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# Oochoristica lygosomae, sp. nov.—a Cestode from ~~the~~ Lizard Lygosoma punctatum

BY

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(With Two Text Figures.)

The material upon which the following description is based was obtained from the intestine of a Skink, *Lygosoma punctatum* Linn., caught in Colombo. There was a heavy infestation of over two dozen Cestodes in the lizard. They were fixed in Carnoy's fluid saturated with corrosive sublimate, and sections were stained in haematoxylin and eosin.

## **Oochoristica lygosomae** sp. nov.

*External.* The worms vary in length from 8. to 15. mm., and have a maximum breadth of about 0.6 mm. They possess from 35-45 proglottides, of which the anterior and immature (23-28 in number) are broader than long, the mature (4-6 in number) are of a length equal to their breadth, and the posterior and gravid (7-11 in number) are three or four times longer than broad (Fig. 1*a*). The terminal gravid proglottides are shed. The scolex measures 0.3 to 0.35 mm. in length and 0.26 to 0.3 mm. in breadth, but it is not distinctly marked off from the next region. The scolex possesses four suckers, two dorsal and two ventral, which are directed antero-laterally. The suckers measure 0.14 mm. in diameter, and, on account of outgrowths of the cuticle of the scolex which overlap the suckers from either side, their apertures are slit-like (Fig. 1*b*). There is no rostellum and cuticular spines are absent. The scolex is succeeded by an indistinct neck in which there is no evident strobilization, and in the most anterior definitive proglottides, 0.55 mm. behind anterior end of the Cestode, the rudiments of the ovaries are apparent. The testes appear coincidently with the genital pore. The genital pores are irregularly alternate and are situated anteriorly in each proglottis at a distance from the anterior end of less than one-third the length of the proglottis. The cirrus sac lies anterior to the vagina.

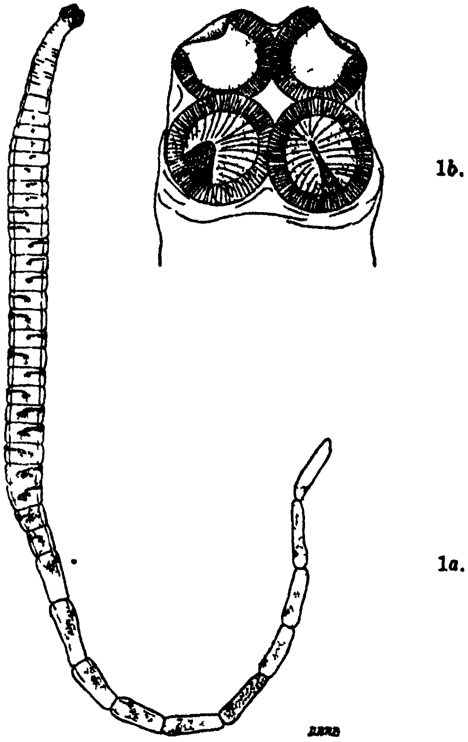

Fig. 1. *Oochoristica lygosomae*

*a* Entire worm × 10. *b* Scolex × 100.

*Muscular system and parenchyma.* There is a comparatively thick cuticula, 6.0 μ in thickness, under which lie many cuticular glands. The longitudinal muscles are disposed in about fifty bundles of fibres which lie external to a very thin layer of circular fibres, and which divide the cortex from the medulla. The thickness of the cortex is about two-thirds that of the medulla, measured dorso-ventrally in the mid line. The entire reproductive system, and the longitudinal excretory vessels lie in the medulla.

*Excretory system.* There are apparently only two longitudinal vessels lying one on either side in the medulla. These vessels are much convoluted, and as the convolutions frequently extend round the genital ducts, it is impossible to tell from any single section whether the genital ducts pass dorsally or ventrally with respect to the excretory ducts. It is found on reconstructing serial sections that the genital ducts lie dorsal to the excretory vessels. The single excretory vessel might therefore be regarded as the ventral vessel, which, when there are two ducts present on either side, is generally the larger. The longitudinal vessels receive a great number of collecting tubules throughout their length. It is possible that there is a very small dorsal longitudinal vessel, likewise much convoluted, which it has not been possible to distinguish from the smaller collecting tubules. In each proglottis towards the posterior limit, the longitudinal vessels are connected by a convoluted transverse vessel.

*Male genitalia.* The testes are few in number, and lie dorsally in the medulla in the posterior half of each proglottis: they lie definitely behind the ovary but one or two testes may lie lateral to the vitelline gland. There are 13 to 18 testes arranged in a single median field. The cirrus sac is large, measuring 175 μ by 55 μ and it extends to the middle line of the proglottis. The cirrus is convoluted, is

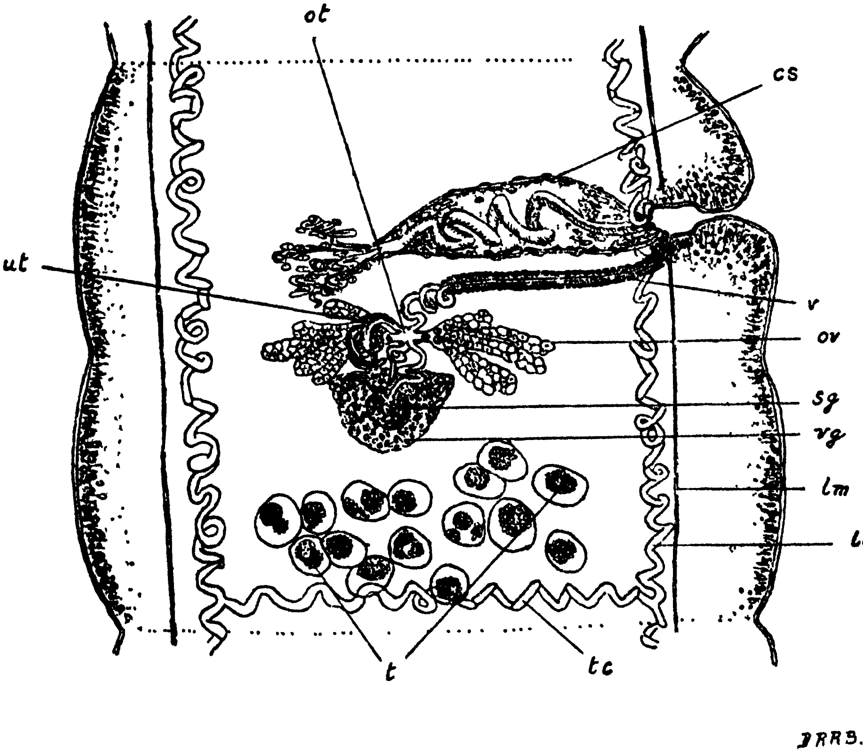

**Fig. 2.** *Oochoristica lygosomae.* Mature proglottis, partly diagrammatic × 80

*cs*—cirrus sac, *lc*—longitudinal excretory canal, *lm*—longitudinal muscles; *ov*—ovary; *ot*—ootype; *sg*—shell gland; *t*—testes; *tc*—transverse execretory canal, *ut*—uterus; *v*—vagina, *vg*—vitelline gland.

surrounded by prostate glands, and it opens into the genital atrium which is 93 μ deep. The genital atrium is constricted, and thus divided into a funnel-shaped external part, in which the narrow part of the funnel is directed inwards, and an inner pear-shaped chamber into which open the cirrus and the vagina. The vasa efferentia could not be traced, but the vasa deferentia, opening into the cirrus, are convoluted and associated with prostate glandular cells. There is no specialized vesicula seminalis.

*Female genitalia.* The ovary, situated ventrally in the centre of the proglottis, is in extent one-third the diameter of the proglottis. The ovary is double or bilobed; each moiety consists of from five to seven finger-like follicles and opens separately by an oviduct into the short ootype. The apertures at the distal ends of the oviducts are guarded, in each case, by a sphincter muscle, which would appear to act as an egg-swallowing apparatus. The mature ovarian ova measure 10.5 μ in diameter and their nuclei are very small measuring 1.25 μ in diameter.

The vitelline gland is a compact body, almost circular in transverse section, but wider anteriorly where it measures 78 μ in diameter. It is situated ventrally, immediately posterior to the ovary in the mid-ventral line, and it lies between the extremities of the ovarian follicles. From the vitelline gland, a narrow thin-walled duct 10 μ in diameter emerges dorsally to follow a convoluted course antero-ventrally and open into the ventral margin of the ootype. Immediately dorsal to the vitelline gland lies the shell gland, spherical in form, measuring 89 μ in diameter. The shell duct, very slightly narrower than the vitelline duct, emerges from the gland anteriorly, to follow a convoluted course and open into the ootype postero-dorsally.

The vagina, opening into the posterior part of the inner division of the genital atrium, lies immediately posterior to the cirrus. It has a narrow lumen of 4.2 μ but the wall of the duct is thick, measuring 16.8 μ across. The vagina follows a curved course, and in the region behind the aporal end of the cirrus sac widens out and becomes convoluted before entering the ootype. The thin-walled convoluted part of the vagina may function as a receptaculum seminis.

