to 3,000 feet. Levella (C.P.), Yakvala, Kalutara, Baduruеliya (W.P.), Kurunegala, Batuluoya, Chilaw (N.W.P.), Tammannava (N.C.P.), Katakeda äla (Sab. P.), Mankulam, Jaffna (N.P.).

Ceylon, India, Assam, Burma, Siam.

Aoria keletius (Cuv. et Val.)

Bagrus keletius Cuv. et Val., Hist. Nat. Poiss. XIV. 1839.
Sinhalese: *Path ankutta.*

Fins. D II. 7-8. A 2·8. PI. 8. V 6. C 17.

Barbels. Four pairs. Nasals reach base of occipital process, or hind edge of preopercle; maxillaries reach anal and at times caudal fin; mandibulars reach tip of pectoral; mentals reach insertion of pectoral.

Measurements. Head 4, eye 3·25-3·9, interorbit 0·9-1, snout 1·2-1·5, depth 3·9. Pectoral, with a strong spine which is denticulate posteriorly, does not reach ventral. Dorsal originates before ventrals, is acutely triangular, its height considerably exceeds head length. Dorsal spine weak, shorter than fin, equals head minus snout. Anal remote from ventrals and caudal; the latter deeply forked with acutely pointed lobes, of which the upper is the longer. It is contained 3 in

length. Adipose fin begins just behind dorsal and ends above base of anal.

Branchiostegals 10 ; gill rakers 17-18, smooth and a little shorter than branchial filaments. Lateral line unbranched. Head with mouth subinferior ; interorbital space flat sloping to snout. Occipital process meets basal bone of dorsal spine. Fontanels close set, equal, narrow and elongate, the posterior one reaching base of occipital process. Length of shoulder bone to gill cleft, equals postorbital part of head. Distance from snout tip to dorsal contained 2·8 in length of fish. Teeth villiform, in continuous bands on jaws and vomers. Mandibular patches nearly separate at symphysis. Length of fish 123 mm.

Colours. Dorsally olive brown, sides yellow, belly white. Fins yellow.

Distribution. Common in rivers and streams. Colombo, Badureliya, Yakvala (W. P.), Muneswaram tank (N.W.P.), Levella (C.P.), Puttalam (N.W.P.).

Ceylon, South India.

Aoria gulio (Ham. Buch.)

Pimelodus gulio Ham. Buch. Fishes of Ganges, 1822.
Sinhalese : *Mana ankutta.*

Fins. D II. 6-7. A 3-4. 10-12. PI. 7-9. V 6. C 17.

Barbels. Four pairs. Nasals reach hind edge of orbit or of preopercle. Maxillaries reach middle of ventrals or anal ; mandibulars reach tip of pectorals ; mentals reach insertion of pectorals.

Measurements. Head 3·25-4, eye 5·5-6, interorbit 2-2·7, snout 2, depth 3·8-4·5. Pectoral with stout, strongly dentate spine, does not reach ventral which is remote from anal. Both the latter bluntly triangular. Origin of dorsal midway between snout tip and adipose fin and anterior to ventrals. Dorsal fin acutely triangular, its height equals head length minus half snout. Its spine weak, feebly serrate and as long as postorbital part of head. Caudal forked with acute tips, the upper lobe longer than the lower and 3·6 in length. Adipose fin small, its base shorter than that of dorsal from which it is remote. Branchiostegals 9, gill rakers 29-33 as long as branchial filaments, smooth. Head with a straight, oblique profile from snout to dorsal ; mouth subterminal ; interorbital space rather convex. Top of head behind midorbital line finely rugose. Skull with a single dorsal fontanel, which extends from in front of eyes to a little behind them. Occipital process fine, contiguous with large basal bone of dorsal spine. Length of shoulder bone to gill cleft, contained 2-2·25 in postoribtal part of head. Distance from snout tip to dorsal contained 2·7 in total length.

Teeth villiform, in continuous bands on vomerines and intermaxillaries; separate at mandibular symphysis. Length of fish 240 mm.

Colours. Brown shot with bronze dorsally, yellow shading into white ventrally, fins a dull orange with dark tips.

Reproduction. Numerous small eggs.

Distribution. A common gregarious estuarine form which often wanders into fresh water.

Point Pedro, Pullu kulam, Jaffna (N.P.), Yodha vava, Tissamaharama, Pallaipothana kalapuva (S.P.), Puttalam, Chilaw (N.W.P.), Colombo (W.P.).

Ceylon, India, Burma, Malay Peninsula, Java, Madura, Sumatra, Borneo.

Family Tachysuridae[1]

Head subconical or depressed; eye free or subcutaneous; body subcylindrical. Mouth wide or narrow, subterminal or subinferior; gill membranes united and connected with isthmus; branchiostegals 5-9. Nostrils close set, no nasal barbel. Barbels three pairs, at times only maxillary or mandibular pair present. Teeth, conical, villiform or incisor-like on jaws, villiform, obtuse, granular or wanting on palate. Air bladder large, free. Dorsal short, with a spine; pectorals with a spine; adipose fin short and above anal which has 14-26 rays, ventral rays 6, caudal forked, free.

Key to Ceylon genera of Tachysuridae

A. Three pairs of barbels present
  1. Palate dentigerous ..... *Tachysurus*

B. Only maxillary barbels present ..... *Osteogeneiosus*

C. Barbels absent on upper, vestigial on lower jaw ..... *Batrachocephalus*

Genus **OSTEOGENEIOSUS** Bleeker

Head strongly depressed, covered with smooth skin and with two unequal close set cephalic fontanels. Mouth subterminal, arcuate; lips thin. Nostrils near tip of snout, the posterior with a fleshy valve. Maxillary barbels alone present and partially ossified. Eyes lateral, orbital margin free ventrally. Jaws with villiform, palate with two patches of strong globose teeth. Branchiostegals five. Dorsal anterior to ventrals.

1. Replaces *Ariidae*, see Fowler (1928).

Osteogeneiosus militaris (Linné)

Silurus militaris Linné, Syst. Nat. Ed. X. 1758.
Sinhalese : *Goraka anguluva, Gal anguluva, Manavăl anguluva.*

Fins. D II. 6-7. A 4·14-16. PI. 10. V 6. C 14-16.

Barbels. One pair. Maxillaries strong, ossified and reach from a quarter to half way down pectoral spine.

Measurements. Head 3·5-3·8, eye 5-6, interorbit 3·5-4, snout 1·6-2, depth 4·2-5. Pectoral spine shorter than fin, thin, serrate and equals postorbital head length. Origin of dorsal midway between snout tip and adipose fin, bases of both fins equal in length. Dorsal fin triangular, its spine shorter, thin, serrate and as long as head minus snout. Ventrals behind dorsal, remote from pectoral and anal. Anal rather elongate with gently emarginate edge. Adipose fin above anal, moderate. Caudal forked, lobes, bluntly rounded and as long as head without snout. Branchiostegals 5, gill rakers 8-9, acute and shorter than branchial filaments. Lateral line runs mid laterally with numerous long, delicate ramifications especially anteriorly. Head strongly depressed in smooth skin with pronounced venation, mouth terminal; anterior and posterior nostrils close set near tip of snout. Two frontal ridges close set between nostrils, diverge posteriorly, bounded externally by two ridges which converge at base of occipital bone. Each of these originates anteriorly in a rugose, bony, supra-orbital prominence. Occipital process strong rectangular, as long as thrice its width, carinate, and rugose anteriorly, reaches basal bone of dorsal spine. Fontanels two, close set ; the anterior ends far behind eye, the posterior small and remote from base of occipital process. Length of shoulder bone behind gill clefts equals half postorbital head length. Teeth villiform on jaws, in short bands. Intermaxillary band continuous, mandibulars separate at symphysis. Two semilunar bands of stout globose teeth on palate, which are narrower and remote from each other anteriorly, wide and nearly contiguous posteriorly. Length of fish 390 mm.

Colours. Dorsally steel blue with bronze reflections, adipose fin dark brown in front, at times with a black spot on top. Interior of mouth a bright yellow. Sides silvery or at times yellow, ventrally white. Fins gamboge yellow or hyaline. Barbels red.

Reproduction. A specimen, 230 mm. long taken in a seine net at Negombo on December 3rd, 1927, had 24 eggs in its mouth. Egg diameter 12-14 mm. The palatal bones were thin and strongly arched and the head resembled a thin bony case unlike the solid fleshy head of the ordinary specimen.[1] The palatine teeth were reduced to narrow bands

1. Possibly *O. sthenocephalus* Day, is merely a sexual modification.

which were covered with mucous membrane posteriorly. The eggs completely filled the buccal cavity. The stomach was empty and shrunken, indicating that the animal was starving. The unpigmented embryo has only the single pair of barbels which are thick and do not reach much beyond orbit. Its mouth ventral. Eggs from Puttalam, September 9th, 1931.

Distribution. Marine and estuarine. A shallow water form. Kalutara, Negombo, Colombo in Beira Lake (W.P.), Puttalam (N.W.P.).

Ceylon, India, East Indies, Singapore.

Genus **BATRACHOCEPHALUS** Bleeker

Head large, bluntly rounded, with short obtuse snout and a single fontanel. Mouth terminal. Nostrils close set. Barbels vestigial and present on lower jaw only. Eye moderate, free, in anterior part of head. Gill membranes united and narrowly attached to isthmus ; there is a free posterior margin without a notch. Jaws with caninoid teeth which are present on palatines. Vomers edentulous. Branchiostegals 5. Dorsal anterior to ventrals.

Batrachocephalus mino (Ham. Buch.)

Ageneiosus mino Ham. Buch ; Fishes of Ganges, 1822.

Fins. D II. 6-7. A 5·15. PI. 9. V 6. C 15.

Barbels. None on upper jaw. Mandibulars vestigial, as long as one-sixth orbit ; mentals faint prominences.

Measurements. Head 3·3, eye 4·5-5, interorbit 2, snout 0·8, depth 4·5. Pectoral remote from ventral and 4·7 in length ; its spine moderate, depressed, markedly serrate posteriorly, faintly so anteriorly and as long as postorbital part of head. Dorsal fin with origin closer to snout tip than to adipose fin and as long as head minus snout. Adipose fin base as long as orbit. Ventrals inserted far behind base of dorsal and reach anal, which is under adipose fin and has its base as long as postorbital head. Caudal forked, lobes broadly pointed, the upper the longer and equal to head length. Branchiostegals 5, gill rakers 7, far apart and much shorter than branchial filaments. Lateral line midlateral. Head rounded, faintly depressed ; mouth terminal ; lower jaw strong, prominent ; snout short, bluntly rounded ; nostrils set close to eye. Skull bones rugose posteriorly and under thin skin. Eye anterior and free. A ridge runs from above eye to occiput in a concave curve. Occipital process subrectangular, as long as broad, and contiguous with basal bone of dorsal spine. A single cephalic fontanel ending behind orbits. Length of shoulder bone behind gill cleft equals half

postorbital head length. Teeth strong, caninoid in two pluriserial ridges both on upper and lower jaws and a short patch on each palatine base. Length of fish 170 mm.

Colours. A pale greenish blue dorsally, sides silvery, belly white. Fins pale yellow, dorsal and upper lobe of caudal dusted with brown.

Distribution. Marine and estuarine. Uncommon. Chilaw lagoon (N.W.P.), Colombo (W.P.).

Ceylon, India, Burma, Java, Sumatra, Borneo.

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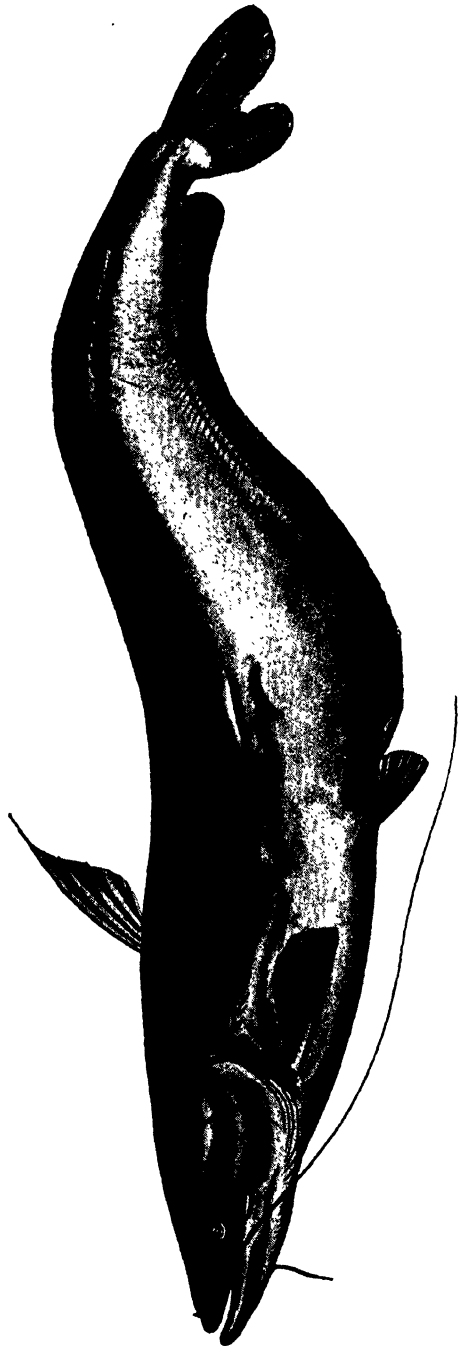
EXPLANATION OF PLATES

Plate LV. *Wallago attu* × $\frac{1}{5}$.
Plate LVI. *Clarias teysmanni* × $\frac{1}{2}$.
Plate LVII. *Heteropneustes microps* × 1.

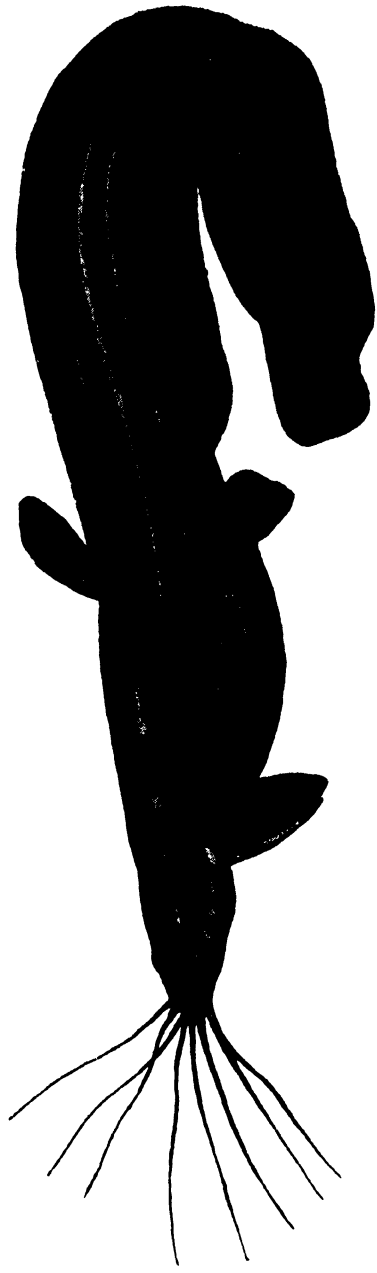


Wallago attu

P. Deraniyagala del.

Clarias leysmanni

P. Deraniyagala del.



Heteropneustes microps

P. Deraniyagala del.

The Gekkonoideae of Ceylon

BY

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WITH SEVEN PLATES

The Gekkonoideae are the most primitive living superfamily of the sub-order Sauria. In common with some other reptilian superfamilies, Geckoes can snap off the tail at will, later regenerating a new one. The removal is effected by breaking a vertebra in the middle. The new tail regenerates only the chorda without the vertebrae. The new covering of uniform, imbricate scales, even in species which possessed enlarged tubercles on the original member indicates a reversal to the primitive unspecialised type (see Plates LXIII, LXIV). As with some other families of Sauria, additional tails arise as regenerations from wounds which fail to break off the original. The feet are highly modified throughout the family and many genera possess adhesive subdigital lamellae enabling them to run along walls and in an inverted position, on ceilings. The claws on the whole show a tendency to reduction.

Geckoes are among the most widespread of tropical reptiles being readily transported, both by drifting timber and by human agency such as ships. In Ceylon they live on trees, under rocks and in houses. The last must be fairly new as the colonies of bats which dwell in the ceilings of old ones prey on them. Each gecko appears to have its own hunting area on a wall, and when one encroaches on its neighbour's preserve a fight usually results. The prey is approached in a series of short swift rushes with a rest after each. Once within striking distance the gecko advances its hind limbs as far forward as it can, then obtaining a purchase with its feet, removes its hands. A push with its tail and feet shoots its body forward bringing its snout in contact with the prey which is promptly seized. The tongue is used for licking up small insects. Sugar syrup is relished by some geckoes which are almost as attracted as are flies and a bottle of syrup kept open in a dark corner is a very efficient trap for several species.

There are fifteen Ceylon species; of these the occurrence of two is in doubt since no specimens have been obtained after the original records by Kelaart. As many mistakes have occurred through the interchange of locality labels, these two should be treated with caution. Of the remaining species, two are peculiar to Ceylon, two are diurnal, the rest nocturnal. The Sinhalese names with the English equivalent are given where possible.

I must here record my indebtedness to the following for help in obtaining specimens: Mr. and Mrs. J. R. P. Perera, Mudaliyar J. E. Perera, Mr. W. W. A. Phillips, Dr. J. C. Hutson of the Agricultural Department and Dr. P. E. Pieris of the Ceylon Civil Service, while Mr. H. W. Parker of the British Museum was so good as to let me compare several specimens with the types in his charge. My thanks are also due to Dr. Malcolm Smith for giving me information as to the classification of *Hemiphyllodactylus typus* hitherto classified as *Lepidodactylus ceylonensis*.

Superfamily GEKKONOIDEAE

Family Gekkonidae

Skull without postorbital or postfronto-squamosal arches, nasals separate. Dentition pleurodont. Vertebrae amphicoelous, intercentra developed. Cervical vertebrae six. Clavicles dilated. Eyelids generally fixed, ear distinct. Tongue smooth or papillate, extensile, depressed and feebly bifid anteriorly. Endolymphatic glands usually well developed. Body subcylindrical or depressed, dorsally with fine granules and at times with enlarged tubercles, ventrally with granular or imbricate scales. Tail fragile, replaceable. Two subcaudal glands open on each side of cloaca. Limbs with modified digits, generally dilated basal joints with adhesive sub-digital lamellae. All or some digits with claws. Femoral and preanal pores which secrete waxy slabs, usual in males. Reproduction by hard-shelled eggs which may be separate or agglutinated.