The uterus, leading from the ootype, is a short convoluted tube which lies, in the main, aporally. Tracing its condition in serial sections of consecutive proglottides, it is seen to be empty in the first mature proglottis, in the next proglottis it has extended posteriorly, contains unsegmented ova which lie in it in groups of 3, 4, or 5, and constrictions appear in the wall of the uterus between each group. In the later proglottides the uterus is constricted farther, so that each embryo is seen to lie singly in a separate cavity. No mature ova were seen in the parenchyma, as described by Beddard (1914). The genital glands degenerate rapidly in the gravid proglottides in which only embryos and onchospheres are to be seen. The embryos measure 27 μ by 19 μ, while the onchospheres measure 22 μ and possess six slightly curved hooks 11 μ in length.

## DISCUSSION

The genus *Oochoristica* Lühe, 1898, has been redefined by Ransom (1910) and Meggitt (1924). In the main these two definitions agree, although Meggitt includes the character of the genital ducts lying dorsal to, or passing between the excretory vessels, and excludes the character of absence of seminal vesicle given by Ransom. The genus of the species here described agrees with both these definitions, except in the character of the position of the testes. Both Meggitt and Ransom describe the testes in *Oochoristica* as numerous, surrounding the female glands posteriorly and laterally. In this species the testes lie definitely behind the ovary, and only a few testes lie to one side of the vitelline gland. But the same condition is seen in *O. amphisbeteta* Meggitt, 1924, which is accepted as belonging to this genus.

Beddard (1914) discusses *Oochoristica* and *Linstowia*, and argues that there is little ground for separating the two genera, but Baylis (1919) points to a marked difference in the uterus and its fate in the two. In the former genus it is at first definitely formed to be broken up into cavities, each containing a single embryo, but in the latter genus the uterus is never strongly marked off and eggs are embedded in the parenchyma *between* the uterine cavities. This point has not been investigated in all species of the two genera, but, if it is considered as a character of generic value, it is one which also determines our specimen as *Oochoristica*.

Meggitt (1920), has given a key to the species of *Oochoristica*, and later (1924 *a*) he lists the known species, while recently Southwell (1930) has completed his account of the Cestodes of India, Burma, and Ceylon, and records seven species from that region. Of the species recorded, only one, *O. cryptobothria* Linstow, 1906, from the Tree Snake *Chrysopelea ornata*, is from Ceylon.

While agreeing with the characters of the genus, the new species differs in most of its specific characters from the species already known. It is a much smaller worm than any of the others, *O. amphisbeteta* Meggitt, 1924, alone approaching it in breadth, although longer and

*O. figurata* Meggit, 1927, approaching it in length although broader: the scolices of both these species are however smaller. The number of testes 13-18, is fewer than in any of the other Oriental Cestodes, although *O. amphisbeteta* and *O. sigmoides* Moghe, 1926, possess 22-24, while the number in the new species (13-18) corresponds with that of *O. tuberculata* (Rudolphi, 1819) (syn. *Taenia tuberculata* Rudolphi) the type species of the genus. The cirrus is actually and relatively larger than that of any other Oriental species. On these grounds it is considered that this Cestode is an undescribed species, and it is therefore named *O. lygosomae* after its host *Lygosoma punctatum.*

The intermediate host is not known, but as the Lizard lives under stones and in the earth, the intermediate host is thought to be a burrowing insect. It is of interest in this connexion that partially digested Mole Crickets, *Gryllotalpa africana,* were found in the gut with the Cestodes.

The following are the diagnostic characters of the new species:—

Host: *Lygosoma punctatum* Linn.

Locality: Colombo, Ceylon.

Size: 8.0-15.0 mm., by 0.6 mm. at broadest region of strobila.

Scolex: Size 0.26 to 0.31 mm. broad; possessing four suckers, two dorsal and two ventral directed antero-laterally.

Suckers: 0.14 mm. in diameter, with slit-like apertures.

Proglottides: 35-45 in number of which 23-28 are immature, 4-6 are mature, and 7-11 are gravid: the terminal proglottides are shed.

Cirrus sac: 175 μ by 50 . No vesicula seminalis.

Testes: 13-18, situated posteriorly in single field, one or two may be lateral to vitellaria, but all are posterior to the ovary.

Ovary: Double, size measured transversely 286 μ; each half of the gland possesses a separate oviduct, provided with a sphincter muscle, opening into the ootype.

Vitellaria: Immediately posterior to ovary, measuring in widest part 78 μ.

Shell gland: Almost spherical, measuring 55 μ, situated dorsal to ovary.

Ova: 10.5 μ in diameter, with nuclei of 1.25 μ.

Embryos: 27 μ by 19 μ.

Onchosphere: 22 μ, hooks 11 μ.

Vagina: Posterior to cirrus; lumen 4.2 μ; aporal end wider, with a few convolutions.

Uterus: Small, and disappearing early by constrictions into separate chambers, each containing one embryo.

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# Contributions to Ceylon Helminthology

## 3. Mesocoelium burti, sp. nov., Mesocoelium marrsi, sp. nov., and Haplorchis pearsoni, sp. nov.

BY

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(With Three Text Figures.)

### **Mesocoelium burti** sp. nov.

These trematodes were given to me by Mr. D. R. R. Burt, who obtained them from the intestine of *Rhacophorus maculatus*. Thirty specimens were found. They were preserved in Carnoy's fluid saturated with corrosive sublimate. The following description is based on the preserved specimens.

The anterior end is somewhat broader than the posterior end. The length of the body is 0.98 mm.-1.06 mm. and 0.45 mm.-0.53 mm. in breadth. The cuticle is beset with spines, which are more numerous on the ventral surface. On the dorsal surface they extend up to 0.41 mm. from the posterior end, while on the ventral surface they extend more posteriorly up to about 0.1 mm. from the posterior end. The oral sucker is subterminal, measuring 0.175 mm. in diameter; the ventral sucker, which is situated about 0 25 mm. from the oral sucker, measures 0.131 mm. in diameter. The ratio in size between the oral and ventral suckers is 4 : 3.

The prepharynx is small. The pharynx is muscular, measuring 0.06 mm. in diameter. The oesophagus is short and the intestinal diverticula are simple, extending laterally and posteriorly to a little beyond the middle of the body.

The excretory pore is at the posterior end and leads into a simple excretory bladder which extends anteriorly to the ovary and bifurcates into two short arms.

The testes (0.14 mm. by 0.122 mm.) are round and are situated asymmetrically; the left testis is more anteriorly placed than the right. The anterior margin of the left testis is usually on a level with the middle of the ventral sucker, while that of the right testis is a little in front of the posterior end of the ventral sucker (Text Fig. 1). In some cases the left testis is situated above the ventral sucker and extends in front of it. The vasa deferentia unite to open into the cirrus sac, which measures 0.1 mm. in length. The cirrus is short and straight. A pars prostatica is present, as also a bilobed vesicula seminalis, which measures 0.031 mm. in diameter. The genital pore is placed ventrally on a level with the posterior margin of the pharynx.

The ovary is situated behind the left testis. It is oval in outline, measuring 0.152 mm. by 0.078 mm. The receptaculum seminis, measuring 0.073 mm. by 0.061 mm. is situated postero-dorsal to the ovary. The extensive coils of the uterus fill the posterior portion of the body. The operculated eggs measure 0.035 mm.-0.036 mm. by 0.019 mm. 0.022 mm.

The vitelline glands consist of small, round follicles, which extend anteriorly to a level with the posterior margin of the oral sucker, while posteriorly they extend almost to the end of the intestinal diverticulum of the left side and beyond it on the right. In many places they overlap or lie under the intestinal diverticula. The two transverse vitelline ducts meet at a yolk reservoir. The left vitelline duct stretches above the middle of the ovary.

### *Relationships of Mesocoelium burti*

The species under description agree closely with *M.sociale* Lühe, *M.meggitti* Bhalerao, and *M.monodi* Dollfus. It agrees with *M.sociale* with regard to the host, but differs from it in the shape of the ovary, in the position of the vitelline ducts and yolk reservoir and in the size of the cirrus. It differs from *M.meggitti* in the size of the suckers, in the extent of the vitellaria, in the distribution of the spines and in its host being an amphibian. Finally it differs from *M.monodi* in the size of the suckers and in the distribution of the spines.

### *Diagnostic characters*

Host: *Rhacophorus maculatus*, in the intestine.

Type locality: Colombo, Ceylon.

Size: 0.98 mm.-1.06 mm. in length; 0.45 mm.-0.53 mm. in breadth; anterior end somewhat broader than posterior end.

Cuticle: beset with spines, which are more numerous on the ventral surface.

Suckers: oral sucker 0.175 mm.; ventral sucker 0.181 mm.; ratio between oral sucker and ventral sucker 4:3.

Prepharynx: present, small.

**Pharynx**: 0.06 mm. in diameter.

**Oesophagus**: short.

**Intestinal diverticula**: extend a little posterior to the middle of the body.

**Excretory pore**: terminal.

**Excretory vesicle**: long, bifurcated at the anterior end.

**Testes**: 0.14 mm. by 0.122 mm.; asymmetrical, left testis anterior to right.

**Vesicula seminalis**: bilobed, 0.031 mm. in diameter.

**Cirrus sac**: 0.1 mm. in length; cirrus, short and straight.

**Ovary**: oval in outline; on left side; 0.152 mm. by 0.078 mm.

**Receptaculum seminis**: 0.073 mm. by 0.061 mm.; postero-dorsal to ovary.

**Laurer's canal**: short, runs anteriorly.

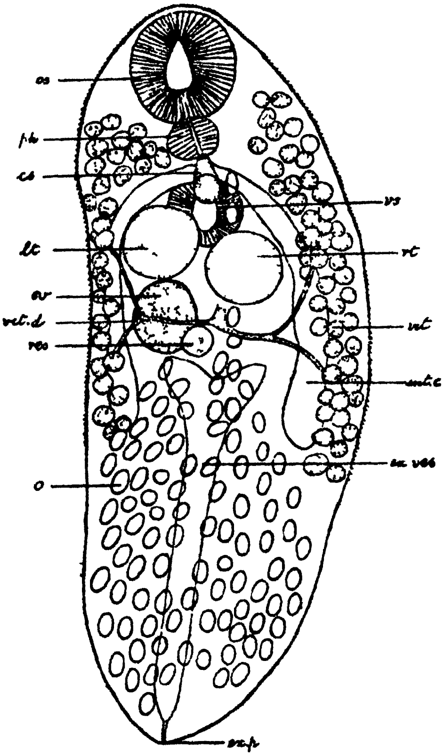

Fig. 1. *Mesocoelium burti*: dorsal view × 100

***cs***, **cirrus sac;** ***ex.p***, **excretory pore;** ***ex.ves***, **excretory vesicle;** ***int.e***, **intestinal diverticulum;** ***lt***, **left testis;** ***o***, **eggs;** ***o.s***, **oral sucker;** ***ov***, **ovary;** ***ph***, **pharynx;** ***res***, **receptaculum seminis;** ***rt***, **right testis;** ***vit***, **vitellaria;** ***vit.d***, **vitelline duct;** ***v.s***, **ventral sucker.**

*Vitelline glands:* extend anteriorly to a level with the posterior margin of the oral sucker, posteriorly to the end of the intestinal diverticulum of the left side, and beyond the intestinal diverticulum of the right side.

*Eggs:* numerous, 0.035 mm.-0.036 mm. by 0.019 mm.-0.022 mm.

The type specimen will be deposited at the British Museum (Natural History).

### **Mesocoelium marrsi** sp. nov.

Three trematodes were obtained from the intestine of *Rhacophorus eques*, which was collected by Mr. D. R. R. Burt at Ohiya. I propose the name *Mesocoelium marrsi* for them, in honour of Mr. R. Marrs, C.I.E., Principal, Ceylon University College.

The worm is 0.52 mm. long and 0.312 mm. broad in the widest region which is on a level with the posterior margin of the oral sucker. The cuticle is smooth. The oral sucker measures 0.148 mm. by 0.131 mm. The ventral sucker measures 0.105 mm.; the ratio between the oral sucker and the ventral sucker is 7:5.

The oral sucker is subterminal. The mouth leads by a short prepharynx into the pharynx, which measures 0.061 mm. in diameter. The oesophagus is short. The intestinal diverticula lead laterally and posterior to the ovary to a distance about 0.12 mm. from the posterior end.

The excretory pore is ventral in position; it is situated about 0.04 mm. from the posterior end. It leads by a short bladder into a long, simple excretory vesicle which extends anteriorly to the level of the vitelline duct, where it bifurcates into two short arms.

The testes are situated asymmetrically. The right testis (0.113 mm. by 0.087 mm ) is placed more anterior than the left. It extends anteriorly to the level of the oesophagus and posteriorly to about the middle of the ventral sucker. The left testis (0.098 mm. by 0.078 mm.) is situated directly above the ventral sucker and it is close to the right testis. The vasa deferentia lead anteriorly to the cirrus sac, which is 0.07 mm. long. The vesicula seminalis is small (0.021 mm. in diameter); the cirrus is long and convoluted. The pars prostatica is not well developed. The genital pore is median and is situated below the posterior margin of the pharynx.

The ovary is oval in outline, measuring 0.105 mm. by 0.078 mm. It is situated behind the right testis, being slightly overlapped by it, and its anterior margin, which lies below the posterior end of the right testis, is on a level with the middle of the ventral sucker. The receptaculum seminis is very small (0.017 mm. in diameter) and is situated above the ovary. Laurer's canal is short.

The vitelline glands consist of a number of rounded follicles which, for the most part, surround the intestinal diverticula. Anteriorly they extend to the level of the posterior margin of the oral sucker. Posteriorly the right vitelline gland extends to a little in front of the end of the right intestinal diverticulum, while the left vitelline gland extends a little further, beyond the intestinal diverticulum on that side. The vitelline ducts meet in the middle line behind the ovary and the median vitelline duct opens into the ootype.

The eggs are few in number and are found in the posterior region. They measure 0.035 mm. by 0.022 mm.

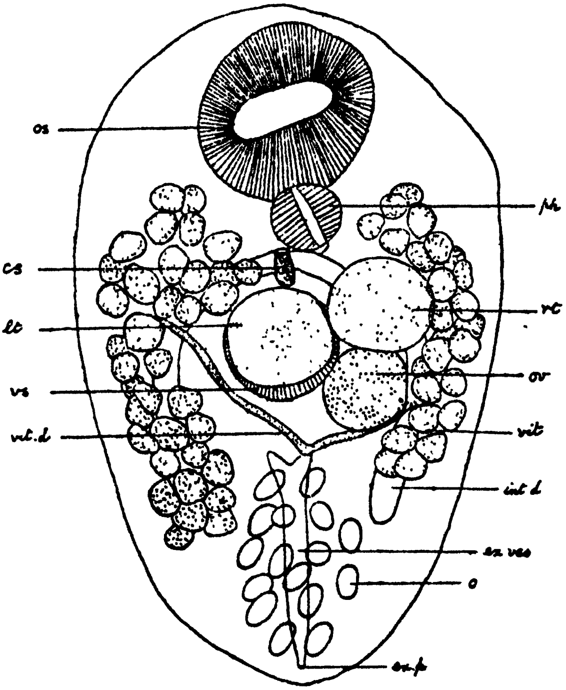

Fig. 2. *Mesocoelium marrsi* : dorsal view × 170

*cs*, cirrus sac; *ex.p*, excretory pore; *ex.ves*, excretory vesicle; *int.d*, intestinal diverticulum; *lt*, left testis; *o*, eggs; *o.s*, oral sucker; *ov*, ovary; *ph*, pharynx; *r.t*, right testis; *vit*, vitellaria; *vit.d*, vitelline duct; *v.s*, ventral sucker.

### *Relationships of Mesocoelium marrsi*

This species agrees with *M.monodi* Dollfus in the asymmetry of the vitelline glands, but differs from it in that it is the right vitelline gland which is the shorter of the two. It agrees with it further in that the left testis overlies the ventral sucker, but differs from it in the fact that *M.monodi* is covered with spines. From the other species of the genus *Mesocoelium* it differs sufficiently to justify this description of it as a new species.

*Diagnostic characters*

Host: *Rhacophorus eques*, in the intestine.

Type locality: Ohiya, Ceylon.

Size: 0.052 mm. in length; 0.312 mm. in breadth; greatest breadth on a level with the posterior region of the oral sucker; ovoid in shape.

Cuticle: smooth (without spines).

Suckers: oral sucker 0.148 mm. by 0.131 mm.; ventral sucker 0.105 mm.; ratio between oral sucker and ventral sucker 7:5.

Prepharynx: present, small.

Pharynx: globular; 0.061 mm. in diameter.

Oesophagus: short.

Intestinal diverticula: reach to about three-quarters of the length of the body.

Excretory pore: ventral.

Excretory vesicle: long, bifurcated at the anterior end.

Testes: asymmetrical, and differ in size; right testis anteriorly placed, 0.113 mm. by 0.087 mm.; left testis lies directly above the ventral sucker, 0.098 mm. by 0.078 mm.

Vesicula seminalis: small, 0.021 mm. in diameter.

Cirrus sac: 0.07 mm. long; cirrus, long and convoluted.

Ovary: Oval in outline, 0.105 mm. by 0.078 mm., situated behind the right testis.

Receptaculum seminis: small, 0.0175 mm., lies directly above the ovary.

Laurer's canal: short.

Vitelline glands: extend anteriorly to the level of the posterior margin of the oral sucker posteriorly beyond the intestinal diverticulum of the left side, but in front of the intestinal diverticulum of the right side.

Eggs: few in number, 0.035 mm. by 0.022 mm.

The type specimen will be deposited at the British Museum (Natural History).

### **Haplorchis pearsoni**, sp. nov.

Three specimens of this trematode were obtained from the rectum of the Brown Fish Owl, *Ketupa zeylonensis zeylonensis*, which was obtained from the Colombo Museum Zoo. It is a new species of the genus *Haplorchis*, for which I propose the name *Haplorchis pearsoni*, in honour of Dr. Joseph Pearson, to whom is due the interest taken in Zoology in Ceylon. I am greatly indebted to Dr. Pearson for much encouragement in my studies on the Platyhelminthes, especially by his providing me with the necessary material from the Museum collection and the Museum Zoo, and by offering me free access to the Museum Library. To Mr. Lyn de Fonseka, of the Museum Library, I am indebted for much help in regard to various references for my papers and also for sending me animals from the Museum Zoo in most favourable condition for study of the parasites.

The specimens were fixed in 10 per cent. formalin and measurements were made in the preserved condition.

The body of the worm is 0.644 mm. long and 0.248 mm. broad. The cuticle is covered with spines, both dorsally and ventrally, the spines extending up to 0.175 mm. from the posterior end.