Key to Ceylon genera of Gekkonidae

A. Digits compressed, curved.
   - α pupil vertical ..... *Gymnodactylus*
   - β pupil round ..... *Gonatode*

B. Digits with expanded bases, inner digit reduced.
   - α No dermal expansion from axilla to groin.
     1. distal joint within digital expansion
        - *a.* A fold of skin from thigh to calf ..... *Peropus*
        - *b.* No fold of skin from thigh to calf ..... *Hemidactylus*

2. distal joint at margin of digital expansion
   a. Subdigital lamellae bifid
      (a^1) Inner digit vestigial.....*Hemiphyllodactylus*
      (a^2) Inner digit distinct.....*Lepidodactylus*
   b. Subdigital lamellae entire.....*Gekko*

β A dermal expansion from axilla to groin.....*Cosymbotus*

Genus GYMNODACTYLUS Spix

Pupil vertical, body, limbs and tail, subcylindrical; limbs strong, digits not dilated, strong, cylindrical at base, compressed distally with a curved sickle-like appearance. Each claw between two enlarged scales, subdigital lamellae single. Body with granules and tubercles dorsally, a lateral fold present or absent. Males with or without preanal and femoral pores. Arboreal and subarboreal.

Key to Ceylon species of Gymnodactylus

A. An enlarged row of subcaudals.....*G. frenatus*
B. No enlarged subcaudals
   1. Tubercles rounded.....*G. nebulosus*
   2. Tubercles trihedral.....*G. triedrus*

Gymnodactylus nebulosus Beddome Plate LIX

Gymnodactylus nebulosus Beddome, Madras Journ. Med. Sci. 1870.
Gymnodactylus collegalensis Beddome, ibid.
Gymnodactylus speciosus Beddome, ibid.

Head large, convex; body short, lateral fold indistinct; tail short, subcylindrical and tapering gradually. Nostril surrounded by rostral, first labial, supranasal and several small scales. Supranasals separated by an internasal. Ear oblique and one-third or half orbit. Rostral subquadrangular about twice as wide as deep; with the median sulcus descending to mid-depth Supralabials 8 to 11; infralabials 7 to 9. Mental triangular, followed by a pair of large chin shields which are contiguous behind its apex; several smaller shields posteriorly. Snout longer than orbit, subacute, interorbital space slightly concave, cephalic granules largest on snout. Dorsally, body covered with small granules which may be uniform, or with slightly larger, round, carinate tubercles sparsely scattered; most numerous over hips. Gular scales granular, ventrals small, hexagonal, subimbricate and larger than dorsal tubercles. Tail with smooth, imbricate scales which are subequal or slightly larger inferiorly. Male without femoral or preanal pores. Digits short, the bases slightly depressed; subdigital lamellae enlarged.

Colours. (Spirit). Light brown with darker bands and spots with dark margins. The single specimen examined showed brown reticulation on postorbital part of head, and three lines from eye to angle

of jaw ; a small spot between shoulders ; a cross band, as broad as snout length, behind axillae. A small vertebral spot followed by two spots almost as large as eye. The latter meet along midvertebral line and are followed by a smaller spot above base of tail. According to Annandale the varieties *collegalensis* and *speciosus* of Beddome are also present in Ceylon. The former has only well defined spots along the vertebral line, the latter has only broad cross bars.

Dimensions. The single adolescent specimen examined measured snout 4 mm., snout to ear 9·9 mm., snout to cloaca 29 mm., axilla to groin 14 mm., tail 25 mm., arm 14 mm., leg 14·5 mm. Boulenger gives the length of the adult as 94 mm.

Distribution : A forest form found under bark of dead trees. Matale (C.P.).

Ceylon, South India.

Gymnodactylus frenatus Günther Plates LVIII and LX

Gymnodactylus frenatus Günther, Rept. Brit. Ind. 1864.

Maha kälä huna (S.) = Great forest gecko.
Mukalan huna (S.) = Jungle gecko.

Head large, triangular, depressed ; body elongate with a faint lateral fold, tail subcylindrical, elongate, tapering gradually. Nostril surrounded by rostral, first labial and three nasals. Supranasals separated by an internasal. Loreal space oblique. Ear oblique, smaller than first labial and an eye diameter behind orbit. Rostral subquadrangular, about twice as wide as deep its median sulcus, does not descend to mid-depth. Supralabials 10 to 12, infralabials 8 to 10. Mental triangular, or subpentagonal followed by two chin shields which are broadly contiguous behind its apex, a few small shields subsequently. (Plate LVIII, fig. 2). Snout 1·5 times orbit, eye closer to ear than to snout tip ; interorbit flat or gently concave.

Cephalic granules small, largest on snout. Body with six or seven longitudinal rows of smooth, circular tubercles from neck to hips and some on hind limbs. Gular granules small ; ventral scales large, smooth, imbricate, with enlarged preanals. Caudals subquadrangular, large, smooth, imbricate, larger ventrally, with an enlarged row of subcaudals. Basal joint of each digit depressed slightly with a row of large, granular, inferior lamellae ; distal joints compressed. 6-7 lamellae under basal joint of inner digit, 8 under fourth digit. Males with four to seven preanal pores and two large openings of subcaudal glands [1] near root of tail, each

1. Each gland consists of a sac lined with a loose, waxy, convoluted membrane capable of extrusion. It has no distinct secretion.

as large as ear opening. Flies of the genus *Phlebotomus* are sometimes found in pairs gorging on the blood of these geckoes.

Colours. A pale cinnamon brown to dirty yellow with dark brown cross bands which have darker edges. Five such bands on body, seven to eight on tail; and indistinct reticulate bands on limbs. Head and labials with a reddish tint. Neck band unites with lateral band from snout to ear which is sometimes continued as an indistinct lateral band. Ventrally pinkish grey. In newly hatched young, the terminal third of tail is white, the last two dark, caudal annuli appearing with age.

Dimensions. The largest Ceylon gecko. Snout 12 mm., snout to ear 29 mm., snout to cloaca 100 mm., axilla to groin 43 mm., tail 100 mm., leg 46 mm.

Food. Insects, tree frogs, small birds and the smaller geckoes.

Reproduction. Male with two large, close set papillae behind opening of hemipenis. Three to six hard-shelled eggs buried in the ground. Dimensions of egg 17 mm. by 15 mm. Eggs found on June 13th, 1927, at Mousakande estate, Gammaduva (C.P.). Newly hatched young measure 42·5 mm. snout to cloaca, 47 mm. tail. Colours as in adult but posterior third of tail white. A batch of 6 eggs, observed by Henry, occupied an interval of one month between emergence of the first and last baby geckoes.

Distribution. On trees and rocks. Kandy, Peradeniya, Gammaduva (C.P.), Hapugastenna, Ratnapura (Sab. P.), Neerodumunnai (E.P.). Ceylon.

Gymnodactylus triedrus Günther Plates LVIII, LXI

Gymnodactylus triedrus Günther, Rept. Brit. Ind. 1864.

Head large; body moderate, subcylindrical with or without a dermal vertebral fold, no lateral fold; tail short, thick, subcylindrical and abruptly tapering at end. Nostril surrounded by rostral, first labial, one supranasal and several small scales; eye with a prominent upper rim of conical granules. Ear about equal to first supralabial, with a row of rather enlarged conical granules on dorsal edge. Rostral subquadrangular, its width somewhat less than twice its depth, the median sulcus extending slightly below its mid depth; contiguous with each supranasal and an internasal. Supralabials 10 to 11; infralabials 8 to 9. Mental triangular, with a pair of enlarged chin shields contiguous behind its apex, followed by one or two smaller pairs. (Plate LVIII, fig. 1). Snout 1·5 times orbit, rather convex dorsally; eye closer to ear than to snout tip; forehead flat or faintly concave; ear one orbit behind eye and twice the size of a tubercle. Cephalic granules conical, small, largest on

snout, with a few conical tubercles between eye and ear and more on neck. Dorsally, body with numerous trihedral tubercles scattered among trihedral granules. Arms and legs with imbricate granules and tubercles intermixed. Gular granules conical, ventral scales imbricate, smooth, slightly larger posteriorly where they equal ear opening in size. Caudals, smooth and imbricate with close set prominent scales in annuli at intervals, larger ventrally. Males with three preanal pores, each in an enlarged scale. Digits strong of medium length, rather cylindrical, with an enlarged pad at distal end of basal joint. Subdigital lamellae smooth, inner finger with 6, fourth with 8, inner toe with 6, fourth with 10.

Colours. Dorsally dark purplish brown with four longitudinal rows of dark ringed white dots, which are equal to, or smaller than, ear. A dark band from snout to ear. Female with three white spots on supralabials anterior to eye, and three others along canthus rostralis. Both sexes have two rows of white spots on head which are confluent dorsally. Tail irregularly banded with ten rings of white spots. Ventrally, a pale purplish grey, light, on throat.

Dimensions. (Male) snout 8 mm., snout to ear 17·5 mm., snout to cloaca 61 mm., axilla to groin 30 mm., tail 52 mm., arm 21·5 mm., leg 25 mm. (Female) snout 6·5 mm., snout to ear 14·5 mm., snout to cloaca 51 mm., axilla to groin 22 mm., tail 33 mm., arm 19 mm., leg 25 mm.

Distribution. In mountain forests.

Peradeniya, Gammaduva, Kitulgalla (C.P.).

Ceylon.

Genus **GONATODES** Fitzinger

Pupil rounded. Body, limbs and tail, subcylindrical. Digits clawed, cylindrical, or feebly depressed at base, with compressed distal phalanges, which are curved, giving digit a sickle-like appearance. Each claw between four scales ; subdigital lamellae single. Body with granules and tubercles dorsally, and lateral fold faintly developed. Males with, or without, preanal or femoral pores. Diurnal, terrestrial or subarboreal.

Key to Ceylon species of Gonatodes

A. No enlarged subcaudals ..... *G. kandianus*

B. A row of enlarged subcaudals ..... *G. jerdoni*

Gonatodes kandianus (Kelaart) Plate LVIII

Gymnodactylus kandianus Kelaart, Prodromus Faunae Zeylanicae, 1852.

Bim huna (S.) = Ground gecko.

Head moderate ; snout rather acuminate, depressed ; body and tail slender and subcylindrical. Nostril surrounded by rostral, first labial

and three nasals. Eye with round pupil, midway between nostril and ear. Eyelid prominent, with a double row of flat, carinate scales. Ear vertical, oval and about one-sixth orbit. Rostral subquadrangular, as wide as twice its depth, deeply divided by the internasal, the median sulcus descending to below mid-depth. Supralabials and infralabials 7 or 8. Mental large, triangular, with truncate apex, followed by chin shields, which are not conspicuously enlarged and which do not meet behind its apex. (Plate LVIII, fig. 4).

Snout 1·5 times orbit; interorbital space rather convex or flat. Cephalic granules large, suboval and carinate on snout, rest small and conical. Dorsal granules with a few scattered, pointed, white tubercles, which are most evident laterally. Supracaudal granules, triangular carinate and imbricate, with 6 longitudinal rows of trihedral, acute tubercles. Granules on limbs imbricate and carinate. Gular granules enlarged anteriorly, those under neck carinate.[1] Ventrals smooth and imbricate, subcaudals somewhat larger, smooth, imbricate, without an enlarged median row. Males with 2 to 4 preanal and 3 to 6 femoral pores on each thigh; each femoral pore with a pointed tubercle behind it. Limbs long, digits with 3 or 4 pads under the basal portion of the fourth digit. Bases of digits not dilated.

Colours. Bluish grey or greenish brown with eight or nine "W" shaped brown cross bands on body interspersed with irregular light blue bands. At times a vertebral band or row of light brown spots from neck to base of tail.

Three or four brown lines from eye to ear and one from snout to eye. Labials brown with light spots. Limbs with 5 or 6, tail with 10 or 12, dark annuli. Belly yellow, each scale dusted with brown; throat at times darker; grey under thighs. Vertebral band in young and adult unaltered by age.

Dimensions. Snout 5 mm., snout to ear 9 mm., snout to cloaca 34 mm., axilla to groin 14 mm., tail 40 mm.

Reproduction. Two to six spherical eggs of 4-6 mm. diameter stuck together in crevices in rocks. Eggs from Gammaduva, September 5th, November 3rd, 1931. Possibly more than one gecko lays in the same place.

Gonatodes kandianus var. **gracilis** (Beddome)

Gymnodactylus gracilis Beddome, Mad. J. Med. Sci. 1870.

First pair of chin shields contiguous, gular granules and ventral neck scales smooth. Plate LVIII, fig. 5.

1. Carinations extremely variable, at times very indistinct.

Gonatodes kandianus var. **tropidogaster** Boulenger

Gonatodes kandianus var. *tropidogaster* Boulenger Cat. Liz. Brit. Mus., 1885

Ventrals and subcaudals generally distinctly carinate ; ventrals rarely smooth.

Distribution. Chiefly under stones close to forest streams, also on trees. The variety *tropidogaster* is the commonest form in the plains and rarely found in mountain localities which yield the typical form and the variety *gracilis.*

Kandy, Gammaduva, Madugoda, Peradeniya (C.P.), Gampaha, Veyangoda (W.P.).

Ceylon, South India, Malay Archipelago.

Gonatodes jerdoni (Theobald) Plate LVIII

Gymnodactylus jerdonii Theobald, Cat. Rept. As. Soc. Mus. 1876.
Gymnodactylus scalpensis Ferguson, Reptiles of Ceylon, 1877.
Bim huna (S.)=Ground gecko.

Head moderate, snout acuminate, depressed ; body moderate, tail slender, subcylindrical. Nostril surrounded by rostral, first labial and three subequal nasals. Eye with round pupil and midway between nostril and ear. Eyelid prominent with enlarged carinate scales anteriorly. Ear vertical, ovate and about one-sixth of eye. Rostral subquadrangular, as wide as twice its depth, its median sulcus descending to below mid-depth. Supralabials 8 to 10, infralabials 7 to 8. Mental large, subtriangular, or subpentagonal, followed by small chin shields which do not meet behind its apex. Snout as long as twice orbit, interorbital space flat or gently convex. Cephalic granules enlarged, subovate and feebly carinate on snout, remainder small and conical. Dorsal granules uniformly small and conical, with two or three white conical tubercles on each side. Supracaudal granules smooth, rounded and imbricate, with a few scattered conical tubercles near base of tail. Gular granules hexagonal, smooth, enlarged anteriorly, those under neck smooth. (Plate LVIII, fig. 3). Ventrals smooth, hexagonal, imbricate ; subcaudals larger with an enlarged median row. Males with five to fifteen femoral pores on each side, their numbers differ on each limb ; conical scales behind them, no preanal pores. Limbs strong, basal digits with large, ovate pad-like subdigital lamellae which are largest distally. Inner digits with 1, fourth with 3 or 4 such pads.

Colours. Dorsally, bluish grey, densely reticulate with brown ; head and labials with light spots. Body with five or six irregular cross

bands of light spots, each as large as pupil. Tail with ten brown annuli outlined with darker, each much wider than interspaces. Tubercles white. Ventrally a canary yellow, gular scales at times dusted with brown. Young with yellow and white spots, labials with yellow spots only.

Dimensions. Snout 4 mm., snout to ear 8 mm., snout to cloaca 35 mm., axilla to groin 15 mm., tail 35 mm., leg 14 mm.

Reproduction. Two eggs 4-7 mm. by 3·5-6 mm. each are generally laid at a time in crevices in rocks. Eggs abundant at Gammaduva, August 26th, 1931. Newly hatched young measured 13 mm. from snout to cloaca, 12 mm. tail.

Distribution. A ground dwelling diurnal form. Gammaduva (4,000 feet). Hewissa, Dikoya (C.P.).

Ceylon, South India (Lamparis Peak, 5,000 feet).

Genus **HEMIDACTYLUS** Oken

Pupil vertical. Body, limbs and tail, subcylindrical, or feebly depressed. Digits free, the basal joints depressed and dilated. Distal phalanges compressed, clawed, angularly bent and originating in middle of basal expansion. Sub-digital lamellae bifid. Body with granules, or intermixed with tubercles dorsally, Lateral fold more or less distinct. Males with femoral or preanal pores. Newly hatched young without rostral caruncle and egg tooth for piercing egg shell.

Key to Ceylon species of Hemidactylus

A. Tubercles smooth, rounded.
   1. Tail subcylindrical ..... *H. frenatus*
   2. Tail depressed. ..... *H. leschenaulti*

B. Tubercles trihedral.
   1. Nostril with supranasal and nasals ..... *H. brooki*
   2. Nostril with supranasal only.
      (*a*) No white tubercles, digits free ..... *H. depressus*
      (*b*) White tubercles, digits partly webbed ..... *H. triedrus*

Hemidactylus frenatus Dum. et Bibr. Plate LXII

Hemidactylus frenatus Dumeril et Bibron, Erp. Gen. III. 1836.
Geval huna (S.) = House gecko.

Head moderate, depressed ; body subcylindrical with faint lateral fold ; tail slender, subcylindrical. Nostril surrounded by rostral, first labial and three nasals. Eye closer to ear than to nostril ; ear subovate, oblique, smaller than first supralabial. Rostral subquadrangular, a dorsal groove present or absent, median sulcus extends slightly below

mid-depth. Supralabials 12 to 13, infralabials 10 to 11. Mental subtriangular or subpentagonal, with 2 or 3 pairs of enlarged chin shields behind, the first pair contiguous behind its apex. Snout 1·6 times eye, interorbital space flat. Cephalic granules fine, enlarged and convex on snout. Dorsal granules slightly larger than occipital ones and intermixed with a few small rounded tubercles much smaller than ear opening. These are subconical over sides and hips. Tail with 6 longitudinal rows of low, conical, tubercles dorsally among the rather large imbricate granular scales. Gular granules small, smooth, convex; ventrals imbricate, smooth. A median row of enlarged subcaudals. Males with an uninterrupted series of 29 to 35 femoral and preanal pores. Distal joints of digits developed; inner one very short, with 5 or 6 bifid subdigital lamellae, fourth digit with 8. Occasionally red mites infest the space under the distal joint of each digit of foot of adult.