The oral sucker is small, measuring 0 056 mm. by 0 035 mm. The prepharynx is short (0.014 mm. long) and the pharynx measures 0.029 mm. by 0.022 mm. The oesophagus is long, measuring 0.087 mm. The two intestinal diverticula pass to the right and left sides of the body posteriorly beyond the level of the middle of the testis. Numerous unicellular glands are present in the anterior region of the body. They are situated in the parenchyma and are especially concentrated ventrally, lying alongside the prepharynx, pharynx, oesophagus and between the intestinal diverticula to the region of the genital pore.

The excretory pore is terminal in position. The excretory vesicle is short and wide, extending to the level of the posterior end of the testis.

The single testis is a large, oval body, lying on the left side in the posterior region, and it measures 0.21 mm. by 0.17 mm. A short vas deferens leads from the testis to open into the vesicula seminalis. The vesicula seminalis is a large, thin-walled organ, consisting of a larger division, measuring 0.157 mm. by 0.105 mm., and a smaller diverticulum (0.066 mm. by 0.049 mm.), which lies on the left side and into the posterior end of which opens the vas deferens. From the larger division leads anteriorly an ejaculatory duct, which soon swells out into a small vesicle anterior to the spheroidal body and finally opens into the genital atrium. There is no cirrus. A large number of prostatic gland-cells open into the terminal portion of the ejaculatory duct.

The spheroidal body is a compact muscular organ, measuring 0.043 mm. by 0.035 mm., which forms part of the inner wall of the genital atrium. It has an outer layer of muscle fibres and an inner muscular portion, which is divisible into two regions. That portion which lies distal to the genital atrium is a mass of muscle fibres containing deeply staining bodies, while the proximal portion, which lies next to the atrium, is deeply folded and has a thick cuticle. No spines are present in the spheroidal body.

The ovary is rounded, measuring 0.08 mm. in diameter. It lies on the right side of the body, anterior and ventral to the receptaculum seminis, and in relation to the testis, the centre of the ovary is in a line with the anterior limit of that gland. The receptaculum seminis (0.181 mm. in diameter) lies dorsal and posterior to the ovary. The oviduct leads to the left side to unite with a duct from the receptaculum seminis in the middle line a little behind the level of the anterior margin of the testis. The oviduct then swells into the ootype, after receiving the vitelline duct. The shell gland is small. The vitelline glands consist of a large number of unicellular glands which lie in the posterior region of the body on a level with the anterior end of the receptaculum seminis, extending almost to the posterior end of the body. They do not form compact follicles, but are more concentrated in certain regions than in others, lying between the testis and receptaculum seminis, on the sides and in the dorsal region of the body. Laurer's canal is not present.

The uterus, filled with eggs, occupies the posterior region of the body, obscuring the outlines of the other organs. The terminal portion of the uterus is muscular and opens into the genital atrium to the left of the spheroidal body. The eggs measure 0.029 mm. by 0.014 mm.

The genital pore is median in position, situated about 0.25 mm. from the anterior end. While spines are present on the ventral surface and in the region of the genital pore, no spines are found in any part of the genital atrium.

### *Relationships of Haplorchis pearsoni*

Two species of *Haplorchis* have been recorded, *H. pumilio* Looss from *Pelecanus onocrotalus* and *H. cahirinus* Looss from a fish, *Bagrus bayad.* The species described in this paper differs from both in that the prepharynx is short, the pharynx lies closer to the oral sucker than to the intestinal bifurcation and in the absence of Laurer's canal. It also differs from *H. pumilio* in the position of the excretory pore, which is terminal in the former and dorsal in the latter. These characters are considered sufficiently diagnostic to create a new species for it.

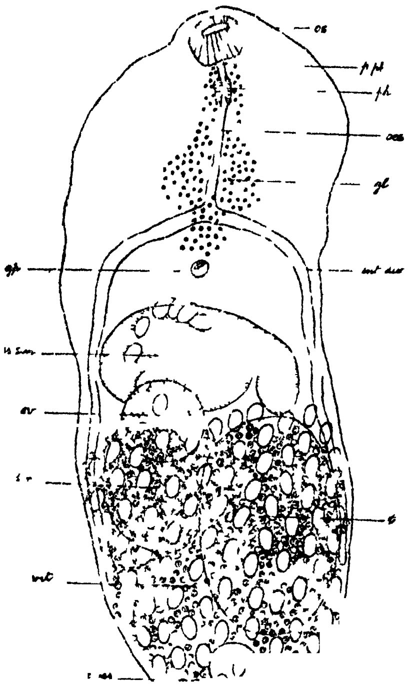

Fig 3 *Haplorchis pearsoni* ventral view × 150

*ex ves*—excretory vesicle, *gl*—unicellular glands, *gp*—genital pore *int div*—intestinal diverticulum, *o*—eggs, *oes*—oesophagus, *os*—oral sucker, *ov*—ovary, *ph*—pharynx, *p ph*—prepharynx, *res sem*—receptaculum seminis, *t*—testis, *ves sem*—vesicula seminalis, *vit*—vitellaria

*Diagnostic characters*

Host. *Ketupa zeylonensis zeylonensis.*

Type locality: Colombo, Ceylon

Size: 0.644 mm. in length; 0.248 mm in breadth.

Cuticle: covered with spines both ventrally and dorsally up to 0.175 mm. from posterior end.

Oral sucker: measuring 0.056 mm. by 0 035 mm

Prepharynx: short, 0.014 mm. long

Pharynx: 0.029 mm. by 0.022 mm.; lying closer to oral sucker than to intestinal bifurcation.

Oesophagus: long, 0.087 mm. in length.

Intestinal diverticula: almost reaching to the level of the posterior end of the testis.

Excretory pore: terminal.

Excretory vesicle: short and wide, extending to the testis.

Testis: single, on left side, 0.21 mm. by 0.17 mm.

Vesicula seminalis: large, with a larger division measuring 0.157 mm. by 0.105 mm. and a smaller diverticulum measuring 0.066 mm. by 0.049 mm.

Cirrus: absent.

Pars prostatica: present, in terminal portion of the ejaculatory duct.

Spheroidal body: 0.043 mm. by 0.035 mm.; spines absent.

Ovary: lying on right side partly in front of anterior level of testis; 0.08 mm. in diameter.

Receptaculum seminis: postero-dorsal to ovary; 0.131 mm. in diameter.

Laurer's canal: absent.

Vitelline glands: diffuse, in posterior region of body.

Eggs: 0.029 mm. by 0.014 mm.

Genital pore: median; spines not present in any part of genital atrium.

The type specimen will be deposited at the British Museum (Natural History).

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# The Gomphines of Ceylon
# (Order Odonata)

BY

F. C. FRASER, Lt Col., I.M.S., F.E.S.

(With Six Text Figures.)

In the first list published of Ceylonese Dragonflies, Dr. Hagen [*Verh. zool.-bot. Ges. Wien*, Vol. VIII, pp. 478-481 (1858)] did not include a single species of the family *Gomphidae*. A supplementary list which he published in the same work in the following year, also records no species belonging to this family.

The first record we find is that of *Gomphus* (?) *ceylonicus* Selys, (1878), and *Gomphus* (?) *nietneri* Selys, (1878), both published in the *Bull. Acad. Belg.* (2) XLVI, pp. 455 and 449. These two species, whose identity is a little doubtful, were collected at Rambodda.

The next mention of this family is found in the *J. Linn. Soc. Zool.* Vol. XXIV, pp. 557 and 558 (1894), where the late Mr. Kirby gives the two species mentioned above under the names of *Aeschna ceylonica* and *Anisogomphus nietneri* respectively, and also gives a third species *Ictinus rapax* Ramb., collected by Col. Yerbury at Periyakulam and Haldummulla.

The last and most recent list published of the Order as occurring in Ceylon is that of Dr. Laidlaw, which appeared in *Spolia Zeylan.*, Vol. XII, 1924, and which contained the names of seven Gomphines. In this list, *Gomphus nietneri* Selys appears under the name of *Heliogomphus nietneri* (Selys), and *Gomphus ceylonicus* Selys, as *Gomphus ceylanicus* Selys, the difference in spelling probably being due to a *lapsus calami*. A new record for *Ictinus rapax* Ramb., is given from Kandy.

In addition to these three, four other species are listed,—*Macrogomphus annulatus* Selys (?), *Mesogomphus lineatus* Selys. *Cyclogomphus heterostylus* Selys and an unnamed *Heterogomphus* which Laidlaw subsequently described as *Heterogomphus ceylonicus* (*Rec. Ind. Mus.* Vol. XXIV, pp. 412-414, fig. 21 (1922). The first of these

Laidlaw queried as *M.annulatus*, and gave a number of specific points in which it differed from that species. He had only two females to deal with but a subsequent examination of a male specimen, in the Colombo Museum, by myself has clearly shown that this insect is a new species and is described below as such. Concerning the second species Laidlaw opined that it might be a geographical race as it differed in many points from the type of *M.lineatus*. Subsequently he redescribed this as a new species under the name of *M.henryi* [*Proc. Zool. Soc. Lond.* pp. 131, 132 (1928)], and was undoubtedly correct in doing so. In regard to the third species, *Cyclogomphus heterostylus*, this was described from a female, and as the markings are very similar to the male of that species, a very natural mistake occurred. Two males, one collected by Col. F. Wall, the other by myself in Kandy, have since shown that this insect is the female of a distinct species, *Cyclogomphus gynostylus* Fras., [*J. Bombay Nat. Hist. Soc.*, Vol. XXXI. No. 1, pp. 162, 163 (1926)]. The last species mentioned has since been transferred to a new genus under the name of *Megalogomphus ceylonicus*, the name *Heterogomphus* being preoccupied.