Colours. Dorsally two rows of spots rather smaller than orbit or a uniform yellowish brown to pale cinnamon, at times with brown reticulation of varying intensity. A brown band from nostril to above neck, bounded by darker lines, may be present or absent. Labials dusted with brown. Tail with 13 brown annuli somewhat wider than interspaces. Ventrally grey or white; some scales occasionally dusted with brown.

Dimensions. Snout 7 mm., snout to ear 14 mm., snout to cloaca 48 mm., axilla to groin 25 mm., tail 61 mm., arm 13 mm., leg 20 mm.

Distribution. A common house gecko. Veyangoda, Colombo, Gampaha (W.P.), Gammaduva, Peradeniya, Ratota, Kandy, Sigiriya (C.P.), Jaffna, Mannar, Mankulam, Pt. Pedro (N.P.), Tamblegam, Kantalai, Polonnaruva (E.P.).

Ceylon, South India, Burma, Malay Archipelago, Addu Atoll in Maldives, China, Indo-China, Islands of Western Pacific and Indian Oceans.

Hemidactylus brooki Gray

Hemidactylus brookii Gray, Cat. Liz. 1845.
Hemidactylus gleadowi Murray, Zool. Sind. 1884.
Pulli geval huna (S.)=Spotted house gecko.

Head large, depressed; body moderate; lateral fold present; tail subcylindrical, gently depressed at base. Nostril surrounded by rostral first labial and 3 or 4 nasals; eye closer to ear than to nostril. Ear subovate, oblique, about as large as first supralabial. Rostral subquadrangular, its width somewhat greater than twice its depth, with a median sulcus extending below mid-depth. Supralabials 8 to 10; infralabials 7 to 9. Mental subtriangular or subpentagonal, with 2

pairs of enlarged chin shields, of which the first are broadly contiguous behind its apex. Snout 1·4 times eye, interorbital space slightly concave. Cephalic granules largest on snout where they are strongly convex and feebly carinate. Occiput with fine granules intermixed with convex or conical tubercles, which become larger on body dorsally, where they are somewhat smaller than ear opening, trihedral and in 16 to 20 longitudinal rows. A few tubercles on hind limbs. Tail with 8 longitudinal rows of pointed carinate tubercles dorsally. Gular granules small, smooth; ventral scales smooth, imbricate, faintly enlarged in preanal region. A median row of enlarged subcaudals. Males with 13 femoral pores separated, by 3 scales mesially, from those of opposite side. Inner digits with 4 to 6 bifid lamellae, fourth with 6 to 8.

Colours. A uniform, light yellowish brown, or mottled, with 3 longitudinal rows of irregular dark brown spots which are smaller than eye. Young with a scattering of light coloured tubercles. A broken lateral band of brown from snout to ear or axilla; labials brown, with light margins. Ventrals greyish pink dusted with brown.

Dimensions. Snout 7 mm., snout to ear 13 mm., snout to cloaca 52 mm., axilla to groin 24 mm., tail 55 mm., arm 17 mm., tail 22 mm.

Reproduction. Two eggs laid at a time 9 by 7 mm., September 17th, 1931, in a Colombo house. Mature embryo with tubercles well developed. Openings of two subcaudal glands conspicuous.

Distribution. A common house gecko. Mankulam, Jaffna (N.P.), Chilaw (N.W.P.), Polonnaruva (N.C.P.), Kantalai (E.P.), Vakvella, Palutupana (S.P.), Colombo (W.P.).

Ceylon, India, South China, Singapore, Borneo, Flores, Africa.

Hemidactylus leschenaulti Dum. et Bibr. Plate LXIII

Hemidactylus leschenaultii Dum. et Bibr. Esp. Gen. III. 1836
Hemidactylus coctaei, part, Günther, Rept. Brit. Ind. 1864
Hemidactylus kelaartii Theobald, Cat. Rept. As. Soc. Mus. 1876

Kabara huna (S.)=Kabarégoya gecko.

Head large, depressed; body of moderate length; stout, with a lateral fold; tail depressed with rounded edges; nostril surrounded by rostral, first labial and three nasals; eye with prominent supraorbital ridges and midway between ear and nostril. Ear large, subovate, vertical, about one-sixth of orbit. Rostral subquadrangular, its width greater than twice its depth, with a median groove and sulcus which descends to middle of depth; supralabials 10 to 12; infralabials 8 to 9. Mental triangular with a pair of enlarged chin shields which are contiguous behind its apex, followed by a smaller pair. Snout 1·5 times orbit; interorbital space flat or slightly concave; cephalic granules largest on snout. Dorsally head and body covered with fine granules,

at times round tubercles intermixed on body especially over hips. Six longitudinal rows of conical tubercles on tail. Throat with granules, ventral scales smooth, imbricate, about one-third of ear opening in size ; an enlarged row of subcaudals. Males with 12 to 19 femoral pores on each side. Digits rather long, depressed, with bifid lamellae, 6 on inner digit and 10 on fourth digit ; distal joint long and compressed.

Colours. Darker in young, more silvery grey with age. Dorsally a pale bluish grey with a vertebral row of 5 large rhomboidal spots, set in "W" shaped reticulate dark cross bands on body. About 8 bands on tail, 5 or 6 on each limb. A dark line from eye to ear continued as lateral band. Head reticulate with brown, the subdigital lamellae bluish. The rhomboidal spots break up into reticulation with age and all dark marks become very indistinct. Silvery white ventrally.

Dimensions. Snout 12 mm., snout to ear 23 mm., snout to cloaca 79 mm., axilla to groin 39 mm., tail 70 mm., arm 36 mm., leg 40 mm. The most heavily built Ceylon gecko.

Distribution. Has been mistaken by several workers for *Hemidactylus coctaei* Dum. et Bibr., a form which does not occur in Ceylon. *Hemidactylus leschenaulti* is found on trees, principally Suriya (S.) *Thespesia populnea* and Kumbuk (S.) *Terminalia glabra* and in houses. It is common in the dry zone and appears at about 5·30 p.m.

Neerodumunnai, Trincomalee, Batticaloa, Kantalai (E.P.), Point Pedro, Jaffna, Elephant Pass, Mankulam, Killinochchi (N.P.), Polonnaruva (N.C.P.).

Ceylon, India.

Hemidactylus depressus Gray — Plate LVIII

Hemidactylus depressus Gray, Zool. Misc, 1829.
Hāli huna (S.)

Head large, depressed ; body moderate with lateral fold feebly defined ; tail feebly depressed in adults, with angular serrate edges. Nostril surrounded by rostral, first labial, supranasal and several smaller scales. Eye midway between nostril and ear. Ear oblique, rather small, about one-eighth of orbit. Rostral quadrangular, its width less than twice its depth with a median sulcus which descends to middle of depth. Supralabials 11 or 12 ; infralabials 8 to 10. Mental triangular or subpentagonal, with a pair of enlarged chin shields widely contiguous behind its apex, for a distance equal to length of mental, followed by another enlarged pair. (Plate LV II, fig. 6). Snout 1·5 to 2 orbits, interorbital space flat, or faintly concave. Cephalic granules largest on snout ; back of head with a few small conical tubercles. Granules conical,

with about 16-20 longitudinal rows of trihedral tubercles each about one-fifth eye diameter, on neck and body. A few tubercles on all limbs. Tail with 6 or 8 longitudinal rows of acutely conical tubercles, which form a serrate edge on each side. Gular granules conical, ventrals, smooth, imbricate scales which are feebly enlarged in preanal region. Subcaudals imbricate with an enlarged median row. Males with 17 to 20 femoral pores on each side separated from opposite set by 3 or 4 scales. Digits rather short, faintly webbed at base; subdigital lamellae bifid, 7 on inner and 10 on fourth digit.

Colours. Reddish yellow with 5 dark brown crosses on body. Their points of intersection form five vertebral spots with light centres 6 to 10 annuli on tail. Limbs reticulate with brown. A dark brown lateral band from snout to ear with a white band above it meets its fellow from the opposite side at back of head. Ventrally pink to greyish white. Young with 5 broad dark cross bands on body which are slightly narrower than interspaces. A light vertebral blotch on each ; while the white lateral band on head is very conspicuous. In old specimens dark markings vague.

Dimensions. Snout 10 mm., snout to ear 22 mm., snout to cloaca 81 mm., axilla to groin 36 mm., tail 89 mm., arm 29 mm., leg 34 mm.

Distribution. Houses and trees. Kantalai (E.P.), Maho (N.C.P.), Mankulam (N.P.), Alutnuvara (U.P.), Hunugalla, Elkaduva, Ratota, Gammaduva, Kandy (C.P.), Vakvella, Palutupana (S.P.), Balangoda (Sab. P.), Vannativillu (N.W.P.).

Ceylon, Malay Peninsula.[1]

Hemidactylus triedrus (Daudin) Plates LVIII, LXIV

Gecko triedrus Daudin, Hist. Rept. IV. 1803.
Kimbul huna (S.) = Crocodile gecko.

Head large, depressed ; body moderate with indistinct lateral fold ; tail subcylindrical, feebly depressed at base, nostril surrounded by rostral, first labial, supranasal and several small scales ; eye with prominent supraorbital ridges and closer to ear than to snout tip. Ear large, subovate, oblique and a quarter or third of orbit. Rostral subquadrangular, its width greater than twice its depth, the median sulcus descending to mid-depth or lower. Supralabials 8 to 10, infralabials 7 or 8. Mental triangular, with two enlarged chin shields contiguous behind its apex, followed by a smaller pair. (Plate LVIII, fig. 7). Snout 1·5 times orbit and covered with large convex granules. Interorbital space flat or slightly concave ; canthus rostralis prominent, rounded. Cephalic granules

1. Not mentioned by de Rooij although Boulenger records it from the Malay Archipelago.

largest on snout, occiput with small tubercles. Dorsally, body covered with small flat granules, and large trihedral tubercles which equal one-third of orbit and are in 16 to 20 longitudinal rows. These are small on head and neck, absent on arms, present on legs with six longitudinal rows on tail. Ventrals smooth, imbricate, as large as quarter of eye; an enlarged row of subcaudals. Digits short, depressed, with bifid inferior lamellae, 4 to 6 on inner and 7 to 8 on fourth digit. Males with 6 to 9 femoral and preanal pores on each side.

Colours. Dorsally, a yellowish olive to purplish brown with 5 or 6 smoky black irregular cross bars, as wide as interspaces and scattered with black ringed white spots which occupy the tubercles, on neck and body. Tail with ten to thirteen similar bands. A white band from nostril to eye, present or absent, and a dark band bounded by white spots beneath it, which may continue as an irregular lateral band. 4 or 5 cross bands of white spots on each limb. Ventrally a pale purplish grey. Iris golden brown. Young with five " W " shaped black dorsal bands and a brown band along back of each thigh.

Dimensions. Snout 11 mm., snout to ear 22 mm., snout to cloaca 81 mm., axilla to groin 40 mm., tail (regenerated) 50 mm., arm 25 mm., leg 27 mm.

Reproduction. According to Kelaart it lays from three to six eggs, slightly larger than those of *Hemidactylus frenatus*. The young roughly resemble those of *H. depressus* in colour.

Distribution. Generally found in pairs. From the plains up to 3,000 feet. A pair taken in a room at Murungan (N.P.), another pair dug up from a termite hillock near Colombo (W.P.). Termites appear to be its favourite food.

Neerodumunnai, Trincomalee (E.P.), Pallaiwalla (S.P.), Kumbalgamuva, Kandy (C.P).

Ceylon, India.

Genus **PEROPUS** Wiegmann

Pupil vertical. Body, limbs and tail depressed. Limbs moderate; digits partially webbed, the basal joints depressed and dilated. Distal phalanges cylindrical, short, originate from within basal dilation. Distal phalange of inner digit vestigial, with, or without, a claw; subdigital lamellae bifid. Body with granules dorsally. A distinct dermal web connects hind edge of thigh and calf in adult. Tail lanceolate, feebly convex dorsally, flat ventrally with carinate lateral edges. Males with femoral or preanal pores.

Peropus mutilatus (Weigmann) Plate LVIII

Hemidactylus (*Peropus*) *mutilatus* Weigm., Nov. Acta Ac. Leop. Carol XVII, 1835.

Gehyra mutilata Bouleng. Cat. Liz. I, 1885.

Peropus mutilatus Barbour, Mem. Mus. Comp. Zool. Harvard XLIV, 1912

Sudhu geval huna (S.)=White house gecko.

Head moderate, body stout, depressed with a lateral fold; tail strongly depressed with acute outer edge. Limbs short, adult with a web of skin connecting calf to thigh. Nostril surrounded by rostral, first labial and three nasals, of which the supranasals are enlarged and in contact mesially. Eye midway between nostril and ear, the latter about a fifth of orbit and round or oblique. Rostral subquadrangular, twice as wide as deep, the dorsal sulcus not descending below mid-depth. Supralabials 7 to 11; infralabials 7 to 8. Mental triangular followed by 2, or usually 3, pairs of chin shields, which end nearly level with each other posteriorly and in the adult occupy nearly one-third of gular surface; the inner pair very broadly contiguous behind apex of mental. Snout rather depressed; forehead flat or faintly concave. Dorsally, no tubercles. Cephalic granules enlarged on snout, others small and round; body granules somewhat larger, smooth, round or hexagonal, not much smaller than ventrals. Supracaudals conical granules. Gular granules distinctly imbricate; ventrals small, smooth, imbricate about a third of ear opening. (Plate LVIII, fig. 8). Subcaudals enlarged, smooth, imbricate with an expanded median row. Males, with a continuous row of 30 to 40 femoral and preanal pores, angular in the middle. Digits partially webbed, inner with distal joint vestigial with, or without, claw and attached to middle of basal expansion; the distal joint in other digits clawed and originates within basal expansion. All with bifid sub-digital lamellae; inner digits with 6 to 7, fourth with 8.

Colours. Dorsally, pale cinnamon brown or pinkish grey, with, or without, 2 to 4 longitudinal rows of round, pale yellow or bluish white spots smaller than eye. An indistinct white band from nostril to ear. Tail with, or without, 8 similar annuli which may be complete or broken into spots. Ventrally, pale pink; scales at times dusted with brown.

Young, light brown with yellow spots dorsally and yellow annuli on tail. A slightly elongate yellow spot behind each eye; labials each with a yellow spot.

Dimensions. Male, snout 6·5 mm., snout to ear 14 mm., snout to cloaca 55 mm, axilla to groin 26 mm, tail 62 mm, leg 20 mm.

Reproduction. Two eggs stuck together terminally; each 10·5 by 8 mm. From Veyangoda, February 5th, 1931, and Colombo, July 27th, 1931. Length of newly hatched young from snout to cloaca 17 mm., tail 17 mm.

Distribution. The commonest Ceylon house gecko found all over Ceylon from Nuwara Eliya (C.P.) to the coast.

Ceylon, Burma, Malay Archipelago, Andamans, New Guinea, Mascarenes, Seychelles, Cuba, Western Mexico, Mauritius, Madagascar, Bismarck Archipelago, Polynesia, d'Entrecasteaux Archipelago.

Genus **COSYMBOTUS** Fitzinger

Pupil vertical. Body, limbs and tail depressed. Limbs moderate; digits more or less webbed, their basal joints depressed and dilated. Distal phalange compressed and originating within extremity of dilated basal part; inner digit small, clawed; subdigital lamellae bifid. Body with granules and at times with tubercles, dorsally. A distinct dermal expansion from axilla to groin, along hind edge of thigh and at times on sides of tail. Males with preanal and femoral pores. Two species known.

Cosymbotus platyurus (Schneider)

Stellio platyurus Schneider, Amph. Phys. 11. 1790.
Hemidactylus platyurus Boulenger, Cat. Liz. 1. 1885.
Cosymbotus platyurus Barbour, Mem. Mus. Comp. Zool. Harvard XLIV. 1912.

This gecko has only been recorded once from Ceylon and has never been found since Kelaart sent some to the British Museum. It is possible that these and the specimen of *Gekko monarchus* were not from Ceylon at all. No specimens have been examined by the writer and the following description is after de Rooij.

Body depressed, with a dermal expansion from axilla to groin and another along posterior edge of hind limb. Tail depressed, flat inferiorly, with a sharp denticulate lateral edge. Nostril surrounded by rostral, first labial and three nasals. Ear small, oval, oblique. Eye closer to ear than to tip of snout. Rostral four sided, not twice as broad as high, a median sulcus above. Supralabials 9 to 11, infralabials 7 to 8. Mental triangular or pentagonal, with two pairs of chin shields, of which the first are larger and contiguous mesially behind apex of mental. Snout 1·5 times orbit, interorbital space concave. Body and tail covered dorsally with uniform granules, which are largest on snout. Ventrally, smooth imbricate scales and an enlarged median row of subcaudals. Males with a continuous line of 34-36 femoral and preanal

pores. Limbs depressed, moderate. Digits dilated and half webbed : inner toe well developed, with 3 to 6 subdigital lamellae : median digits with 7 to 9.

Colours. Grey above marbled with darker, usually a dark lateral band from eye to shoulder. Ventrally white.

Dimensions. Head and body 61 mm., tail 66 mm.

Distribution. Ceylon (?), Himalayas, N.E. India, Burma, Malacca, Indo-China, Philippines, Malay Archipelago.

Genus **LEPIDODACTYLUS** Fitzinger

Pupil vertical. Body, limbs and tail depressed. Digits partially webbed, their basal joints depressed and dilated. Distal phalanges short, compressed and originate from extremity of the basal dilatation. Inner digit clawless. Subdigital lamellae bifid. Body with granules dorsally. Males with femoral or preanal pores.

Lepidodactylus lugubris (Dum. et Bibr.) Plate LVIII

Platydactylus lugubris Dumeril et Bibron, Erp. gen. III. 1836.

Head longer than broad, obtusely acuminate : body rather elongate with short weak limbs, tail depressed with carinate edges. Nostril surrounded by rostral, first labial and three nasals, ear round and larger than ventral scales. Rostral quadrangular, without a median sulcus, its width about 2·5 times its depth, contiguous with supranasals and three internasals. Supralabials 11 to 12 ; infralabials 9 or 10. Mental, subpentagonal, much smaller than rostral, about equal to or smaller than infralabials and bordered posteriorly by four transverse rows of gular scales, which are enlarged into small shields. (Plate LVIII, fig 9). Snout 1·9 to 2 times orbit ; forehead concave ; eye closer to ear than to snout tip. Dorsal granules fine, uniform, without tubercles, largest on snout. Gular granules small ; ventral scales smooth, hexagonal, imbricate, with 4 rows of rather enlarged preanals. Caudal scales subequal and about twice ventral scales ; no enlarged subcaudals ; males with 25 to 31 preanal and femoral pores in a long angular series. Digits partially webbed ; inner toe clawless, moderately developed and with 9 to 10 bifid subdigital lamellae, fourth toe with 12 to 15.