During a collecting trip to Ceylon made in the month of May (1932), mainly for the purpose of studying the Ceylon Platystictas, I was able to investigate the occurrence of species of Gomphidae on the spot and am now in a position to give an amended and up-to-date list of the island's fauna, which now numbers eleven species.

## LIST OF SPECIES OF GOMPHIDAE.

1. *Ictinus rapax* (Rambur).
2. *Gomphidia pearsoni*, sp. nov.
3. *Megalogomphus ceylonicus* (Laidlaw).
4. *Macrogomphus lankanensis*, sp. nov.
5. *Cyclogomphus gynostylus* Fraser.
6. *Heliogomphus nietneri* (Selys).
7. *Heliogomphus lyratus*, sp. nov.
8. *Heliogomphus walli* Fraser.
9. *Heliogomphus ceylonicus* (Selys).
10. *Mesogomphus henryi* Laidlaw.
11. *Burmagomphus sinuatus*, sp. nov.

### 1. **Ictinus rapax** (Ramb.)

*Diastatomma rapax* Rambur, 1842. *Ins. Nevrop.* p. 169.

*Ictinus rapax* Selys, 1854. *Bull. Acad. Belg.* (2) XXI, p. 90; *Id.* 1857. *Mon. Gomph.* p. 276; Kirby, 1890. *Cat. Odon.* p. 77; *Laidlaw*, 1922. *Rec. Ind. Mus.*. Vol. XXIV, p. 373; Williamson, 1908. *Proc. U. S. Nat. Mus.* Vol. XXXIII, p. 279; Fraser, 1923. *J. Bombay Nat. Hist. Soc.* Vol. XXIX, pp. 661-663.

Common throughout the plains, especially in paddy lands. Breeds in all tanks around Colombo. Was found commonly around Kandy during May. Does not differ from type in any way.

### 2. **Gomphidia pearsoni**, sp. nov.

*Male.* Abdomen, including appendages, 60 mm. Hindwing 42 mm.

Head: labium bright yellow; labrum black marked with two small citron yellow spots at base; bases of mandibles citron yellow at base; anteclypeus brown, paler at the middle; postclypeus bright citron yellow in its lower half, black in the upper half; frons black with a large broad triangular spot of greenish-yellow on each side above and slightly overlapping on to the anterior surface; vertex and occiput black, the latter fringed with short dark hairs; eyes bottle-green during life.

Prothorax black, unmarked; thorax black marked with bright greenish-yellow as follows,—a broad, slightly interrupted mesothoracic collar; short pyriform antehumeral spots, their lower points strongly divergent; a small upper humeral spot; two stripes on the sides, an anterior moderately broad, anterior to the level of the spiracle, and a very broad one covering the posterior two thirds of the metepimeron; lastly a small upper and a lower spot lying between these two stripes. Legs entirely black.

Wings hyaline, palely enfumed especially at apices; pterostigma long, black, braced, covering 5 to 7 cells; 4 cells in discoidal triangle of forewings, 3 in the hind; 2 to 3 cells in the subtriangle of forewing, entire in the hind; 3 cubital nervures in forewings, 2 in the hind; nodal index,—$\frac{12\cdot22 \mid 23\cdot13}{12\cdot15 \mid 14\cdot13}$.

Abdomen black marked with bright citron yellow as follows.—segment 1 with a vestige of an apical dorsal spot and a fine linear apical stripe on each side; segment 2 with the oreillets, a small spot on the sides apicad to them and a middorsal triangular basal stripe extending for two thirds the length of segment; segments 3 to 6 with small basal triangular dorsal spots bifid behind and gradually growing smaller from 3 to 6, being mere tiny points on the latter segment; segment 7 with its basal half yellow, traversed on the sides by the fine black jugal suture; segment 8 with a narrow linear basal lateral stripe on each side, remaining segments unmarked.

Anal appendages black; superiors half as long again as segment 10, compressed laterally, narrow and of even width throughout, bevelled to a point at apex; inferior only one third as long, deeply cleft to form two triangular lobes, the apices of which are turned up slightly and end in 3 minute spines or teeth.

*Distribution.*—One male collected by the writer five miles above Belihul Oya, 10.V.32, and another male in the Colombo Museum collection, Bibile (Gal Oya), 22.VII.29, collected by Mr. Henry. This species is closely related to *G.kodaguensis* Fraser, from S. India and is distinguished from it by its larger size, abdomen 60 mm. long compared to 53 mm. in this latter species; the black ground colour is far more extensive than in *G.kodaguensis;* segment 10 is unmarked and lastly the subtrigones of forewings are split up into 3 cells instead of only 2.

Type at present in the Colombo Museum. Female unknown. Paratype in the writer's collection. It gives me great pleasure in naming this species after Dr. Pearson, Director of the Colombo Museum.

### 3 **Megalogomphus ceylonicus** (Laidlaw)

*Heterogomphus ceylonicus* Laidlaw, 1922. *Rec. Ind. Mus.* Vol. XXIV, pp. 412-414, fig. 21; Fraser, 1923. *J. Bombay Nat. Hist. Soc.* Vol. XXIX, pp. 676, 677.

A rare species of which only a single male and two females are at present known. The type, a male, is in the British Museum, the females are in the Colombo Museum and the writer's collections respectively. This sex has not yet been described.

*Female.* Abdomen 49 mm. Hindwing 46 mm.

Head: labium bright yellow; labrum black with two large greenish-yellow spots confluent anteriorly to form a horse-shoe shaped spot; anteclypeus yellow; postclypeus black with a small yellow spot on each side; frons black broadly greenish-yellow above but very narrowly interrupted in the sulcus by an extension forwards of the basal black; vertex black; occiput yellow at its middle and behind.

Prothorax black with a tiny geminate spot on dorsum of middle lobe and a linear spot on each side. Thorax black marked with greenish-yellow as follows,—a broad mesothoracic collar narrowly interrupted in the middle line, oval antehumeral spots diverging outwards below, the outer portions of the antealar sinus, two broad lateral stripes, one on the mesepimeron, the other, much broader, covering the greater part of metepimeron, and lastly an upper and a lower spot between these two stripes. Legs black, coxae with a large spot of yellow and all femora broadly yellow on the outer sides except at distal ends.

Wings hyaline, very broad and long, nearly as long as the abdomen; pterostigma black, broad and long, strongly braced; all triangles untraversed; 1 cubital nervure in all wings; anal loop well formed, of 2 cells; nodal index,—$\frac{11\cdot18}{11\cdot12}\Big|\frac{18\cdot10}{14\cdot12}$.

Abdomen black marked with greenish-yellow as follows,—an irregular stripe on each side extending from segment 1 to the apical third of segment 3 and represented on segments 4 to 6 by small basal lateral triangular spots; an elongate middorsal stripe on segments 2 and 3, vestigial and apical on segment 1, trilobate on segments 2 and 3 and represented on segments 4 to 6 by middorsal basal triangular spots, large and tapering apicad on segment 4, smaller on the two following segments; segment 7 with its basal two thirds yellow, but rather more extensively so on the sides; segments 8 and 9 with small baso-lateral spots, and segment 10 with a pair of tiny subdorsal spots.

Anal appendages short, narrow and cylindrical, finely pointed; vulvar scales very short, deeply and narrowly cleft, the sides of the fissure prolonged as two robust points.

*Distribution.*—Nalanda and Balangoda, Ceylon. The allotype female in the writer's collection was taken by Col. F. Wall, 16.X.24. The species is closely allied to *M.hannyngtoni* Fraser from S. India, but is a much smaller insect and is marked differently.

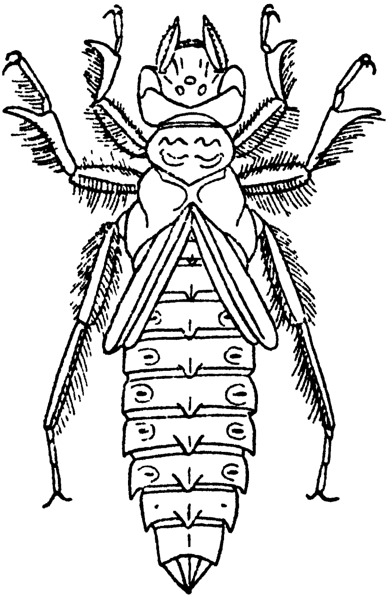

**Fig. 1. Larva of *Megalogomphus ceylonicus* (Laid.)**

*Larva.*—There is a single exuviae of this insect in the Colombo Museum which closely resembles that of *Megalogomphus hannyngtoni* its near relative from S. India. It is in fact a miniature of that insect, being 34 mm. in length as compared to 45 mm. for *hannyngtoni*, and 8 mm. across the abdomen as compared to 13 mm. Beyond this difference in size, I can find no other character by which to define them except the mask, the lateral lobe of which is deeply bifid at the end and has two robust teeth preceding the two long and equal terminal ones. In *M.hannyngtoni* this lobe ends in a single robust tooth which is finely dentate on its inner border.

### 4. **Macrogomphus lankanensis**, sp. nov. (Fig. 2, *c* and *d*.)

*Macrogomphus annulatus* Laidlaw, 1924. *Spolia Zeylan.*, Vol. XII, p. 340.