Colours. Dorsally, cinnamon brown, redder tail. Labials with dark margins ; a dark band from snout tip to axilla and three or four brown lines over each eye. About eight " W " shaped dark cross bars, with darker margins, on body and eleven on tail. Limbs and sides reticulate with brown. Ventrally, dirty yellow merging into orange on tail. Some scales dusted with black or brown.

The note of this gecko varies from the cry usual to this family and consists of a prolonged, subdued repetition of the sound "tick" emitted about fifteen or twenty times at a stretch. Its movements are slower than those of most geckoes owing to its short limbs.

Dimensions. Snout 5 mm., snout to ear 11 mm., snout to cloaca 41 mm., axilla to groin 22 mm., tail 34 mm., leg 17 mm.

Reproduction. According to de Rooij two eggs are laid together on leaves. They measure 10 by 7 mm., and newly hatched specimens have more cylindrical tails than the adult.

Distribution. In houses and on trees. Colombo (W.P.), Peradeniya, Gampola (C.P.).

Ceylon, Malay Archipelago, Burma, Nicobars, Andamans, Penang, Bismarck Archipelago, Solomon Islands, Banks New Hebrides, Sandwich Islands, Polynesia.

Genus HEMIPHYLLODACTYLUS Bleeker

Pupil vertical. Body, limbs and tail cylindrical, slender. Digits slender, cylindrical at base, strongly depressed distally with bifid subdigital lamellae. Inner digits vestigial, clawless: the remainder with the terminal phalange free, projecting and clawed. Body with juxtaposed or subimbricate granular scales dorsally, imbricate scales ventrally. Males with preanal pores. A single species.

Hemiphyllodactylus typus Bleeker [1]

Hemiphyllodactylus typus Bleeker, Nat. Tijds. Ned. Ind. XX, 1860.
Lepidodactylus ceylonensis Boulenger, Cat. Liz. 1. pl. XIII. fig. 3. 1885.

Head much longer than broad, body elongate, limbs and tail weak and cylindrical. Nostril surrounded by rostral, first labial and three small nasals ; ear small ovate. Rostral as broad as twice its depth. Upper and lower labials 11 or 12. Mental small, triangular, no chin shields ; snout as long as from eye to ear and 1·5 times orbit. Head and body with very small granules dorsally which are slightly enlarged on snout. Ventrals larger and flat. Tail with uniform small scales and, according to Annandale, prehensile. Digits free, inner vestigial. Median toes with 4 or 5 bifid subdigital lamellae. Male with an angular row of 15 preanal and femoral pores.

Colours. Dorsally brown marbled with darker with small round yellow dots. A dark streak from snout to shoulder passing through eye. A small light spot on each digit. Ventrally dirty white spotted with brown.

1. Not seen by the writer. Description after de Rooij. Dr. Malcolm Smith informs me that *Lepidodactylus ceylonensis* is a synonym for *Hemiphyllodactylus typus* and sends me the measurements of the only Ceylon specimen in the British Museum.

Dimensions. Snout 3·5 mm., snout to ear 8 mm., snout to cloaca 37 mm., tail 32 mm., axilla to groin 18 mm., hind leg 12 mm.

Distribution. Gampola, Peradeniya (C.P.).

Ceylon, Burma, Malacca, Sumatra, Java, Borneo.

Genus **GEKKO** Laurenti

Pupil vertical. Body and tail subcylindrical or slightly depressed. Digits free or partially webbed, strongly dilated basal joints ; distal phalanges very short, compressed ; claws retractile, absent on inner digits. Subdigital lamellae single. Body with juxtaposed, granular scales or tubercles, dorsally. Males with preanal, or femoral pores.

Gekko monarchus (Dum. et Bibr.)

Platydactylus monarchus Dum. et Bibr., Erp. Gen. III, 1836

A single specimen sent by Kelaart to the British Museum has been reported as from Ceylon, but the species has never been taken since. Much doubt exists as to whether the locality label of this specimen was correct. This description is from Boulenger's Fauna of British India. Head and body moderate ; tail slightly depressed. Nostril surrounded by rostral and first labial ; eye closer to ear than to snout tip ; ear oval, oblique and one-third of orbit. Supralabials 10 to 11 ; infralabials 9 or 10. Mental subtriangular, with the first pair of chin shields enlarged and three times as long as broad, followed by a few smaller, irregular shields. Snout 1·6 times orbit ; interorbital space concave. Cephalic granules rather large on snout, rest very small with a few larger intermixed. Dorsally, small granules on body and limbs intermixed with numerous irregular, conical tubercles ; tail with annulate rows of small flat, granular scales and transverse series of conical tubercles directed backward. Gular granules very small ; abdominal scales moderate ; subcaudals large, irregular, expanded. 12 to 14 transverse rows of supra-caudals ; 3 to 4 subcaudals in each caudal annulus. Femoral and preanal pores in a long series 16 to 20 on each side.

Colours. Brown or grey spotted with blackish, a double row of vertebral spots. Tail with alternating dark and light annuli. Ventrally whitish.

Dimensions. Snout to vent 3·25 inches, tail 4·16 inches.

Distribution. Ceylon (?), Malay Peninsula and Archipelago.

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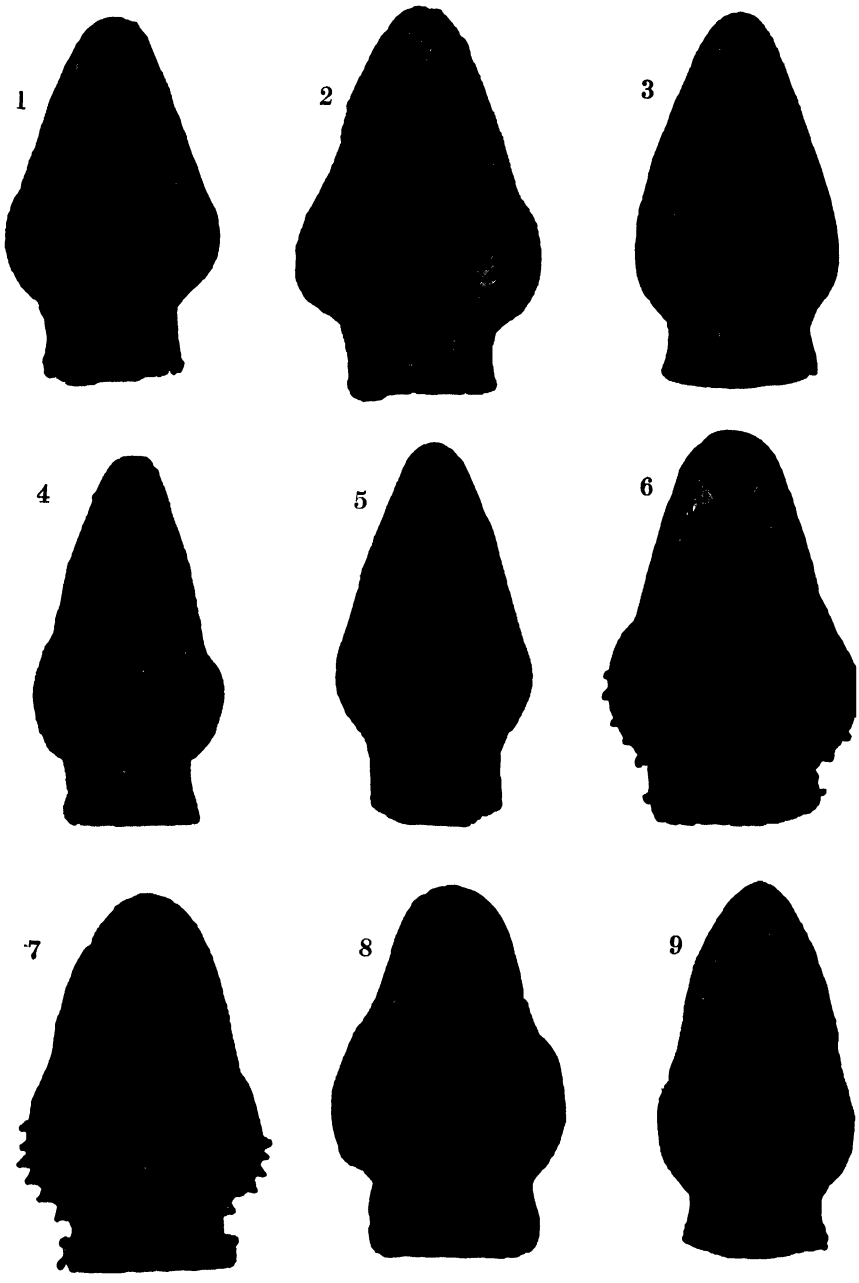
EXPLANATION OF PLATES

Plate LVIII. Chin shields of Ceylon Geckoes 1·5
Fig. 1. *Gymnodactylus triedrus*
Fig. 2. *Gymnodactylus frenatus* × 1·3
Fig. 3. *Gonatodes jerdoni* × 7
Fig. 4. *Gonatodes kandianus* × 7
Fig. 5. *Gonatodes kandianus* var. *gracilis* × 7
Fig. 6. *Hemidactylus depressus* × 1·4
Fig. 7. *Hemidactylus triedrus* 1·2
Fig. 8. *Peropus mutilatus* 2·5
Fig. 9. *Lepidodactylus lugubris* × 4

Plate LIX *Gymnodactylus nebulosus* × 1·75
Plate LX *Gymnodactylus frenatus* × 1
Plate LXI *Gymnodactylus triedrus* × 1·4
Plate LXII *Hemidactylus frenatus* × 3
Plate LXIII *Hemidactylus leschenaulti* × 1
Plate LXIV *Hemidactylus triedrus* × 1



P. Deraniyagala del.

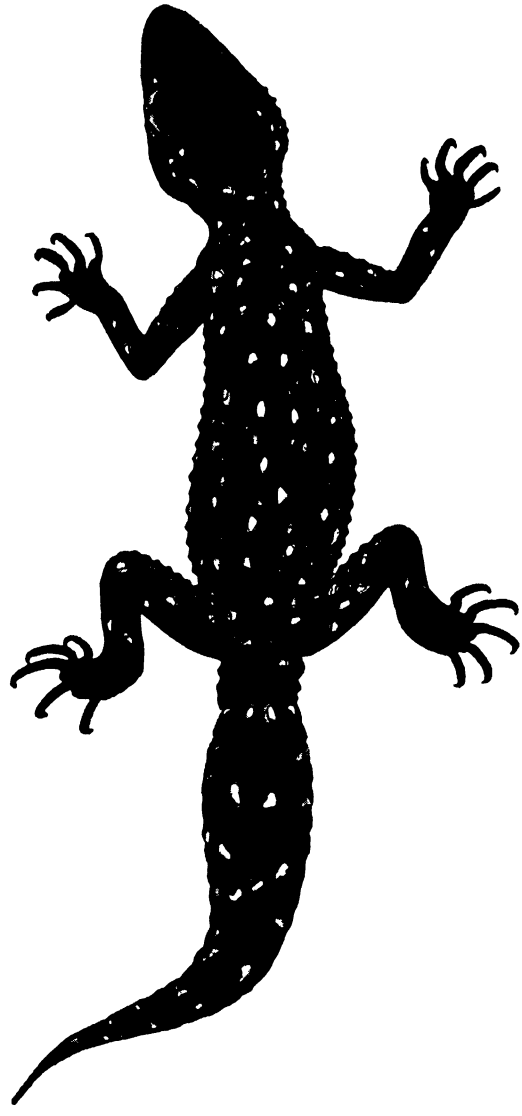
Chin shields of Ceylon Geckoes

P. Deraniyagala del.

Gymnodactylus nebulosus

P. Deraniyagala del.

Gymnodactylus frenatus



P. Deraniyagala del.

Gymnodactylus triedrus

P. Deraniyagala del.

Hemidactylus frenatus

P. Deraniyagala del.

Hemidactylus leschenaulti

P. Deraniyagala del.

Hemidactylus triedrus

The External Characters of the Bonnet Monkeys of India and Ceylon

BY

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WITH ONE PLATE

In none of the classical works on the Primates, nor in the works dealing with the animals of the Oriental region, is there a good account of the contrast in external characters of the two forms of Bonnet Monkey. Most of the descriptions of the Indian and Ceylon Bonnet Monkeys are, in my opinion, based on characters that are too liable to individual, sexual or age variation, as for example, hair-colour, redness of face or proportionate length of tail. The only "safe" character that is made consistent use of is the form of the "bonnet." This is a very important item, but anyone with more than a passing acquaintance with these monkeys will agree that the differences between them are far deeper than mere alteration in the shape of the "bonnet," in fact even a casual observer could not help noticing the difference between the two. Yet in turning up one of the well-known accounts to find exactly what the differences consist of, very little genuine information can be obtained, and such characters as are used are found to be put forward with hesitancy, or else they are found to be variable. This ambiguity is due, I think, to the fact that these descriptions are based on dried skins rather than on the living animal. The best account, and that making use of the greatest number of "safe" characters, is that of H. O. Forbes (4), but even here the descriptions are short, incomplete, and in places, indecisive. The more recent standard monograph by D. G. Elliot(3) has its descriptions based on previous work,and on an apparently small number of very old dried skins. In the case of the Bonnet Monkeys, Elliot goes as far as to choose isolated skins and describe them as typical of the species, regardless of individual or other variations. But all who are at all well acquainted with the genera and species of Monkeys are aware, as pointed out by Pocock (10), that the work of Elliot is in many respects very unreliable.

One effect of these earlier descriptions is that, although in most of them the Indian and Ceylon Bonnet Monkeys are ranked as separate species, a very serious doubt is left in the mind as to whether or not they are merely geographical races of a single form. Blanford (2) definitely expresses this view and confesses his belief that there are no constant differences between them. Even as recently as 1925 Pocock (9) has tentatively put forth a similar view, *i.e.*, that they are " perhaps local forms of a single species." There can, of course, be no doubt that in the first place the differences between these two monkeys arose as a result of geographical separation ; but the question arises as to whether the degree of differentiation between them has become fixed and constant, and of an order sufficiently great to rank the Ceylon form as a species, or only as a subspecies. My object in this paper is to prove that the older works were correct in regarding the two as separate species ; and at the same time to specify the constant distinguishing characters between them, sifting the older lists of characters, and amplifying the description of those characters that I consider important. In addition I hope to draw attention to one or two new and finer points of demarcation between these two specific forms. I have also made an attempt herein to figure some of the characters of the " bonnet" and its related parts, for this does not appear to have been done hitherto.

NOMENCLATURE

In dealing with any group of monkeys in recent years the matter of terminology has been a difficult one, and in no group is it more serious than in the Macaques, to which group the Bonnet Monkeys belong. J. A. Allen (1) showed fairly conclusively that the proper generic term for the Macaques should be *Silenus* (Goldfuss, 1820), and that Elliot's usage of the name *Pithecus* was wholly unjustified. In the same year, however, O. Thomas (11) reviewed the question of naming the chief groups of Old World Monkeys, and advocated the use of the well-known name *Macaca* for the Macaques, provided that the Linnaean title *Simia* is dropped, as indeed it ought to be. At the same time, he urged the use of the term *Pithecus* to supplant the familiar, but invalid name *Semnopithecus*, for the Langurs. As Thomas's judgment has almost universally been followed by British zoologists, I adopt the term *Macaca* (Lac., 1799) for the Macaques.

Numerous authors have endeavoured to divide the Macaques into subgenera, and amongst these the Bonnet Monkeys stand well apart as long-tailed Macaques with the hair on the crown arranged in radiating fashion from a central point. Reichenbach (1862) proposed the term

Zati as a subgeneric title to include them. Pocock (9) has recently shown that the subgenus is also characterised by the peculiar form of the glans penis, and on these grounds his most recent opinion is that *Zati* should have full generic rank.

With regard to specific titles of the two forms of Bonnet Monkey, I have followed the suggestions given by Hinton and Wroughton (5), in 1921. They showed conclusively that *M. sinica*, L., should stand for the Ceylon Monkey, whilst the next available name for the Madras Macaque is *M. radiata*, Geoffr.

The subgenus **Zati**, Rchnb., 1862

The subgenus *Zati* includes the two species of Bonnet Monkey, the true or South Indian Bonnet Monkey, or Madras Macaque; and the Ceylon Bonnet Monkey or Toque. These two are closely related by a number of important characters common to both; whilst at the same time they differ in these characters from all other Macaques. The following characterisation of the subgenus is based on that given by Pocock (9), but is supplemented by additional notes from my own observations:

1. Hair on the vertex arranged in a radiating manner from a central bare spot, so as to form a definite "pileum," popularly termed the "bonnet." In both forms, I find that the central bare spot is in adults about 1 cm. in front of a line joining the two external auditory meatuses.

2. Forehead and cheeks thinly haired, but not "nearly naked" as stated by Pocock.

3. Tail stout and as long as the head and body together. This is the longest tail to be found in any Macaque, for as a general rule Macaques are short-tailed animals. There are no constant differences in the length of tail between the two forms of *Zati*, as has been repeatedly affirmed by earlier writers.

4. No naked skin around the ischial callosities.

5. Glans penis has a raised crescentic corona glandis, whilst the anterior and lower part of the glans is produced to form a vertical ridge, with the vertical external meatus of the urethra upon it.

6. Pocock (9) describes a catamenial swelling in the female. In an earlier paper (8) he states that there is no haemorrhage accompanying menstruation in Bonnet Monkeys. My experience is the opposite in both these respects. There is no obvious pudendal swelling accompanying the sexual cycle in Bonnet Monkeys such as occurs in many other monkeys; but I have repeatedly seen haemorrhage at six-week to two-month intervals in both kinds of Bonnet Monkey. Recent work by Zuckerman (12) and by Parkes and Zuckerman (6) has shown that Bonnet Monkeys are peculiar in having a thick leucorrhoeic vaginal

discharge at all times, irrespective of whether the animal is menstruating or not. The discharge is put down as a secretion of the cervix uteri. My observations confirm the presence of this discharge in both Indian and Ceylon animals, and I have noticed that it occurs before the animal reaches puberty. It likewise continues unabated during pregnancy. In some individuals the secretion is more mucoid and transparent, whilst in others it is thick and opaque. It has a characteristic odour, and appears to function as an attraction to the male.