*Male.* Abdomen 45 mm. Hindwing 33 mm.

Head: labium black, lateral lobes yellowish; labrum black marked with two large triangular citron yellow spots; bases of mandibles citron yellow; ante- and post-clypeus black, the latter with two small points of yellow below; frons black, the crest broadly yellow, this colour overlapping on to the upper half of front, base of frons above, vertex and occiput black, the latter fringed with short black hairs.

Prothorax black with a moderately large rounded spot on each side of the middle lobe and a small oval spot on the middle of posterior lobe.

Thoarx black marked with citron yellow as follows,—ante-humeral stripes parallel with the middorsal carina, thickened below and tapered below as far as the antealar sinus, the stripe shaped like a tin-tack with the head broadened accordingly below; a small upper humeral spot, two broad lateral stripes, the posterior of which cover the anterior half of metepimeron, and between these two stripes, an upper and a lower rounded spot. Legs black, the anterior pair of femora with an oval yellow spot on the inner side.

Wings hyaline; pterostigma blackish brown, braced, covering 5 cells; anal triangle 3-celled; 2 cubital nervures in forewing, 1 in the hind; 10 to 11 postnodal nervures in forewings, 10 in the hind, 15 to 16 antenodals in forewings and 11 in the hind.

Abdomen black marked with citron yellow as follows,—segment 1 with a middorsal apical triangular spot and a large triangular apical spot on each side; segment 2 with a trilobate middorsal stripe in continuation of the spot on segment 1, a very large spot on each side which includes the oreillets and a smaller triangular apical lateral spot; segments 3 to 6 with rather large baso-lateral spots; segment 7 with its basal half yellow, this area with a small black triangular baso-dorsal spot; segment 8 with a linear subdorsal basal spot on each side; remaining segments unmarked.

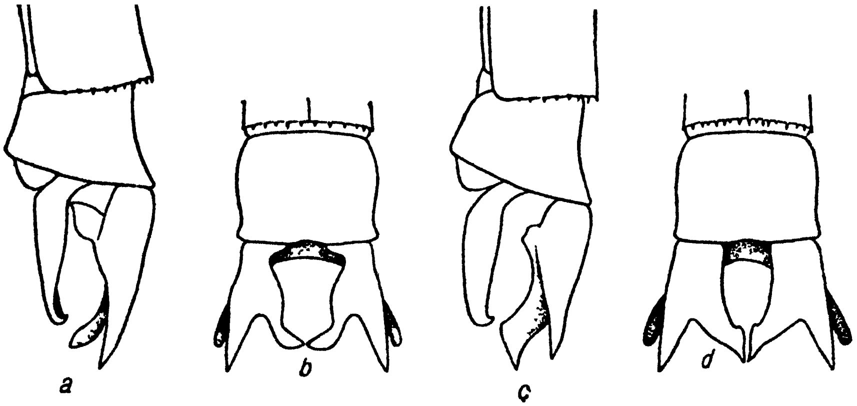

Fig. 2. Anal appendages of:

*a Macrogomphus annulatus* Selys, ♂, left side. *b Macrogomphus annulatus* Selys, ♂, dorsal. *c Macrogomphus lankanensis* sp. nov. ♂, left side. *d Macrogomphus lankanensis* sp. nov. ♂, dorsal.

Anal appendages: superiors creamy yellow except the tip of inner branch which is black, rather longer than segment 10, subcylindrical at base, bifurcated into two branches at beginning of apical third, the outer branch projecting straight back and pointed acutely at apex, the inner angulated strongly in, its apex tapering and turned up and with a robust obtuse tooth situated subapically below; below appendage, a squared tubercle slightly basad the middle; inferior appendage black, deeply cleft into two slender branches which are curved strongly up and end in a minute backwardly directed spine.

*Distribution.*—Murunkan, N. P., July, 1922, and Haragama, July to August, 1910. Probably widely distributed in various parts of the island in submontane tracts. Differs from *M. annulatus* by the shape of the appendages and by the black ground-colour much more extensive. I have not seen the female but Laidlaw gives the following notes,—" Black on labrum much more extensive, postclypeus almost entirely black with 2 very small points of yellow; no yellow spot on occiput; antehumeral stripes narrower and the upper humeral spot obsolete." This is in accordance with the male except for the upper humeral spot which is present in the male and which is probably variable.

Type male in the Colombo Museum.

### 5. **Cyclogomphus gynostylus** Fraser (Fig. 3).

*Cyclogomphus gynostylus* Fraser, 1926. *J. Bombay Nat. Hist. Soc.* Vol. XXX, pp. 162, 163.

I was fortunate enough to secure another specimen of this rare and curious dragonfly. The type, a teneral and rather distorted specimen taken on the banks of Kandy Lake by Col. Wall, 4.IX.24, is still in my own collection. The new specimen was also taken at Kandy, 8.V.32, and is a fully adult male. The markings of this specimen do not differ from the figure given by me (*J. Bombay Nat. Hist. Soc.* Vol. XXX, No. 4) except that the black humeral stripe on thorax is much thicker than shown there. The female mentioned by Laidlaw as belonging to *Cyclogomphus heterostylus* Selys, is quite certainly the female of this new species, as its markings do not differ materially from *C.heterostylus*. The latter species has not been recorded further south than the Deccan, and is hardly likely to turn up in Ceylon, as all species of the genus are remarkably local. The Ceylon species may be determined by the unique shape of the superior anal appendages.

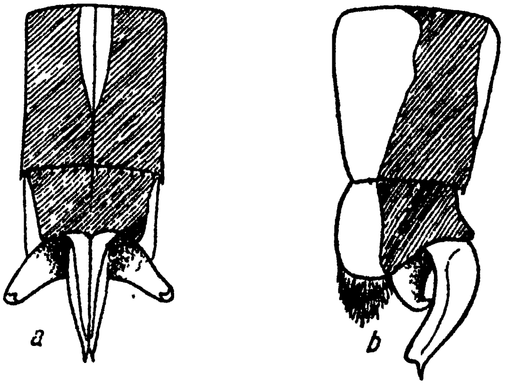

Fig. 3. Anal appendages of *Cyclogomphus gynostylus* Fraser, ♂.
*a* Dorsal view. *b* Left side.

### 6. **Heliogomphus nietneri** (Selys)

*Gomphus ? nietneri* Selys, 1878. *Bull. Acad. Belg.* (2) XLVI, p. 449.
*Anisogomphus nietneri* Selys, 1878. *Bull. Acad. Belg.* (2) XLVI, p. 449; Kirby, 1890. *Cat. Odon.* p. 69.
*Leptogomphus nietneri* Selys, 1878. *Bull. Acad. Belg.* (2) XLVI, p. 449; Williamson, 1907. *Proc. U. S. Nat. Mus.* Vol. XXXIII, p. 295; Ris, 1912. *Suppl. Ent.* p. 69.
*Heliogomphus nietneri* Laidlaw, 1922. *Rec. Ind. Mus.* Vol. XXIV, pp. 379-380, (*H. selysi* Fras. nec *nietneri* Selys); Fraser, 1922. *ibid.* Vol. XXIV, p. 416, (*H.* sp. nov. nec *nietneri* Selys); Laidlaw, 1924 *Spolia Zeylan.*, Vol. XII, p. 339; Fraser, 1926. *J. Bombay Nat. Hist. Soc.* Vol. XXX, p. 847.

The type of *H.nietneri*, from Ceylon, is in the Hagen collection, Museum of Comparative Zoology, Mass. U. S. A.; its description was communicated to Selys by Hagen. Its position in the genus *Gomphus* was from the first doubtful; Hagen had suggested the name of *Anisogomphus* for a new genus in which to place it but this name had already been preoccupied for other unrelated species of Gomphines by Selys. Kirby however included it under genus *Anisogomphus* in his Catalogue, 1890. Ris foreshadowed its generic separation but included it under genus *Leptogomphus* in 1912, and Laidlaw finally raised it to generic rank in 1922. Although it was the first species of the genus to be described, it is not the genotype, as the species described by Laidlaw from Assam, under the impression that it was *H.nietneri* turned out to be a new species which has since been named *H.selysi* Fraser. Laidlaw qualified his description by stating that he believed it not unlikely that the Assam specimen would prove to be a distinct species.

In addition to *H.nietneri*, another species from Ceylon was described in the same publication by Selys under the name *Gomphus ? ceylonicus*. This specimen was a female but from its venation and the character of its markings, it seems quite clear that it was referable to genus *Heliogomphus* · Selys in fact stated that it was closely related to *H.promelas* (Selys), a species from S. India. The type of *Heliogomphus ceylonicus* is also in the Museum of Comparative Zoology and its description was communicated by Hagen to Selys.