With regard to the time of onset of puberty in Bonnet Monkeys, there are few data to go on, but I would remark, supplementing a note in Pocock's paper on the subject (8), that the testicles, in the male, are not in the scrotum at birth, in fact there is no scrotum till puberty, when the testicles descend. Prior to this event there is merely a transverse duplicature of skin in the position of the future scrotum. I have observed the process of descent in examples of both animals in captivity, and have noted that the descent of the testes takes some months to be completed, and for a time the glands are capable of being withdrawn into the inguinal canal. Even in old males the testes are extremely retractile, though not into the canal. In certain psychological states, such as anger and fear, the organs are withdrawn well above the base of the penis.

Macaca (Zati) radiata, Geoffr.

The South Indian Bonnet Monkey

This animal differs markedly from its Ceylon relative. Phillips (7) merely states that it differs in size and colour. Forbes (4) and Elliot (3) lay most stress on the shape of the "bonnet" and the colour of the hair in discriminating them. It is stated in both accounts that the Ceylon form is redder than the Indian, but I maintain that hair colouration in both forms is too variable to give a safe diagnosis. True, Ceylon monkeys are, on the average, redder than Indian ones, but even Elliot describes the Indian form as of a "general reddish brown hue." Body size again is a poor criterion, since old Ceylon monkeys may grow as large as Indian ones.

After sifting all the characters carefully, I have come to the conclusion that the following present the best diagnosis for the Indian Bonnet Monkey :—

General Form. Sturdily built. Thorax deeper and shoulders broader than in *M. sinica*. Limbs stout. Tail long. Face prominent, but cheeks hollowed.

Skin pigmentation. Face, lips and ears dirty flesh colour. Palms of hands and soles of feet brownish flesh colour. Dorsum of hands and feet darker, pigment extending some distance up forearm and leg. Dorsum of tail nearly black. Nails black. Callosities bright pink. Neck and scrotum unpigmented. Rest of ventral surface of trunk and inner aspects of limbs sky-blue.

Hair. Body covered thickly with dense coat of fine crisp or slightly wavy hair. Lateral aspects of limbs similar. Ventral surface of trunk and medial surfaces of limbs less thickly clothed.

Vertex of head has hair arranged in radiating manner, as in fig. 3. Hairs on the anterior part of the rosette are only half as long as elsewhere, so as not to cover the forehead. In front of the rosette there are some dark hairs arranged in the primitive manner, *i.e.*, with a central parting. They do not extend far laterally. The supraorbital ridges have a few stiff black hairs also tending to point laterally. Face elsewhere is covered sparsely with stiff black hairs. These are much more numerous but softer in texture than in the Ceylon Monkey.

Colour of Hair. General colour of upper parts, and of outer aspects of limbs, olive-grey, inclining to yellowish or rufous on the shoulders, especially in females. Each hair on these parts is grey at its base and for 2/3 of its length, thereafter ringed alternately with dirty yellow and black or grey. "Bonnet" darker and more uniformly coloured. Tail grey above, paler below and at tip. Dorsum of hands and feet covered with silvery-grey hairs, sometimes inclining to yellowish.

Ventral aspect of trunk and neck, and inner surfaces of limbs dirty white. No white hairs in pre-auricular region, or between ears and "bonnet." This is in great contrast with the Ceylon Monkey. Hairs on face and cheeks black. Numerous black hairs on ears.

Sexual Differences. As stated by Elliot the female has a paler coat than the male. She inclines more to yellow on the upper parts, and therefore approaches the Ceylon animal in colour. She can, however, easily be distinguished by her pale flesh-coloured face and ears. I would not go as far as to say, with Elliot, that the female differs in having a lesser tendency to alternation of colours on the individual hairs. I have seen females with a slight purplish pigmentation of the lips. I suspect them to have been pregnant, which condition will account for a temporary pigmentation, as in the human female. Such pigmentation is thus not comparable with the dark pigmentation so characteristic of the Ceylon Bonnet Monkey.

Macaca (Zati) sinica, L.

The Ceylon Bonnet Monkey or Toque

In many descriptions of these monkeys, the Ceylon animal is said to be smaller than its Indian relative. This statement is obviously based on insufficient living material. Old male Toque Monkeys grow as large as their Indian fellows, though an apparent smallness is rendered evident by their less sturdy build. Probably total body weight would prove to be far less in a Toque, than in a Madras Macaque of corresponding sex and age.

Ceylon Macaques are generally described as redder than Madras Macaques. This in the main is true, but the distinction is liable to great variability in degree. Toques are very variable in their coat-colours, both from individual to individual, and also in the same individual at different times of the year. Most are washed with reddish or orange on the tips of the hairs of the back, pileum and outer aspects of the limbs, but some are duller, and the red effect is not outstanding, these individuals thus approaching the olive or greyish general colour exhibited by the Madras Macaque. On the contrary there is often a suffusion of yellowish hair on the shoulders in the Indian species ; whilst in the female Indian Bonnet Monkey, this yellow is frequent, and may incline to rufous in parts.

Another character that has been assigned to the Toque Monkey is a red face. Elliot lays great stress on this. I regard it as not excessively common. Red faces are seen in wild and captive Toques, but they are not constant even in the same individual at all times. Personally I have only seen the condition in mature or maturing females. Males have very pallid faces. In developing a red face a young female usually shows the first signs on the nose. From this the condition may spread as a generalised diffuse erythema ; or it may appear as an irregularly distributed macular eruption. The region round the eyes always remains pallid. I have seen the macular type of reddening on the face of a mature female Madras Macaque.

A fourth factor I wish to condemn is the ratio between tail-length and body-length. There is no constant difference between the two Bonnet Monkeys in this respect. Both have long tails, but in both the tail length is variable from individual to individual. I have seen Indian Monkeys with tails longer than Ceylon animals of the same body size.

None of the above four characters that have been previously utilised in distinguishing the Ceylon and Indian forms of Bonnet Monkey

are to be deemed "safe." I therefore suggest the following outline of the characters of *M. sinica* :—

General form. As large as, but less sturdily built than, *M. radiata.* Shoulders narrower, thorax less deep and limbs slenderer. Face prominent, but more square-cut on account of the cheeks being less hollowed out than in *M. radiata.* Ears not so prominent as in *M. radiata,* but more prominent in males than females.

Skin-pigmentation. Face dirty flesh colour, but not so muddy as in the Madras Macaque. There are often scattered black spots on the face. Both upper and lower lips in the adult have their margins deeply pigmented with black (Forbes mentions this in the upper lip only). In young specimens the pigmentation of the lips is only faintly marked, but increases with age. It can always be detected in the living animal by everting the lips slightly. Margins of eyelids pigmented in the same way. Conjunctiva pigmented up to the cornea. Ears very deeply pigmented (not merely "blackish" as indicated by Forbes. This is one of the most obvious characters of the Toque Monkey. The whole auricle may not be black ; the tragus being frequently unpigmented, and always in the new-born young and in the adult female. Even in old males the tragus is less evenly pigmented than the rest of the external ear). Skin around the attachment of the auricle is unpigmented.

Hands, feet and tail pigmented black. Palms and soles paler than dorsum. On the extensor surfaces of the forearm and leg, the skin-pigmentation reaches as high up as the elbow and knee respectively. This is considerably further than the corresponding pigmentation reaches in *M. radiata,* and at the same time is much darker. Nails black. Ventral aspect of trunk and neck, and medial surfaces of limbs sky-blue. Nipples slaty blue. Scrotum never pigmented. Callosities dirty flesh colour.

Hair. Dorsal aspect of trunk and lateral surfaces of limbs well clothed. Ventral surface of trunk and medial sides of limbs more sparsely haired. Dorsal areas are covered with a coarser, wavier hair than in *M. radiata.*

Pileum arranged as in fig. 2. The centre of the rosette is situated in the same position as in the Indian Bonnet Monkey. There is an appreciable bare area in the centre, and the skin of this area is pigmented brown. All the hairs radiating from this spot are of equal length, so that the cap is more symmetrical than in the Indian form, and the forehead is covered to a greater extent. Forbes mentions that the "bonnet" occasionally forms an erect tuft. I presume that he refers to the fact that the fore part of this structure is occasionally raised to a higher level instead of lying adpressed on the skull. I do not understand the statement made by Phillips and others that the Toque's

"bonnet" shows a median parting. If the hairs are arranged in a radiating manner, they cannot well form a parting in addition. I imagine that the reference is to the hairs lying immediately beneath the fore part of the pileum. These are well developed and arranged transversely with a median parting, just as the same hairs are in the Indian animal, the only difference being that in *M. radiata* they are exposed, whilst in *M. sinica* they are hidden by the long hairs of the anterior part of the "bonnet," contrary to the statement made by Hinton and Wroughton (5).

The face has numerous scattered hairs, but these are less in number, and more bristly than in the Madras Macaque. Some are of the nature of degenerate sinus hairs. They are found on the chin, lips and supraciliary ridges.

Colour of Hair. General colour of upper parts and outer aspects of limbs reddish or chestnut in adult specimens. Becoming more rufous on shoulders and on proximal segments of limbs. Yellower in younger specimens ; but tending more to olive with age. Very aged animals approach the Indian Monkey in colour. Each hair is grey at the base, and is then alternately ringed with yellow and grey, or chestnut and grey. In some the basal 2/3 is black.

On the neck the dark dorsal hairs are restricted to a narrow band. This broadens out anteriorly into the "bonnet," which has the same general colour as the rest of the upper surface. The "bonnet," however, may show alternate zonings of colour corresponding to the alternations on its constituent hairs. It is yellow or red at the centre, followed peripherally by zones of grey and yellow or red. These colours are, however, variable. In the new-born animal the "bonnet" is uniformly dark, and the hairs in it are arranged in a whorl rather than in a rosette.

Hairs on the ventral aspects of the trunk, neck, and inner surfaces of the limbs are clear white. There are also white hairs, with a few dark ones interspersed, forming a characteristic whorl on the preauricular region. These hairs extend backwards around the base of the auricle, and dorsal to the auricle they form a light band between it and the constricted dark band on the mid-line of the neck dorsally. This is the arrangement which Forbes briefly dismisses with the statement that a " space " about the ears is whitish. It is in great contrast with the condition in the Indian Bonnet Monkey.

Hairs on dorsum of hands and feet yellowish. Tail hairs blackish at base, becoming silvery grey or yellowish towards tip of tail. Whitish below.

Sexual differences. The male is on the average a third larger than the female, and more powerfully built. He has a more square-cut muzzle, higher supraciliary ridges, and the eyes are wider apart. The

female tends to be less heavily pigmented, but there are variations in both sexes in this character. The tragus of the ear is generally unpigmented in the female. The ears are more prominent in the male than the female. Forbes states that the limbs are redder in the female, but this is not the case. He also refers to a patchy indigo-blue pigmentation of the chest and belly in the female. As I have already pointed out, there is a blue pigmentation in both sexes, as in the Madras Macaque. This is not more pronounced in the female than in the male, and does not appear to become exaggerated during pregnancy, as is the case with similar pigmentations in the human female.

Characters of the Young. The newly born young has a fairly uniformly coloured coat of olive brown, with a slight yellowish or orange wash on the shoulders and outer sides of the limbs. The bonnet is much simpler in design, having rather the nature of a whorl than a radiation like that seen in the adult (see fig.1). The "bonnet," moreover, does not extend so far forward as in the adult, and leaves the transversely running hairs with the median parting fully exposed, as in the adult of the Indian species. As the animal grows the front part of the bonnet generally becomes porrect in some degree, later still becoming closely adpressed to the skull.

Pigmentation of the skin is practically absent at birth except for a slight brownish tinge on the naked parts of the hands and feet. The characteristic pigmentation of the lips, ears, eyelids, etc., does not commence to show until the animal is about three months old. In commencing, the pigmentation appears as a diffuse brownish tinge, later deepening to jet black. In the case of the ears, the flat part becomes pigmented first and the tragus last. As already indicated, the tragus may remain white throughout life, especially in the female.

SUMMARY AND CONCLUSIONS

I have endeavoured to show in the foregoing account that :—

1. The two forms of Bonnet Monkey have hitherto been insufficiently characterised, because the factors made use of are too variable.

2. There are, besides the form of the pileum, a number of constant distinguishing features.

3. These features taken together are sufficient to warrant specific rank for both forms.

4. The safest diagnostic signs are those relating to pigmentation of the skin.

The specific characters of the two Bonnet Monkeys may be shortly summarised thus—

Character	*M. radiata*	*M. sinica*
1. Pileum	Does not cover forehead	Covers forehead to supraciliary ridges
2. Face	Muddy flesh colour with soft black hairs	Pale flesh colour with bristly hairs
3. Lips	Unpigmented	Margins black
4. Ears	Prominent, but unpigmented	Black ; less prominent
5. Periauricular hairs	Dark	Well-marked white tract between ears and pileum and dark dorsal hairs of neck

The study of the specific differences between the Madras and Ceylon Macaques, and the mode of appearance of the specific characters in the young Ceylon animal leads me to the conclusion that the latter animal is a more specialised form that has developed new features as a result of geographic separation from the primitive stock. This stock is represented to-day by the living Madras Macaque. None of the characters in the above table are present in the foetal *M. sinica*, nor even at birth. All are the product of post-natal development in just the same way as many of the features peculiar to adult human anatomy are developed only during early childhood. The only way in which the Madras animal has progressed beyond the typical Macacine form is in the shape of the pileum. In the Ceylon animal the distortion of the pileum from the simple antero-posterior hair tract is even more advanced than in the Madras form. In addition the Ceylon Macaque has developed a dark pigmentation of the skin in many of the naked parts, and probably this in time will lead to a complete blackening of such parts, as is indicated by the fact that scattered black spots tend to develop anywhere on the face, in addition to the constant pigmentation of the lip and eyelid-margins and the auricles, and naked parts of hands and feet. As pointed out above, these parts are all unpigmented in the new-born, the pigmentation appearing gradually after about the third post-natal month.

In closing I may add that the two Bonnet Monkeys interbreed freely. This does not affect their specific rank, for many other species will interbreed in like manner, both with one another and with the Bonnet

Monkeys. In this connection it occurs to me incidentally that from a specimen in my possession of a full term foetus, the result of a cross between a Madras Macaque and a Crab-eating Macaque (*M. ira*), I noticed that the "bonnet" is transmitted to the offspring in the whorl-like condition usually present in the pure-bred Bonnet Monkey. I therefore suspect that this new type of hair arrangement is genetically dominant to the normal arrangement in the Crab-eating Macaque.

Whilst this paper has been passing through the press, there has appeared another on the same subject by R. I. Pocock (Journ. Bombay Nat. Hist. Soc., Sept., 1931). Pocock covers but little of the ground dealt with in this contribution, but one or two points need mention. He appears to have made no further observations on the differences between the Indian and Ceylon Macaques, except that he has drawn attention to the characteristic whorl of hair in front of the ears in the Toque, and to which I have made allusion on p. 318 of this paper. Pocock still expresses his view that these two monkeys are probably races of one species, and yet proceeds immediately to treat them as separate species, and even to split up both of them into a number of geographical races. He is surely very premature in doing this. He apparently has only a small number of dried skins on which to base his observations, and commits all the indiscretions of former systematists by not comparing the skins with the living animal. Until this is done it is useless to work out local races when even the species has not been properly defined. I trust that my paper supplies the latter defect, and I hope later to check Pocock's observations on local races by future work on living animals or at least complete carcases.[1] Possibly some of these races are valid, but as far as the Ceylon form is concerned, it seems very unlikely that three races are to be found in the dry zone alone, with the possibility of others in the wetter areas of the island. An adequate knowledge of the geography of Ceylon is essential to the proper understanding of the distribution of the races of monkeys living therein.

EXPLANATION OF PLATE LXV

Diagrams illustrating the arrangement of the hair on the vertex in three Bonnet Monkeys :—

Fig. 1. *Macaca sinica*, full term foetus. Note whorled arrangement, and the primitive arrangement of the fine hair-tracts anterior to the whorl. Note also absence of pigment in the ears.

Fig. 2. *M. sinica*, adult male. Note more complete "bonnet," white tract between "bonnet" and ears, and the jet-black ears.

Fig. 3. *M. radiata*, adult male. Note construction of the "bonnet" and absence of pigment in the ears. Note also absence of a white tract between ears and "bonnet."

All the above are drawn ½ natural size.

1. My procedure in the absence of living animals is to preserve the dead carcase by injection of the arteries immediately it is obtained in the jungle.

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1 2 3

Bonnet monkeys

W. C. Osman Hill del.

Additions to the Fauna of Ceylon. No. 1

Two new Rodents from the Hills of Central Ceylon

BY

W. W. A. Phillips, F.Z.S., M.B.O.U.

I.

In 1924 while examining, at the British Museum, a collection of Rats made by a Colombo Museum Collector at Nuwara Eliya in April 1923, I came across four specimens of a large, long-furred rat, which appeared to be new to science and undescribed. At that time I wrote a short paper but, being anxious to obtain further information as to the standing and distribution of the new form, I refrained from publishing it.

Recently, however, I have received from my friend, Mr. A. C. Tutein-Nolthenius of West Haputale, Ohiya, another specimen which appears to be identical with the Nuwara Eliya specimens and I now feel that I can publish the description.

The new species is more like *Rattus. r. kelaarti* than any other Ceylon rat, but from that species it differs in several essentials and may at once be distinguished by its stouter build and general squat appearance.

Rattus montanus sp. nov.

The Nillu Rat

Size large, with a stouter build and relatively shorter legs than in *kelaarti* ; head relatively rather small ; hind foot 34 mm. in the type, but averaging 33 mm. in the five specimens examined ; tail long, considerably longer than the head and body, shorter relatively than in *kandianus* but longer than in *kelaarti*, stout at the base, rounded, ringed and scaly, with minute stiff hairs throughout its length ; claws small, those of the hind feet almost concealed by white hairs.

Skull. Of the same general appearance as in *R. r. kelaarti*, but inclined to be relatively broader in the braincase ; upper molar series distinctly larger than in either *kelaarti* or *kandianus*, the 2nd molar larger and having a slightly different arrangement of the cusps. The bases of the molar teeth, in the type, are stained black.

Fur. Long, soft and fairly close, with many longer piles, to 45 mm. in length, intermixed along the back ; of the underparts fine and close, of a moderate length. Feet covered with fine short hairs.

Colour. General colour of the upper parts dark grey brown, with a distinct rufescent tinge, darker along the back where the longer piles are numerous, and more rufescent along the sides ; the longer piles are lead-grey for the greater part of their length with dark brown tips, while the finer hairs are lead-grey with rufescent tips ; head like back, with the exception that the fur is shorter and is inclined to be slightly more rufescent in colour.

Under parts light steely grey, the dark colours of the upper parts fading gradually into the grey of the lower with no line of demarcation between ; the hairs of the lower parts are bluish grey for the greater part of their length with whitish tips ; sides of the face light-grey, fading to pure white on the chin and upper throat ; feet light grey-brown paling to almost white on the inner surfaces of the forearms and on the toes of the hind feet ; naked parts of the ears dusky ; tail unicoloured, dusky blackish brown, with the fine hairs dusky ; long whiskers, shiny black.

Measurements, taken in the flesh :

	Sex.	*Head and body*	*Tail*	*Hind feet*	*Ear*
Type	♂	180 mm.	198 mm.	34 mm.	21 mm.
Nuwara Eliya Spcms.					
No. 12	♂	178 mm.	212 mm.	31 mm.	23 mm.
15	♂	165 mm.	204 mm.	33 mm.	20 mm.
19	♂	160 mm.	197 mm.	33 mm.	22 mm.
16	♀	160 mm.	223 mm.	33 mm.	21 mm.

Skull	*Greatest length*	*Condylo-incisive length*	*Zygomatic breadth*	*Least interorbital breadth*	*Braincase breadth*	*Molar series*
Type	?	40·2	20	5·7	17	7·7

Type. I have selected as the type of the species, the fine specimen collected by Mr. A. C. Tutein-Nolthenius ; it is an adult ♂, caught at West Haputale, Ohiya, on May 15th, 1931. The type is being presented to the British Museum, through the kindness of Mr. Tutein-Nolthenius.

Type locality. West Haputale; Ohiya, Uva Province, Ceylon ; altitude 5,200 feet to 6,000 feet. The type specimen was caught in a vegetable garden, not far from the forest.

Remarks, etc. At present this large rat is known only from the type locality and from Nuwara Eliya (6,100 feet). It would appear to be confined in its range to the highest hill forests of the mountains of the Central and Uva Provinces and to be essentially a jungle rat.

The type specimen was killed by a cat in a bungalow garden on a tea estate, surrounded by heavy forest ; it had evidently strayed in from the close-by jungle, in search of food. Its stomach contained vegetable matter only. Mr. Tutein-Nolthenius reports that the species had not been noticed previously in this locality.

The Nuwara Eliya specimens were collected at the time of the inflorescence and seeding of the nillu plant (Strobilanthes sp.). This evergreen plant, of which there are a number of species, grows very freely in the jungles of the higher Ceylon hills. After growing for 12 years it flowers, seeds and then dies.

As soon as the plant begins to seed, in a given area, many birds and small mammals, from the surrounding country side, flock to it to feed on the falling seeds and they in their turn are followed by the numerous carnivorous animals and birds that prey upon them ; so that when the nillu over a large area is seeding, a wonderful concourse of wild life takes place.

Rats of several species are much in evidence at these times ; they collect in large numbers and gorge themselves on the easily obtained food. But, as a diet, the seed of the nillu appears ultimately to have a stupifying, if not poisonous, effect, for towards the end of the season Jungle Fowl may sometimes be caught by hand and many rats are often found, especially near water, in a moribund condition.

In 1923 the nillu, in the jungles adjacent to Nuwara Eliya, flowered and seeded, causing a great influx of rats. Later, many of these were picked up dead or dying round about the lake. It was then that specimens of this new species first came to light, hence the association of the name of the nillu plant with this rat.

II

Amongst an interesting collection of small mammals made by Mr. E. C. Fernando, Taxidermist to the Colombo Museum, at Kumbalgamuwa in the Kandyan Hills, are three specimens of a spiny-mouse which appears to be new to science. Hitherto no spiny-mouse has been described from Ceylon. Blanford, however, in his Mammalia (page 418) states that one occurs in the Island, but on what authority is not now known and no previously collected specimen is in existence.

I have much pleasure in naming this new species after its discoverer.

Leggadilla fernandoni sp. nov.

The Ceylon Spiny-Mouse

Size moderate—98 mm. in the *type*—a little larger than the mainland species *L. gurkha* from Bihar and Orissa, but not so large as *L.*

grahami from Coorg; hind foot 17 mm. in the type, but 18 mm. in the other two specimens; tail approximately 20 mm. shorter than the head and body.

Skull. Very much resembling that of *L. gurkha* in size and appearance, but slightly broader in the brain-case.

Fur. Very spinous on the upper parts, composed chiefly of relatively long flattened spines (to 11 mm. in length) intermixed with a number of very fine hairs; short but spiny and with a few fine hairs intermixed on the underparts. Tail ringed and sparsely clothed with short coarse hairs. Feet well clothed with short fine fur.

Colour. General colour of the upper parts rufescent sandy fawn; the individual spines light slate grey with the fine fur rufescent fawn; underparts pure white, the white meeting the rufescent fawn of the sides at a definite line along the flank; tail dark above, whitish below; feet pure white.

Measurements, taken in the flesh:

		Head and Body.	*Tail.*	*Hindfoot.*	*Ear.*
Of the Type.	♂	98 mm.	82 mm.	17 mm.	damaged
No. 2	♂♂	101 mm.	78 mm.	18 mm.	16 mm.
No. 3	♂	94 mm.	70 mm.	18 mm.	15 mm.

Measurements of the skull of the type (♂). Greatest length 23·3 mm. condylo-incisive length 21 mm., brain-case breadth 11 mm., interorbital breadth 4·5 mm., zygomatic breadth 11·5 mm., length of upper molar series 3·5 mm. (Teeth much worn).

The skulls of the other two specimens are both slightly larger than that of the type, with upper molar series of 4·5 mm.

Type. A very old ♂ collected on April 12th, 1931, by Mr. E. C. Fernando at Kumbalgamuwa (3,000 feet) in the Mulhalkelle district in the Central Province, Ceylon. The type, together with one paratype, (another ♂) has been presented to the British Museum, through the kindness of the Director, Colombo Muesum. Unfortunately both the skin and skull are somewhat damaged.

Remarks. From the mainland species, *L. gurkha*, which it most nearly resembles, this new species may be distinguished by its more distinctly rufescent colour and by the longer and flatter spines of its coat.

The type, which is evidently a very old male, is more rufescent and has longer and broader spines than either of the other two specimens collected in the same locality. One of these latter (apparently a

youngish male) is considerably darker and has shorter and finer spines. It may be therefore that, in this species, the colour becomes more rufescent and the spines longer with advancing age.

No female specimens having yet been obtained, the mammary formula is, therefore, unknown.

It is quite obvious that many of the *species* as at present recognised, are, strictly speaking, nothing more than *geographical races*, and I would have preferred to have been able to describe the present new form as an Island race, of one of the mainland forms, rather than as a distinct species. Until the whole genus has been revised, however, it may be allowed to stand as described.

The three specimens collected were all taken in traps, the type in a vegetable garden near a bungalow, the other two in lantana scrub jungle.

Additions to the Fauna of Ceylon. No. 2

Some new and interesting Bats from the Hills of the Central Province

BY

W. W. A. Phillips, F.Z.S., M.B.O.U.

WITH ONE PLATE

I

Early in March this year, a Tamil labourer arrived at my bungalow with two small bats which he had caught that day, while he was working in the cardamom jungles.

Careful examination has proved them to belong to a genus hitherto unrecorded from the Island, and to a species new to science. This species I now have pleasure in naming in honour of my small daughter who has developed a keen love for, and interest in, all the timid inhabitants of the jungles surrounding her home.

Murina eileenae sp. nov.

The Ceylon Tube-nosed Bat

Size small; muzzle relatively long, blunt but rather narrow (5·5 mm.), granulated and hairy, with the exception of the area surrounding the nostrils; nostrils typically protrudent and tubular; upper lips with overhanging fringe of small hairs; eyes small, placed nearer to the orifice of the ear than to the nostrils; ears carried directed forward at an angle, relatively large, rounded, with the margins convex throughout and with very small projections at the base of the basal lobe of the inner margins; tragus long (7 mm.) narrow and tapering, narrow at the base, then broader, then gradually tapering to a rather blunt point, inner margins slightly convex, outer margins slightly convex at the base but concave towards the tip.

Wings moderately broad (48 mm. in width at the 4th digit), well cambered; thumbs relatively long (7·5 mm.) membranes from the base on the outer toe, thin in texture and semi-transparent; tail shorter than

the head and body, enclosed within the interfemoral membrane, with the exception of the extreme tip; interfemoral membrane hairy, with well developed calcanea; feet hairy, small, equipped with relatively long sharp claws.

Fur. Fur woolly and very soft, moderately long on the upper parts but shorter on the underside, spreading as a fine down on to the wing membranes at the sides of the body, both above and below, but more so on the upper surface. Moderately dense on the upper sides of the legs, feet and tail and spreading thence on to the interfemoral membrane which is sparsely furred throughout, the fur being most dense and forming a fringe along the calcanea; upper surface of the forearms with short sparse fur.

Colour. Fur of the upper parts, reddish ferruginous fawn, with the base of the fur greyish; under parts warm creamy fawn; naked ears and nasal area light brown; wing membranes semi-transparent, blackish brown, with the flesh of the forearms showing through; interfemoral membrane more brown than the wing membranes, with the fur ferruginous.

Measurements, taken in the flesh:

	Sex	*Forearm*	*Head and body*	*Tail*	*Hind foot*	*Ear*
Of the Type	♂	30 mm.	46 mm.	32 mm.	6 mm.	14 mm.
Of other specimens.						
No. 2	♂	31 mm.	48 mm.	32 mm.	6 mm.	15 mm.
No. 1	♂	31 mm.	45 mm.	34 mm.	6 mm.	14 mm.

Skull.	*Greatest length*	*Condylo-incisive length*	*Zygomatic breadth*	*Braincase breadth*	*Breadth across posterior molars.*	*Least interorbital breadth*	*Tooth row*
Type	16 mm.	14·3 mm.	9·5 mm.	7·7 mm.	4·5 mm.	4·5 mm.	4·5 mm.
No. 1	17 mm.	15 mm.	9·7 mm.	8·25 mm.	5·3 mm.	4·5 mm.	4·5 mm.

Type. Adult ♂; caught on 4th May, 1931, at Mousakande, Gammaduwa, altitude 3,000 feet, in the East Matale Hills, Ceylon; presented to the British Museum; two paratypes (one preserved in alcohol) are in the Colombo Museum.

Remarks. The type and the other two specimens examined were all caught in heavy jungle, planted with cardamoms, on the side of a mountain running up to over 5,000 feet in altitude. When discovered they were all sleeping in the dead and dry leaves of the cardamom plants that were being pruned. Two were found together one day and one on another day. They were all caught alive and proved to be all males. The colour of the fur of this bat blends very well with the colour of the dead leaves in which they hide, and I think it is probable that, like the Painted Bat (*Kirivoula picta*), they generally choose large dried up leaves, hanging from the plant, in which to pass the day. In all probability it is a low flying bat, obtaining its food while fluttering round the undergrowth in the jungle.

This new species very closely resembles *M. cyclotis* of the Sikkim and Darjiling Hills, of North India, with specimens of which species I have compared it. The Ceylon form, however, is less bright in the colour of the fur and the wing membranes are considerably darker.

II

Amongst an interesting collection of small Mammals, made by Mr. Fernando of the Colombo Museum, in the hills east of Kandy, is a specimen of a small reddish Kerivoula of a species hitherto unknown in the Island.

Although but a single specimen has been secured, and the skull of this is badly damaged, it is so distinctive and comes from a locality so remote, that I have no hesitation in describing it as a species new to science and naming it in honour of Mr. A. H. Malpas, the present Acting Director of Colombo Museum. Mr. Malpas, by his interest and active assistance, has helped forward, greatly, the study of natural science in Ceylon.

Kerivoula malpasi sp. nov.

Malpas's Bat

A Kerivoula of very much the same size and general apperance as *K. hardwickii* but with a relatively shorter tail and more rufescent colouring.

Ears naked throughout and relatively large, tips rounded, inner margins regularly convex from base to tip, outer margins deeply concave immediately below the tip, the lower portions being regularly convex again; tragus long, attenuated, narrowing gradually to a point.

Wing membranes from the base of the outer toes: interfemoral membrane naked, well developed; calcaneum long, extending approximately two-thirds of the distance from the ankle to the tail; membranes thin in texture, semi-transparent and quite naked, with the fur of the body ceasing abruptly, both on the upper and the lower sides, on meeting the membranes; tail considerably shorter than the head and body; feet small, equipped with relatively long sharp claws, with a few short hairs on the toes.

Skull. Apparently very much as in *K. hardwickii* and *K. crypta*, but that of the type is too damaged and crushed to permit of measurements being taken.

Fur. Very soft and of moderate length; confined entirely to the body.

Colour. General colour of the upper parts rufescent brown, with the fur of the head, shoulders and mantle self-coloured but that of the lower back and hinder parts generally, with the base dark grey ; lower parts, light rufescent fawn, with the base of the fur dark brownish grey ; membranes and ears unicoloured, semi-transparent blackish brown.

Measurements of the type (taken in the flesh) are :—Head and body 43 mm., tail 35 mm., hindfoot 5 mm., ear 15 mm., forearm 32 mm.

Type. Adult female ; taken at Kumbalgamuwa (3,000 feet) in the Mulhalkelle district of the Central Province. The Mulhalkelle district lies on the north-eastern aspect of the hills of the central mountain cluster, some 30 miles east of Kandy. The type was collected by Mr. E. C. Fernando on March 31st, 1931; through the courtesy of the Director of the Colombo Museum it has been presented to the British Museum.

Remarks. This interesting little bat was caught at dusk one evening in the garden of a bungalow. It was fluttering low round some bushes and was knocked down with a branch of brushwood.

Blanford (Mammalia, page 340, No. 214) states that there is a specimen of *K. hardwickii*, from Ceylon, in the British Museum collection. If this specimen is in existence, it will most probably be found to be another specimen of the present species.

The present species is considerably more rufescent in colour than either *K. hardwickii* or *K. crypta*, the two species to which it is closely allied.

III

One evening, early in March this year, I shot for examination, a long-winged bat as it was flying over my bungalow. On going to pick it up, I was much surprised to find, lying on the grass, not the expected Sheath-tailed Bat but a chocolate coloured animal with which I was not familiar. Examination has proved it to be a specimen of Dobson's Wrinkled-lipped Bat (*Tadarida*), of a genus hitherto unrecorded from Ceylon.

As this bat has not hitherto been described from Ceylon I now give a short description of it.

Tadarida tragata (Dobson)

Dobson's Wrinkled-lipped Bat

PLATE LXVI

Size moderately large ; muzzle naked, broad and blunt, the lips very thick with the upper overhanging the lower and both much

wrinkled or fluted, the upper one more so than the lower ; eyes large ; ears naked, large, fluted, somewhat irregular in shape, directed well forward in life, outer margins separated from the antitragus or terminal lobe by a deep notch ; inner margins distinct, furred towards the base, close together but not joined by any band across the forehead ; tragus short, sub-triangular and truncated above.

Wings long and rather narrow, thumb small, with a well developed pad or callosity at the base ; interfemoral membrane well developed ; calcaneum long, extending about three-quarters the distance from the ankle to the tail. Tail moderately long, the distal half free, the basal portion contained in the interfemoral membrane ; feet rather small and short, with small, very short claws partially concealed by comparatively long, soft hairs.

Fur. Soft, dense, short and even on both the upper and the lower parts, ceasing abruptly on meeting the membranes on the upper surface, but spreading slightly on to the interfemoral membrane on the under surface.

Colour. Bright chocolate brown above, with the base of the fur lighter ; dull chocolate brown, with the base of the fur whitish, on the lower parts. Membranes dark brown.

Measurements. The measurements, taken in the flesh, of the two specimens secured are :—No. 1 ♀. Head and body 70 mm., tail 39 mm., hind foot 9 mm., ear 21 mm., forearm 49·5 mm.

No. 2 ♀. Head and body 74 mm., tail 42 mm., hind foot 8 mm., ear 21 mm., forearm 48 mm.

The measurements of the skull of No. 1 are : condylo-incisive length 19·3 mm., zygomatic breadth 12·2 mm., breadth of braincase 10 mm., least interorbital breadth 4·8 mm., breadth across muzzle at lachrymal processes 7·5 mm., palatal breadth, across posterior molars, 8 mm., tooth row 5·5 mm.

Remarks, etc. Two specimens were shot flying over my bungalow, Mousakande, Gammaduwa, at dusk. They appeared as the evening closed in having apparently emerged from a long crevice in the precipitous cliff close by. There is, most probably, a small colony living in this cliff, at certain seasons of the year, but as the crevice in which they appear to have their sleeping quarters is unapproachable, this is surmise only. The altitude of the cliff is approximately 3,500 feet above sea level.

The flight of this bat is swift and steady. On the wing it much resembles the Sheath-tailed Bats, *Saccolaimus* and *Taphozous* and, like them, it comes out rather early in the evening and flies high up in the sky.

I have compared these two Ceylon specimens with specimens from Cutch, on the Indian mainland, very kindly sent to me by the Authorities of the Bombay Natural History Society. The Ceylon specimens appear to be identical, in both colour and measurements, with the Indian and are quite indistinguishable.

IV

Curiously enough, only a few weeks after the discovery of Dobson's Wrinkled-lipped Bat (*Tadarida tragata*) at Gammaduwa, Mr. E. C. Fernando, the Colombo Museum Taxidermist, while on a collecting trip in the hills to the south-east of Kandy, secured three specimens of another wrinkled-lipped bat, of a different genus.

On comparing these with specimens of the Indian Wrinkled-lipped Bat (*Chaerephon plicatus*) from Tenasserim, very kindly loaned to me from the Bombay Natural History Society's collections, I find that the new Ceylon specimens are not only slightly darker in general hue but are considerably smaller than the mainland representatives. I am able, therefore, to describe our Island form as a new race under the name *insularis*.

As the species has not hitherto been described from Ceylon I am giving a moderately full description of it.

Chaerephon plicatus insularis sub. sp. nov.