In the Colombo Museum material which I was able to examine through the kindness of Dr. Pearson and Mr. Henry, I found two well defined species of *Heliogomphus*, one of which was *H.lyratus* sp. nov., described below, and the other *H.walli* Fras. Now it was probable but by no means certain that one of these two might be *H.nietneri*, and of the two, *H.walli* seemed to be the most likely as the subbasal spine on the superior anal appendages of *H.lyratus* is so enormous that Selys would certainly have commented upon it had it been the same in *H.nietneri*. To solve this problem I wrote to Mr. Nathan Banks of the Museum of Comparative Zoology, Mass., asking him to compare my figure of the anal appendages of *H.walli* with the type of *H.nietneri*. He very kindly obliged and sent me the accompanying figure (Fig. 4*e*) and the following notes,—" Your figure of *H.walli* is very close to *Anisogomphus* (*Heliogomphus*) *nietneri*. I enclose a sketch of *A.nietneri;* you will see that the upper arm (superior appendage) has the tooth at basal third sharper and directed outward and the margin before it is a little concave; beyond the spine, the appendage turns in at nearly a right angle (not evenly curling); the apical recurved hook is longer, more slender than in your figure of *walli*. The lower process (inferior appendage) projects more laterally, less posteriorly than in *walli*."

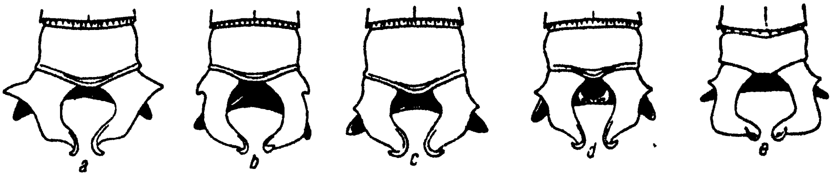

Fig. 4. Dorsal view of anal appendages of:

*a Heliogomphus lyratus*, sp. nov., ♂. *b Heliogomphus walli* Fraser, ♂. *c Heliogomphus kalarensis*, sp. nov., ♂. *d Heliogomphus promelas* (Selys), ♂. *e Heliogomphus nietneri* (Selys), ♂.

I have compared Mr. Banks' figure with actual specimens of *H.walli* and find that the differences he mentions are borne out, the subbasal spine of the superior appendages in the latter being very definitely directed backward and the appendage thereafter being evenly curled. In addition to these features, *H.nietneri* differs from *walli* by having the occiput yellow and the postero-lateral stripe of thorax almost at the posterior border. Thus it still seems better to regard *H.walli* as a species distinct from *nietneri*.

Finally it is necessary to mention that a re-examination of the specimen taken at Kalar, Nilgiris, which I opined was very closely related to *H.nietneri*, differs in so many respects that I have decided to give it specific rank under the name of *H.kalarensis*. Thus we now know of three species from within Indian limits,—*H.promelas* (Selys) and *H.kalarensis* Fras., from the Western Ghats; *H.selysi* Fras., from Assam and Burma; whilst there are possibly four species from Ceylon,—*H.nietneri* (Selys) described from a male, *H.ceylonicus* (Selys) described from a female, and certainly not conspecific with the former, and *H.walli* Fras., and *H.lyratus* sp. nov., both sexes of which are described below.

## 7. **Heliogomphus walli** Fraser

*Heliogomphus walli* Fraser, 1925. *J. Bombay Nat. Hist. Soc.* Vol. XXX. No. 4, pp. 849, 850.

*Male.* Abdomen 36 mm. Hindwing 31 mm.

Head: labium with lateral lobes yellow, middle lobe black, as also the tips of the lateral; labium black marked with two large triangular citron yellow spots at the base; rest of head black except for a moderately large broad greeny-yellow stripe on crest of frons which overlaps the front border slightly; the base of frons black and sending a prolongation forwards in the sulcus to nearly cut the yellow stripe on crest in two; occiput naked, a narrow transverse sulcus at its posterior part, an anterior ridge along its anterior border with a short medial ridge running straight back from the middle of the latter. (Fig. 5*a*.)

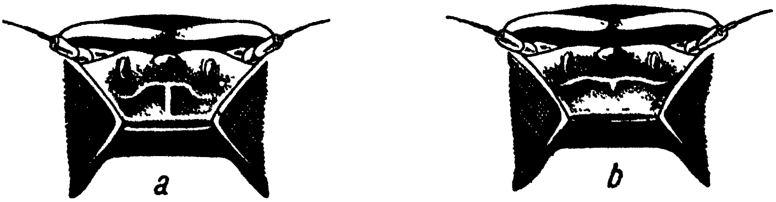

**Fig. 5. Dorsal view of vertex and occiput of:**

*a Heliogomphus walli* Fraser, ♂, ♀. *b Heliogomphus lyratus* sp. nov., ♂, ♀.

Prothorax black with a narrow anterior yellow collar.

Thorax black with a very narrow, slightly interrupted mesothoracic collar, very short linear antehumeral spots extending neither below nor above but strongly divergent below; laterally greenish-yellow with a narrow black stripe on each lateral suture, that on the anterior suture markedly broader than that on posterior; beneath yellow, pruinosed white in adults.

Wings hyaline; pterostigma dark ochreous heavily bordered with black nervures, covering 3 to 4 cells, unbraced; 2 cubital nervures in all wings; anal triangle 3-celled; nodal index,—$\frac{15\cdot16}{13\cdot12}\ \frac{16\cdot14}{11\cdot13}$.

Abdomen black marked with citron yellow as follows,—segment 1 with a small triangular middorsal basal spot and its sides broadly; segment 2 with a laterobasal spot which includes the oreillets, a lateroapical spot on each side and a short, middorsal very narrow stripe; segments 3 to 8 with small triangular laterobasal spots on each side particularly large on segment 8; segments 7 and 8 with lateroapical spots also; the middorsal carina finely yellow from segments 3 to 7; remaining segments unmarked.

Anal appendages: superiors black for the basal third, yellowish thereafter, moderately broad at base, directed at first a little obliquely outwards and then at junction of middle and apical thirds turned rather abruptly inwards but the angulation rounded. A small subbasal spine on the outer side which is not very conspicuous; the apical third turned in and curled almost perpendicularly upward and then a little outward. The two appendages enclosing a foramen and lyriform. Inferior appendage much shorter but with a long narrow branch on each side which projects from beneath the superiors, black. (Fig. 4*b*.)

*Female.* Abdomen 38 mm. Hindwing 36 mm.

Marked similarly to the male but the yellow crest on frons very slightly interrupted; occiput sculptured similarly to the male.

Wings similar to the male but one or more wings with occasionally a single cubital nervure only. Legs, which are entirely black in the male, have the femora of the hind pair in the female paler and yellow on the inner side.

*Distribution.*—The male in the Colombo Museum collection is from Balangoda, IV.26; the female in the same collection, from Morningside Estate, Rakwana, May, 1929; whilst the female in my own collection is from Nalanda, 10.IX.24.

This species differs from *H.nietneri* in the colour of the labium; the occiput, which is entirely black; the absence of an upper humeral spot and the costal border of the wings black. The position also of the posterior stripe on the sides of thorax is different, this being " presque terminale " in *H.nictneri*. The anal appendages also are shaped differently as stated above.

Type in my own collection; allotype male in the Colombo Museum collection.

### 8. **Heliogomphus lyratus,** sp. nov. (Fig. 5*b*.)

*Male*. Abdomen 34 mm. Hindwing 30 mm.

Head: labium with lateral lobes yellow, middle black as also the tips of the lateral; labrum black marked with two large triangular yellow spots at base; rest of head black except for a moderately broad greenish-yellow stripe on crest of frons, slightly overlapping on to the front and almost cut in two at the middle by the fusion of the frontal and basal black; occiput naked, with a narrow transverse sulcus at its posterior part and ridged in front, but no median ridge. (Fig. 5*b*.)

Prothorax black with a narrow anterior yellow collar.

Thorax black with a very narrow, slightly interrupted mesothoracic collar, very short linear antehumeral spots extending neither below nor above but divergent below; laterally greenish-yellow with a narrow black stripe on each lateral suture; beneath yellow, pruinosed white in adults. Legs black, coxae yellow outwardly.

Wings hyaline; pterostigma dark ochreous heavily bordered with black, covering 3 to 4 cells, unbraced; 2 cubital nervures in the forewings, rarely only 1, and only 1 in the hind; anal triangle 3-celled; membrane obsolete; nodal index,—$\frac{15\text{-}16}{13\text{-}12}\Big|\frac{16\text{-}14}{11\text{-}13}$.

Abdomen black marked with citron yellow as follows,—segment 1 with a minute triangular middorsal basal spot and its sides broadly; segment 2 with a laterobasal spot which includes the oreillets, a lateroapical spot on each side and a short middorsal, very narrow stripe; segments 3 to 7 with small triangular laterobasal spots on each side and the middorsal carina on segments 3 and 4 only finely yellow; remaining segments unmarked.

Anal appendages,—superiors black for the basal two thirds, apical third yellow tipped with black, very broad and flat at base as seen from above and with an enormous subbasal outer spine projecting at right angles to the body axis, after which the appendage narrows abruptly and is directed obliquely inwards, the basal third strongly angulated inward with a lower outer obtuse spine at the elbow, and the apex curled up almost perpendicularly and its extreme point outwards. (Fig. 4*a*.)

Inferior appendage shorter, black, broadly but shallowly bifid, its rather long branches projecting from beneath the superior appendages.

*Female.* Abdomen 33 mm. Hindwing 30 mm.