The Ceylon Wrinkled-lipped Bat

Size moderate, smaller than in typical *plicatus* and with a shorter forearm ; tail considerably shorter than the head and body, and with rather more than half of it free of the membrane as in the typical race.

Muzzle almost naked, broad and blunt, with very thick and fluted lips, the upper overhanging the lower ; eyes large, overshadowed by the large projecting ears, as in other members of the family ; ears large and irregular, the inner margins joined at the base by a distinct band across the forehead, outer margin irregularly convex and separated from the well developed antitragus or terminal lobe by a deep notch ; tragus very small and insignificant, truncated.

Wings long and narrow, with the membranes from the tibia, rather leathery in texture ; thumb rather small, with a well developed pad or calosity at the base, as in *Tadarida tragata* ; interfemoral membrane poorly developed ; calcaneum moderate, extending scarcely half the distance, between the tibia and the tail ; tail relatively short, the major portion free ; feet rather short, the toes and small claws partially concealed by long hairs.

Skull. Closely resembling typical *plicatus* but slightly smaller.

Fur. Soft, dense, very short and even both above and below; ceasing abruptly on meeting the wing membranes but spreading slightly, as very fine down, on to the interfemoral; limbs quite naked.

Colour. Dark chocolate brown above; dull chocolate below; base of all fur lighter and inclined to whitish; across the shoulders there is a whitish band where the fur of the neck meets that of the shoulders; membranes dull blackish brown.

Measurements of the type (♂), taken in the flesh: head and body 66 mm., tail 40 mm., hind foot 10 mm., ear 19 mm., forearm 42 mm.

Of two other males from the same locality as the type.

No. 1. Head and body 65 mm., tail 30 mm., hind foot 10·5 mm., ear 16·5 mm., forearm 44 mm.

No. 2. Head and body 61 mm., tail 38 mm., hind foot 9 mm., ear 20 mm., forearm 43 mm.

Skull of type. Condylo-incisive length 17 mm., greatest length 18 mm., zygomatic breadth 11 mm., braincase breadth 10 mm., least interorbital breadth 4 mm., palatal breadth across posterior molars 8 mm., tooth row 8 mm.

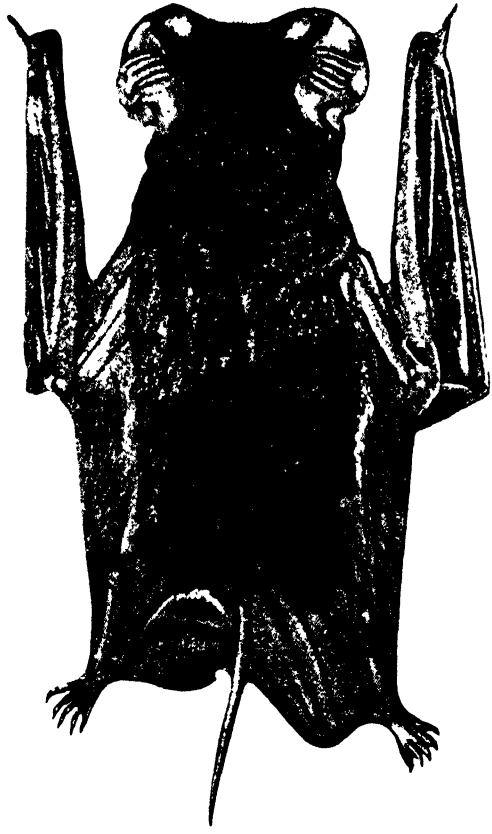
Type. Adult ♂, shot on 9th April, 1931, by Mr. E. C. Fernando, at Kumbalgamuwa (altitude 3,000 ft.), near Mulhalkelle, 30 miles south-east of Kandy in the hills of the Central Province, Ceylon. The type has been presented to the British Museum, through the kindness of the Director, Colombo Museum. Two paratypes, both males, one of which is preserved in alcohol, are in the Colombo Museum.

Remarks. The three specimens collected by Mr. Fernando, at Kumbalgamuwa, were all shot rather late in the evening as they were flying high overhead. The flight is described as fast and the general habits of the animal are probably very much the same as those of other high flying bats such as the sheath-tailed bats (*Saccolaimus* and *Taphozous*).

EXPLANATION OF PLATE LXVI

Tadarida tragata (Dobson). ·1 approx.

Note.—This bat was photographed in a suspensory position, but has been reversed in the illustration for the sake of convenience.



Tadarida tragata (Dobson)

Survey of the Distribution of Mammals in Ceylon

BY

W. W. A. Phillips, F.Z.S., M.B.O.U.

Under the above heading it is proposed to publish, from time to time, reports on collections of mammals made in various districts of the Island, by the Colombo Museum Collectors and others interested in the study of our Island's fauna.

Through the publishing of these reports an interesting record will be kept of collections made in new localities, and the occurrence of all new, or hitherto unrecorded, species will be put on permanent record.

In 1913 and 1914 Major E. W. Mayor, working on behalf of the Bombay Natural History Society's Mammal Survey of India, Burma and Ceylon, made two large and very interesting collections, the one in the Southern and Uva Provinces and the other in the Central, Eastern and Northern Provinces, the results of which were published in the Bombay Natural History Society's Journal (Vol. XXII, No. 4, p. 700 and Vol. XXIV, No. 1, p. 79).

These two collections, which were worked out at the British Museum by Miss Kathleen V. Ryley and Mr. R. C. Wroughton, respectively, in conjunction with similar collections from the mainland of India, added very greatly to the general knowledge of Ceylon mammals and their distribution, both within the limits of the Island and on the neighbouring mainland. The reports thereon, together with the scientific results following, have formed the basis of all recent work on our mammals.

Since Major Mayor's collections were completed, considerable strides have been made in defining the range, within the Island, of each species and sub-species, and, in addition, a number of other species, either new or hitherto unrecorded, have been added to the list of our mammalian fauna.

In this connection, however, much work still remains to be done; this is well illustrated by the fact that, in three collections made this year in various localities in the hills of the Central and Uva Provinces,

no less than six new species and sub-species have been discovered and the ranges of a number of other forms have been shown to be much more extended than was formerly supposed.

Ceylon, as is now well-known, is, broadly speaking, divisible into three definite climatic tracts or zones, each of which has a fauna and flora differing in many respects from those of the other two. In many cases the mammalian forms found in one given zone are peculiar to it, and are not found in the remainder of the Island ; hence the interest and importance of working out the exact range of each species.

It is proposed to give the following reports in much the same form as those of the Bombay Natural History Society's Mammal Survey, in order that they may be used in conjunction with, and as a supplement to, these excellent and most useful reports.

The numbers given against the name of each species will be found to correspond, for the sake of easy reference, to the numbers given in the "Check List of the Mammals of Ceylon." as published in the Ceylon Journal of Science (Spolia Zeylanica, Vol. XV, p. 119, 1929). Further information as to the general distribution of each species may be obtained from this list, if desired.

It is not proposed to give any synonyms in these reports, but collector's notes, and other remarks of interest, will be given as fully as possible.

REPORT No. I

Collection	No. 1
Locality	West Haputale, Ohiya.
Date	April, May and June, 1931.
Collected by	A. C. Tutein-Nolthenius, Esqr.

The collection with which this first report deals was made and prepared by Mr. A. C. Tutein-Nolthenius of West Haputale Estate, Ohiya. It contains a number of specimens of interest, especially a fine series of the recently described *Rattus ohiensis* (C.J. of S.. Sec. B., Vol. XV, pt. 2, p. 167), a single specimen of a new rat (*Rattus montanus*) and several specimens of a very small shrew, evidently akin to the Indian Pigmy Shrew, if not identical with it.

West Haputale, Ohiya, is a tea estate situated on the southern aspect of the mountains of the Central and Uva Provinces, some 15 miles west of Haputale. Most of the land consists of rather steep slopes running from approximately 4,500 feet at the bottom of the estate to over 6,000 ft. at the top. The whole estate is more or less surrounded by virgin forests in which small rodents and shrews seem to be plentiful. The rainfall averages 92·87 inches annually, most of which falls during November and December and March to May; the upper part

of the estate is subject to high winds at certain times of the year. On the plateau above the estate are the Horton Plains (7,000 feet) and the jungles of Pattipola and Ambawela which were visited by Major Mayor in 1914. The fauna and flora is chiefly alpine and the great majority of the mammals belong to forms endemic to the Island.

Previous to the present collection, a small number of specimens had been collected in this neighbourhood in 1929; among them were two new species, *Rattus ohiensis* and *Vandeleuria nilagirica nolthenii*.

The present collection was made either on the estate or in the jungles immediately surrounding it, at an altitude of approximately 6,000 feet. Mr. A. C. Tutein-Nolthenius is to be congratulated upon the very useful work he has done and the interesting collection he has made. It is hoped that he will be able to extend the field of his collecting. A collection from the mid-country zone lying just below his estate, at an altitude of 2,500 to 4,000 feet, should be productive of interesting results, especially if some bats can be included.

In this report I have included only those species of which specimens have been obtained; all mention of the larger species which inhabit these jungles, but of which no specimens occur in this collection, have been omitted.

(No. 34) **Suncus montanus** (Kelaart)

The Ceylon Highland Shrew

♂ 1, ♀♀ 3, in alcohol 1. ♀

This is, by far, the commonest shrew of the highlands. These specimens were trapped in the jungle and all appear to be quite typical.

(No. 37) **Suncus** sp.

Ceylon Pigmy Shrew

♀♀ 2, in alcohol.

These diminutive shrews average about 54 mm. head and body; 33 mm. tail; 9·5 mm. hind foot and 6 mm. length of ear; they are very dark, glossy, blackish brown on the upper parts, with lighter, greyish underparts. They are evidently allied to the Indian Pigmy Shrew (*Suncus perrotteti*) but would seem to differ from that species in colouring.

One or two specimens of the same shrew have been taken at Mousakande, Gammaduwa, in the East Matale Hills. The present specimens were taken in the bungalow garden.

(No.72) **Funambulus sublineatus obscurus.** (Pelz. and Kohl.)

The Ceylon Dusky-striped Jungle Squirrel

♂ ♂ 3. typical.

These three specimens of this pretty little squirrel were taken in traps set in the jungle for rats. This squirrel generally spends as much of its time on the ground as in the bushes and trees, hence its capture in traps set for rats.

(No. 77) **Rattus rattus kelaarti** (Wroughton)

The Ceylon Highland Rat or Kelaart's Rat

♂ ♂ 8 (2 juveniles), ♀ ♀ 7. (2 juveniles), in alcohol ♀ 1, ♂ 1 (juvenile).

This is the common rat of the neighbourhood; it is found, very plentifully, both in bungalows and other buildings and also in the jungle away from habitations. Some of the specimens, taken round about the bungalows, appear to be hybrids between *kelaarti* and the lowland form (*R. r. kandianus*) which has been transported everywhere by the unwilling agency of man and has interbred largely, close to habitations, with the indigenous form.

(No. 77 A) **Rattus montanus** Phillips

The Nillu Rat

♂ 1.

A single specimen of this large, interesting rat was caught by a cat in the vegetable garden attached to one of the estate staff bungalows. Since 1923 no specimen had been secured. In 1923 four specimens were taken at Nuwara Eliya, together with numbers of *R. r. kelaarti* at the time of the seeding of the Nillu plant (*Strobilanthes* sp.). But pending the securing of further specimens, the describing of the species, as new, was held over until the present year.

(No. 78 A) **Rattus ohiensis** Phillips

The Ceylon Bi-coloured Rat.

♂ ♂ 4, ♀ ♀ 3, in alcohol ♂ ♂ 3, ♀ ♀ 5 (1 juvenile)

This rat was first described from a single specimen collected at West Haputale in December, 1928. Since then other specimens have been collected both at West Haputale and at Gammaduwa in the East

Matale Hills. The present fine series provides useful data as to measurements and shows that the average male grows considerably larger than the average female. Many of these specimens have a variable portion of the tip of the tail pure white all round. In some, as much as 30 mm. of the tip is white, while in others only the extreme tip is coloured. Mr. A. C. Tutein-Nolthenius suggests that this white tip may be a sign of adolescence and that the colour darkens with age, but it seems more likely that it is merely a local colour variation. There is no sign of a white tip to the tail in any of the nine Gammaduwa specimens.

(No. 80) **Mus dubius** Hodgson

The Common Indian House Mouse

♂ 1, in alcohol, ♀ 1, in alcohol.

Mice seem to be unusually uncommon at West Haputale, as only two specimens have been caught in three months of trapping. The male specimen is quite typical with the exception of its abnormally short tail, but the female is a giant among mice and quite the largest that I have examined ; its measurements are, head and body 96 mm., tail 17 mm. (damaged), hind foot 16 mm., ear 10 mm.

(No. 82) **Coelomys mayori** Thomas

Mayor's Coelomys or Spiny Rat

♂ ♂ 4, ♀ ♀ 9, in alcohol ♂ ♂ 3, ♀ ♀ 3.

This very fine series is useful as showing the individual colour variations to which the underparts are liable ; in thirteen the underparts are the usual normal grey but in the other six the colour varies from whitish grey to pure white as in the mid-country form *Coelomys bicolor*. It seems very possible that at lower altitudes *mayori* may gradually grade into *bicolor* and that the two may be but geographical races of the one species.

Mr. A. C. Tutein-Nolthenius is continuing to collect ; further specimens will be examined with much interest.

REPORT No. 2

Collection	No. 2
Locality	Mulhalkelle district, Central Prov.
Altitude	2,000/3,000 feet.
Date	April 4th/10th and May 26th/June 9th, 1931.
Collected by	Mr. E. C. Fernando, Taxidermist, Colombo Museum.

This report is on a collection made by Mr. Fernando on two visits to the Mulhalkelle district, in the hills some 30 miles south-east of

Kandy. The collection is of exceptional interest as it contains representatives of not less than three species new to the Island (of which two are new to Science, I believe) together with several forms not previously recorded from the hills. It adds considerably to our knowledge of the distribution of a number of species of bats.

The locality from which the collection comes is on the eastern aspect of the central hill cluster of the Central Province, at a mean altitude of approximately 2,000/3,000 feet. Above, the hills run up to the peak of Pedro (8,292 feet), the highest mountain in Ceylon, and immediately below they slope down into the low-country of the dry zone.

Much of the district is opened up in tea estates and many of the specimens were collected on or around an estate; the remainder of the countryside is composed of jungle, patches of lantana scrub and terraced paddy fields (where sufficient water is to be had from the hill streams) with villages in the hollows and valleys.

Mr. Fernando is to be congratulated upon having made such a very interesting and useful collection.

(No. 8) **Rousettus seminudus** (Kelaart)

The Ceylon Fruit Bat

♂ 1, ♀♀ 3, ♀♀ 2, juveniles. Kumbalgamuwa. 3,000 feet.

All these were obtained, together, from a cave temple. Three are of the normal colouring but one female is more rufous than usual. Two of the females had produced young ones fairly recently—most probably the two young that were obtained. The young are rather more fully clothed with fur than the adults.

(No. 10) **Cynopterus brachyotus ceylonensis** Gray

The Ceylon Short-nosed Fruit Bat

♂♂ 3, ♀♀ 18, ♂ 1, juvenile. Kumbalgamuwa. 3,000 feet.

This is a very interesting series that goes far to confirm my theory that there is only one species of *Cynopterus* in Ceylon—not two as stated by Dr. Knud Andersen (Catalogue of Chiroptera B.M. (N.H.), pp. 598/603 and 624/625).

The measurements of the present series vary as follows :—

		Head and body	*Tail*	*Hind foot*	*Ear*	*Forearm*
♂s (3)	Maximum	101 mm.	12 mm.	15 mm.	21 mm.	69 mm.
	Average	94 mm.	12 mm.	13·5mm.	20 mm.	65·5mm.
	Minimum	89 mm.	10 mm.	13 mm.	19 mm.	60 mm.
♀s (18)	Maximum	103 mm.	17 mm.	16 mm.	20 mm.	68 mm.
	Average	94 mm.	12 mm.	13 mm.	19 mm.	64 mm.
	Minimum	89 mm.	8 mm.	13 mm.	16 mm.	58 mm.

and these measurements are roughly typical of nearly all series that I have examined.

I have now examined a number of series of specimens of this bat from many parts of Ceylon and, although I find quite an appreciable difference both in size and colour between the larger and the smaller types, I have been quite unable to divide them into two separate species.

Arranged in order of magnitude according to the length of the forearm, the specimens available for examination gradually increase in size from the least to the greatest, without any definite point appearing, either in the measurements of the body or of the skull, at which it would be possible to make a division.

On the data at present available, I am satisfied that all the specimens that I have been able to examine, both from the hills and from the low-country, are referable to one species only. I have, therefore, referred all to *C. brachyotus ceylonensis* as on a general average they appear to be too small to be referable to *C. sphinx sphinx*.

Most of the Kumbalgamuwa specimens were shot from kitul trees.

(No. 11) **Rhinolophus rouxi rouxi** Temminck

The Rufous Horse-Shoe Bat

♂ ♂ 2. Kumbalgamuwa. 3,000 feet.

♂ ♂ 2, ♀ 1. Mylapitiya. 2,000 feet.

In colour these specimens vary from light reddish brown to dark grey, which is quite usual. They were caught in an old plumbago pit or in paddy lofts.

(No. 13) **Hipposideros lankadiva** Kelaart

The Large Indian Leaf-nosed Bat

♂ 1, ♀ 1. Kumbalgamuwa. 3,000 feet.

♂ ♂ 5 Mylapitiya. 2,000 feet.

All the present specimens of this large bat are typical in colour, with the exception of one which is more reddish brown than usual. The two Kumbalgamuwa specimens were both shot flying low over the undergrowth at dusk, but the Mylapitiya specimens were taken in an old abandoned plumbago working.

(No. 14) **Hipposideros speoris speoris** (Schneider)

Sykes' Leaf-nosed Bat

♂ ♂ 3, ♀ ♀ 2. Kumbalgamuwa. 3,000 feet.

♂ 1. Mylapitiya. 2,000 feet.

All typical with the exception of a small ♂, shot at dusk at Kumbalgamuwa, which is smaller than usual, with a forearm measurement of 42 mm. only, and has very short fur. It appears to be a sub-adult specimen. Those obtained at Kumbalgamuwa were either shot at dusk or found in caves and paddy lofts and that taken at Mylapitiya was in an abandoned plumbago pit.

(No. 15) **Hipposideros brachyotus** (Dobson)

The Dekhan Leaf-nosed Bat

♂ ♂ 3. Kumbalgamuwa. 3,000 feet.

All typical. Two were taken in a paddy loft.

(No. 17) **Megaderma spasma ceylonensis**

The Ceylon Vampire Bat

♀ ♀ 4. Kumbalgamuwa. 3,000 feet.

All obtained from a hollow Kumbuk tree growing beside a stream. One very small young ♀ was also obtained, with its mother.

It is interesting to find this and the next species, both occurring at an altitude of 3,000 feet ; hitherto these bats had only been found in the low-country.

(No. 18) **Lyraderma lyra lyra** (Geoffroy)

The Indian Vampire Bat

♀ ♀ 5. Kumbalgamuwa. 3,000 feet.

All collected from a hollow tree and all quite typical. Three of them were sub-adults ; these were more blue grey in colour than the adults.

(No. 20) **Pipistrellus coromandra** (Gray)

The Coromandel Pipistrelle

♂ ♂ 2, ♀ ♀ 5. Kumbalgamuwa. 3,000 feet.

Probably Kumbalgamuwa is on the extreme limit of the range of this species, as I believe the smaller *P. mimus mimus* takes its place in the districts nearer to Kandy. In colour, two of these specimens were dark bistre, two lighter bistre and three dark rufous bistre. Three of them were obtained from a hollow papaw tree ; the remainder were shot flying over at dusk.

(No. 22) **Hesperoptenus tickelli** (Blyth)

Tickell's Bat.

♀ ♀ 4. Kumbalgamuwa. 3,000 feet.

All quite typical. Shot flying over at dusk.

Scotophilus wroughtoni Thomas

Wroughton's Bat

♀ 1. Kumbalgamuwa (11/4/31) 3,000 feet.

Among the first Kumbalgamuwa collection is a bat of this species. Its measurements are; Head and body 70 mm., tail 48 mm., hind foot 9 mm., ear 13 mm., forearm 48 mm. Colour of upper parts plain yellowish brown, underparts yellowish white. Unfortunately the skull is so badly damaged that it cannot be measured. It is a typical specimen of *S. wroughtoni*, which species was first found at Anuradhapura in 1914 by Major Mayor, working on behalf of the Bombay Natural History Society Mammal Survey. It was shot flying over in the dusk.

Kerivoula malpasi Phillips

♀ 1. Kumbalgamuwa (31/3/31) 3,000 feet.

Mr. Fernando obtained one specimen of a little rufous coloured bat, hitherto unknown in the Island. It is evidently a second species of *Kerivoula*, and represents, I am inclined to think, a species hitherto undiscovered. It was knocked down one evening as it was fluttering, low down, near the bungalow he was living in. Its measurements are : Head and body 43 mm., tail 35 mm., hind foot 5 mm., ear 15 mm., fore-arm 32 mm. The skull is unfortunately badly damaged.

(No. 27) **Miniopterus fuliginosus** (Hodgson)

♀ 1. Kumbalgamuwa. 3,000 feet.

Shot flying over late in the evening. Quite typical. A common species in the mid-country hills.

Chaerephon plicatus insularis Phillips

The Ceylon Wrinkled-lipped Bat

♂ ♂ 2, ♂ 1, in alcohol. Kumbalgamuwa. 3,000 feet.

These three specimens are the first of this genus to be obtained in Ceylon. They may prove to be typical *C. plicatus*, but I am under the impression that the underside is much lighter in colour in true *plicatus* than in these specimens.

All of them were shot late in the evening, flying rapidly overhead.

(No. 33) **Suncus murinus kandianus** (Kelaart)

The Kandyan Shrew

♀ ♀ 4. Kumbalgamuwa. 3,000 feet.

All these shrews are dark grey in colour ; but they are rather smaller than typical *kandianus* and, were it not for their colour, I would list them as *montanus*.

Undoubtedly, the small blackish shrew *montanus* of the highlands and the larger but greyer shrew *kandianus* of lower altitudes, are two forms of the same species. I have now been able to examine a number of specimens, such as the present, that are more or less midway between the two. The two so-called species grade into one another in the mid-country zone between 2,500/3,500 feet and are evidently two forms of a single species.

The present specimens were trapped about buildings.

(No. 39) **Crocidura horsfieldi** (Tomes)

Horsfield's Shrew

♂ 1. Kumbalgamuwa. 3,000 feet.

The single specimen obtained of this diminutive shrew is a typical, sub-adult specimen, not quite full grown. The species seems to be well distributed and not uncommon throughout the Kandyan hills at altitudes of about 3,000/4,000 feet.

The present specimen was picked up dead near a bungalow.

(No. 76) **Rattus rattus kandianus** (Kelaart)

The Common Ceylon House Rat

♂ 1. juvenile, ♀ 1. Kumbalgamuwa. 3,000 feet.

Leggadilla sp.

The Spiny Mouse

♂ ♂ 2. Kumbalgamuwa. 3,000 feet.
♂ 1. Mylapitiya. 2,000 feet.

These are the first specimens of a Spiny mouse to be obtained, from Ceylon, during the last 30 years or so. Blanford (Mammalia, p. 418) records the occurrence of a Spiny mouse in Ceylon, but on what authority is, today, not known. These present specimens would appear to be

of a hitherto undescribed species. Two were trapped in a vegetable garden and one in a lantana jungle.

(No. 80) **Mus dubius** Hodgson

The Common Indian House Mouse

♂ 1, ♀ ♀ 3. Kumbalgamuwa. 3,000 feet.

Two of the females are very large specimens measuring as follows :— Head and body 82 and 82 mm., tail 93 and 91 mm., hind foot 16 and 16 mm., ear 13 and 13 mm. They were trapped in the jungle.

See also Report No. 1.

(No. 81) **Leggada booduga fulvidiventris** Kelaart

The Ceylon Field Mouse

♂ 1, ♀ 1. Kumbalgamuwa. 3,000 feet.

♂ ♂ 2. Mylapitiya. 2,000 feet.

All four specimens were taken in traps ; this pretty little mouse is common in most places up to about 4,000 feet.

(No. 86) **Golunda ellioti coffaea** (Kelaart)

The Coffee Rat

♂ 1. Kumbalgamuwa. 3,000 feet.

Trapped in the jungle ; quite typical.

REPORT No. 3

Collections	Nos. 3 and 4.
Locality	Southern (Palatupane Resident Sportsman's Reserve), Southern Province.
Altitude	About 10 ft. to 50 ft. above sea level.
Date	23rd to 29th March, 1931, and July 31st, 1931.
Collected by	A. C. Tutein-Nolthenius, Esqr., and Mr. E. C. Fernando.

The two small collections, with which this report deals, were made independently, and on different dates, by Messrs. A.C. Tutein-Nolthenius and E.C. Fernando in the same area, while they were on shooting trips.

Traps were taken and were set at night, but the results were disappointing, only the Ceylon Gerbil being trapped in any numbers. Bats were collected as opportunities occurred, but the primary object of the trips was shooting specimens of the larger fauna so no special efforts were made to make collections representative of the area.

The smaller mammals, only, are dealt with in this report; the larger are too well-known to require comment.

The Southern Resident Sportsman's Reserve lies in the Southern Province, some 30 miles north-east of Hambantota; it is bounded on the east by the Yala Game Sanctuary and on the south by the sea. The country is, for the most part, flat, sandy, scrub-covered plain with one or two rocky knolls and out crops—the homes of bears and innumerable Leaf-nosed Bats—and several grass-covered "damanas." The rainfall of this part of the Island averages annually under 40 inches, practically all of which falls during November, December and January, the north-east monsoon period. For the remainder of the year, the country is parched and burnt up, the animal population relying for water upon one or two small water holes and the Menik Ganga, the river that forms the boundary between the Reserve and the Sanctuary. The whole area is uninhabited, except for the Game Sanctuary Guardian's house at Yala and the Game Watchers' huts.

Leopards, bears, buffaloes, sambhur, spotted deer and elephants are very numerous throughout the area.

(No. 12) **Rhinolophus beddomei sobrinus**

The Great Indian Horse-shoe Bat

♂ 2, ♀ 1. Talgasmankande (E.C.F.)

These three specimens were discovered, together, in a hollow tree and were shot after being driven out. The species appears to be uncommon in Ceylon and to be confined in its distribution, to the jungles of the wet and dry zones of the low-country.

(No. 13) **Hipposideros lankadiva** Kelaart

The Large Indian Leaf-nosed Bat

♀ 1. Talgasmankande (E.C.F.)

The single specimen of this fine bat was shot late in the evening flying low over the river. It is most interesting to find it occurring in the dry low-country; hitherto it has been found only in the Kandyan hills, at medium altitudes, and it was believed to be confined to these wet zone hills.

See also Report No. 2.

(No. 22) **Hesperoptenus tickelli** (Blyth)

Tickell's Bat

♂ 1. Talgasmankande (E.C.F.)

A common species found all over the low-country and to an altitude of about 3,000 feet in the hills.

See also Report No. 2.

(No. 73) **Tatera ceylonica** Wroughton

The Ceylon Gerbil or Antelope Rat

♂ 3, ♀ 1. Buttawewa ; ♂ 1, ♀ 1. Palatupane (A.C.T.-N.)

A very common species throughout the area. Burrows are commonly seen both in the grassy plains and among the sand-dunes.

This Gerbil must do considerable damage to ground nesting birds and their young ; it is very fond of birds eggs and is carnivorous when the opportunity occurs.

(No. 76) **Rattus rattus kandianus** (Kelaart)

The Common Ceylon House Rat

♀ 1. Talgasmankande (E.C.F.)

The "common" Rat does not seem to be at all common in this bush country, away from all habitations. This specimen is the first that has been recorded from this area ; it is a small female, fulvous sandy brown in colour.

See also Report No. 2.

(No. 79) **Millardia meltada** (Gray)

The Soft-furred Rat

♀ 1. Yala ; ? 1. Palatupane. (A.C.T.-N.)

These two specimens are the first of the species to be recorded from this area, but specimens were taken by Major E. W. Mayor, for the Bombay N. H. S. Mammal Survey (J.B.N.H.S., Vol. XXII, No. 4, 1914) at both Hambantota and Weligatta. The species does not appear to be common within the Reserve.

The following species have been collected previously within this Reserve:—

No. 1. *Macaca sinica*
The Toque Monkey

No. 2. *Pithecus entellus thersites*
The Ceylon Langur

No. 11. *Rhinolophus rouxi rouxi*
The Rufous Horse-shoe Bat

No. 14. *Hipposideros speoris speoris*
Sykes' Leaf-nosed Bat

No. 25. *Leuconoe hasselti*
Van Hasselti's Bat. One obtained in 1925 on the Menik ganga.

No. 38. *Crocidura kelaarti*
Kelaart's Shrew. Two or three specimens of a small, grey shrew were taken at Katagamuwa in 1918, and have been provisionally referred to the above species. Unfortunately they all appear to be juveniles. Further specimens are a great desideratum.

No. 42. *Panthera pardus fusca*
The Leopard or Panther

No. 44. *Felis rubiginosa*
The Rusty Spotted Cat

No. 46. *Viverricula malaccensis*
The small Indian Civet Cat

No. 49. *Herpestes lanka*
The Common Ceylon Mongoose

No. 56. *Herpestes smithii zeylanicus*
The Ceylon Ruddy Mongoose

No. 57. *Herpestes vitticollis*
The Striped-necked Mongoose

No. 58. *Canis lanka*
The Ceylon Jackal

No. 60. *Melursus ursinus*
The Sloth Bear

No. 65A. *Ratufa macroura sinhala*
The Common Ceylon Giant Squirrel

No. 67. *Funambulus palmarum kelaarti*
The Lowland Ceylon Palm Squirrel

No. 84. *Vandeleuria rubida*
The Long-tailed Tree-mouse

No. 86. *Golunda ellioti coffaea*
The Coffee Rat or Bush Rat. Further specimens of this Bush-rat are a desideratum.

No. 87. *Acanthion leucurus leucurus*
The Indian Porcupine

No. 88. *Lepus sinhala*
The Ceylon Black-naped Hare

No. 89. *Bubalus bubalis bubalis*
The Buffalo

No. 90. *Muntiacus malabaricus*
The South Indian Barking Deer

No. 91. *Axis axis ceylonensis*
The Ceylon Spotted Deer

No. 93. *Rusa unicolor unicolor*
The Sambhur

No. 94. *Moschiola meminna*
The Indian Chevrotain or Mouse Deer

No. 95. *Sus cristatus cristatus*
The Indian Wild Pig

No, 96. *Elephas maximus zeylanicus*
The Ceylon Elephant

No. 97. *Manis crassicaudata*
The Indian Pangolin

Note on the diving powers of Halobates

BY

G. M. Henry

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In "Treubia," Vol. VIII, p. 384 (1926), Dr. H. C. Delsman, in the course of a valuable paper on the propagation of *Halobates*, states that his observation of these insects convinced him that "*Halobates* cannot dive, and that no attempt to frighten it can induce it to dive. When frightened it always takes recourse to rapid flight. If, by some accident, —as happened regularly in our plankton-catches,—the animals get under the surface of the water, they indeed make swimming movements with their legs, but they cannot emerge again to the surface and evidently have to die."

On several occasions, at Bambalapitiya and Barberyn Island on the West Coast and at Kalkudah on the East Coast of Ceylon, while sea-bathing in the early morning, I have had good opportunities of observing *Halobates flaviventris* Esch. at very close quarters, under natural conditions, and I am able to state, with no doubt whatever, that this species, at least, dives freely when disturbed and re-appears on the surface. While chasing the insects with a short-handled net I was able to approach them very closely and could see their movements distinctly. The actual dive was so quick that a *Halobates* scudding along before one appeared merely to vanish suddenly. Under water, however, their movements are impeded and the insect can be seen for a fraction of a second before it breaks the surface-film on returning to the surface.

The fact of their diving seems to be established also by the fact that, on the Pearl Banks they are frequently captured in large numbers in completely submerged tow-nets. I believe that, as suggested in the "Cambridge Natural History," Vol. VI, p. 552, they dive below the surface for safety in rough weather.

I have, however, noticed that, after being caught in a net, they seem, in many cases, to lose the ability to regain the surface, and drown as suggested by Dr. Delsman. It seems probable that the friction of the

net removes some of the waxy efflorescence which covers these insects and so destroys the surface-film which ordinarily prevents their being wetted.

Besides diving and scooting over the surface at great speed, they are able to leap completely off the water as noted by F. C. Hadden (Proc. Hawaiian Ent. Soc. VII, No. 3, p. 459).

Pairs were often seen *in cop.*, especially in a sheltered bay at Barberyn Island.

A curious association between Ophichthus apicalis and percoid fishes

BY

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It has been known for many years that some fishes enter the urogenital passages of other animals. The best known example is *Fierasfer* which infests the cloaca of holothurians and at times damages its host by its movements. Less well-known is the Brazilian "Candyru" or *Vandellia cirrhosa* Cuv. et. Val. This is a slender Pygidid cat-fish of the Amazon and Orinoco basins, which is greatly dreaded by bathers owing to its urinophilous habit of entering the urethra and working its way into the bladder. The victim usually succumbs to the injuries caused by the fish's spines.

It is now found that an eel has somewhat similar habits, but in this case the host is a large, demersal percoid fish. Probably these bottom feeding fishes are most accessible to the eel which is a bottom dweller[1] and it is strange that the eel selects these fishes which prey largely on it.[2]

Determination of the species of eel was rather difficult as all were found dead and desiccated inside the body of the host. The head and body was always squeezed flat by the peristaltic movements within the host and the entire specimen thickly coated with mucous. After examining a dozen specimens from fishes caught on Pedro Bank, it was identified as *Ophichthus apicalis* (Bennett) and Mr. J. R. Norman of the British Museum to whom the specimens were then sent, is of the opinion that this determination is probably correct.

In every instance the specimens were obtained a few minutes after the capture of the host. The eels were so shrivelled, that the branchiostegals and vertebrae showed prominently through the stringy flesh in marked contrast to eels retrieved from the stomach contents of these fishes. Such eels were half digested, soft, pulpy and much thicker.

1. Elasmobranchs have not been examined.
2. Deraniyagala—Anguilliform fishes of Ceylon, Ceylon Journal of Science, Section B, Vol. XV, p. 16.

These shrivelled eels were preserved in formalin, later soaked in water and cleared of mucous with a camel hair brush. The general appearance was very slender with a large head. The eye was smaller, the snout longer than in fresh *O. apicalis*.

Colour, brown dorsally with numerous stellate melanophores, lighter ventrally.

The host is usually about 600 mm. in length, the eels ranging from 140 mm. to about 180 mm. The usual number of dead eels taken from a single fish is two but at times as many as four have been discovered in the same host. The percoids so affected are *Serranus pantherinus*, (Bleeker); *Lethrinus nebulosus* (Forskål); *Lethrinus miniatus* (Schneider); *Pristipomoides pristipoma* (Bleeker); and several Lutianids chiefly *Lutianus dodecacanthus* (Bleeker).

The first specimens were noted from a *Lethrinus nebulosus* on October 1st, 1926, trawling at a depth of 27 to 30 fathoms. This fish had two shrivelled eels in its urogenital passages. No record was kept until again in August, 1930, many of the fishes trawled were found to be infested and trawl No. 25, August 30th, 1930, in 32 to 135 fathoms at Lat. 9°36′ N. Long. 80°52 E. gave several such examples.

That the eel has assumed this habit for only a part of its life is denoted by its unmodified colouration. Purely commensal forms such as Fierasfer lose most of their pigment as a result of the sheltered existence. As only dead, shrivelled eels have hitherto been found it is possible that the living eels if present either quit their host under the discomfort of the suddenly lowered water pressure caused by the ascent of the trawl or they are forcibly expelled from the cloaca by the sudden expansion of the hosts' swim bladder.

It is not known whether the eel habitually spends this stage of its existence in the percoid's cloaca and occasionally wanders higher up into the urogenital passages from which it cannot return and dies there or whether the eel is commensal in invertebrates as is Fierasfer and enters the fish by mistake. Once inside, the constriction of the percoid's sphincter muscles imprisons it and it dies of asphyxia after working its way as high up as its duration of life and the width of the passage permit.

It is of interest to note that fish eggs were found among the jaw bones of two of these mummified eels and usually the pectoral fins of the eel are reversed to point anteriorly showing that it entered the host, tail first. This form of entrance is very probable, as all Ophichthid eels burrow into the sand with the conical finless tail which is specially adapted for the purpose.

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