Differs in some respects from the male: stripe on frons broader and not constricted at the middle; an upper small triangular yellow humeral spot on each side of thorax on the dorsal side of the humeral suture; abdomen marked as follows,—a middorsal stripe on segments 1 to 7, triangular on segment 1, narrow and linear on the remaining segments and not quite extending to the apical end of segments 5 to 7; a linear stripe on segments 1 to 8, very broad on segments 1 and 2 and the base of 3, then becoming broken up into an apical and a basal spot on the remaining segments; anal appendages shortly conical, yellow. Wings palely enfumed; only 1 cubital nervure in all wings; nodal index, $\frac{12\text{-}15}{13\text{-}11}\Big|\frac{15\text{-}14}{12\text{-}13}$; vulvar scale nearly half the length of segment 8, broadly triangular and with a narrow cleft extending from its apical end to about halfway to base.

*Distribution.*—Haldummulla during June; type male and allotype female in the Colombo Museum. Differs from *H.nietneri* by the colour of the labium, the occiput entirely black, upper humeral spot absent in the male, costal border of wings black, abdominal markings of male more restricted, and by the anal appendages especially, the enormous subbasal spine of superiors being quite different from the short spine in *nietneri.* The latter feature will also determine it from *H.walli*, which has a short, backwardly directed spine. (See Fig. 4*a*, p. 28).

### 9. **Heliogomphus ceylonicus** (Selys)

*Gomphus ceylonicus* Selys, 1878. *Bull. Acad. Belg.* (2) Vol. XLVI, p. 455; Williamson, 1907. *Proc. U. S. Nat. Mus.* Vol. XXXIII, p. 305; Laidlaw, 1922. *Rec. Ind. Mus.* Vol. XXIV, p. 398.

*Aeschna ceylonica* Kirby, 1890. *Cat. Odon.*, p. 68.

*Heliogomphus ceylonicus* Fraser, 1925. *J. Bombay Nat. Hist. Soc.* Vol. XXX, pp. 849, 850.

The type is a female in the Hagen collection, now in the Museum of Comparative Zoology, Mass., U. S. A. Selys himself compared this species to the female of *H.promelas*, a species from the Nilgiris, S.

India. The male of the latter was unknown at that time and so Selys included the species in genus *Gomphus*. The discovery of the male later by myself showed that *promclas* was a *Heliogomphus* closely allied to *H.walli* and *H.lyratus*, so that it is evident that *G.ceylonicus* belongs to the same category and is a true *Heliogomphus*. Selys stated that it was closely allied to *promelas;* it differs from other species of the genus by its much larger size—abdomen 41 mm., and hindwing 39 mm. in length; the pterostigma long and broad and pale yellow in colour, *but unbraced as in other species of the genus;* the postclypeus with a transverse stripe broken up into three spots; the occiput fringed with hairs behind (naked in others) and furnished with some minute spines; lastly, segment 7 of the abdomen has a broad basal yellow annule, a feature common to many species of Gomphus *sens strict*. No species belonging to the latter genus has so far been taken in Ceylon although one species is known from S. India.

*Distribution.*—The type is from Rambodda.

### 10. **Mesogomphus henryi** Laidlaw

*Mesogomphus lincatus* Laidlaw, 1924. *Spolia Zeylan.*, Vol. XII, p. 340, Fig. 1.
*Mesogomphus henryi* Laidlaw, 1928. *Proc. Zool. Soc. Lond.* Part 1, pp. 131, 132.

The commonest hine in the island. I found it everywhere and at all elevations, thus agreeing with *M.lincatus* which is its near relative in India, and which it entirely replaces in Ceylon. It is a more jungly insect than *M.lineatus* and takes to trees readily when disturbed; usually it is to be found sunning itself on rocks in midstream; at Balangoda I could see no less than five specimens all resting in similar situations close together and they were almost as numerous on the stream at Urugalla.

### 11. **Burmagomphus sinuatus**, sp. nov. (Fig. 6).

*Female abdomen* 34 mm. Hindwing 27 mm.

Head: labium pale yellow, middle lobe clouded with black; labrum glossy black with two large bright citron yellow spots narrowly separated at the middle line; bases of mandibles citron yellow; anteclypeus black; postclypeus black with a medial triangular and a large spot on each side bright greenish-yellow; frons black with its crest bright greenish-yellow, very narrowly interrupted at the middle; vertex and occiput black, the latter with a large rectangular spot of greenish-yellow on its anterior half; eyes bottle-green during life.

Prothorax black, the anterior lobe, a narrow anterior linear spot and a much broader one on each side of the middle lobe, and a tiny geminate spot on the dorsum all citron yellow.

Fig. 6. Thoracic markings of *Burmagomphus sinuatus*, sp. nov. ♀.

Thorax black marked with bright citron yellow as follows,—a mesothoracic collar emarginate at the middle but not interrupted, oblique antehumeral stripes diverging strongly below but not nearly reaching the mesothoracic collar, an upper humeral spot and a short stripe below overlapping the end of the antehumeral stripe and lying en echelon to it (This is an intermediate stage between the entire separation of the humeral and antehumeral stripes and their fusion at the point of overlapping seen in *B.sivalikensis* and *B.pyramidalis*, respectively; it is in fact a link between them showing how the fusion of the two stripes has created the bayonet-shaped stripe found in the latter species); laterally greenish-yellow with a narrow black stripe on the posterolateral suture and a thicker broadly interrupted stripe on the anterior suture, the upper portion of this latter stripe sloping obliquely back to nearly fuse with the middle of the former stripe. Legs black, inner sides of the anterior pair of femora and the outer surfaces of coxae and trochanters bright yellow.

Wings hyaline; pterostigma golden yellow framed in black nervures, braced, covering 4½ cells; nodal index,—$\frac{9\text{-}12}{9\cdot 9}\Big|\frac{14\text{-}10}{9\text{-}11}$.

Abdomen black marked with bright citron yellow as follows,—segment 1 very broadly yellow on sides and dorsum, the two areas including a narrow longitudinal black stripe; segment 2 with a bilobate middorsal stripe tapering to a point apicad, its sides and beneath broadly yellow including a small rudimentary oreillet but excluding a small black area at the base and another small black spot near the apical border of segment; segment 3 with a tiny basal middorsal point of yellow, a large basolateral triangular spot and a narrow lateral stripe lying midway between this spot and the apical border of segment; segments 4 to 8 with only basolateral spots which are almost or just confluent at a point over the dorsum of segments; on segment 8 this spot linear and narrowly confluent with a second linear spot, the two merely separated by the fine black jugal suture; the joints between the 8th and 9th segments yellow and the latter segment with a small subdorsal apical spot; segment 10 unmarked.

Anal appendages short, conical, black, acute at apex; vulvar scales very short, triangular and deeply bifid at apex.

*Distribution.*—A single female taken by myself alongside the river, on a bush, Urugalla, 8.V.32. This specimen is the first of its genus to be taken in Ceylon and brings the island's fauna in yet closer relationship to that of the Indian Peninsular and more especially the Western Ghats where three species of the genus are known.

This species is distinguished from *B pyramidalis* by the interruption of the humeral and antehumeral stripes and the same feature will serve to determine it from *B.siamensis* and *B.vermiculatus*. From *B.laidlawi* from the Western Ghats, it differs only by the stripe on the anterolateral suture broadly interrupted and out of alinement, whilst from *B.cauvericus* it differs by the upper part of the stripe on the anterolateral suture not confluent with that on the posterolateral suture. To both of these latter it is very closely related and may be regarded as a connecting link between the two species. Type in my own collection.

## CONCLUSION

This list of species belonging to the family *Gomphidae* has been compiled from the previous writings of Hagen, Selys, Kirby, Williamson, Laidlaw and my own, supplemented by collections made by Col. F. Wall, I.M.S., in 1924, which he generously gave me, and by a large collection in the Colombo Museum to which I had access owing to the kindness of Dr. Pearson and Mr. Henry; I am especially indebted to the latter for his help. Lastly I had the opportunity of collecting some hundreds of specimens of Odonata during my brief trip to the island in May and June.

Without exception all eleven species mentioned above are either found in the south of the Indian Peninsula or are very closely related to species from that area and would appear to have originated from the mother continent and that at no distant date.

The only marked departure is that found in *Cyclogomphus gynostylus* whose superior anal appendages have undergone a surprising evolution and are quite different from anything seen in the genus; for the rest though, the body markings have preserved their generic homogeneity very closely. This species was probably the earliest of the *Gomphidae* to arrive in the island.

All the figures of anal appendages shown together have been drawn to the same scale from camera lucida studies except that of *Heliogomphus nietneri* (Selys) which is from a drawing by Mr. Nathan Banks.

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# Some Larger Rhegnopteri of Ceylon

BY

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(With Four Plates and Six Text Figures.)

The Rhegnopteri comprise some of the largest and speediest of oceanic fishes. They are of great economic importance owing to the abundance and high quality of their flesh while their speed and strength place them in the forefront of ' game fishes '. The fusiform body is evolved for swift progress through water while friction is reduced to a minimum by the reduction of scales and the retractile nature of their fins, which show either hypertrophy or reduction posteriorly. The majority of these fishes exhibit distinct migratory tendencies probably largely influenced by the swarming periods of the smaller fishes, on which they prey, and by the two monsoons

These large forms are rare in Museums and are then not always intact. Hence systematic accounts dealing with them have too often been based on photographs and anglers' descriptions,—data by no means reliable.

Detailed knowledge of the seasonal appearances of these fishes at the various archipelagos of the Indian Ocean may throw considerable light on other problems, mainly oceanographic, and Ceylon is probably in a key position to note such migrations. Its location at the extreme end of the Indian subcontinent places it at the edge of the continental shelf and in a very central position next to the deep oceanic area, hence the relative abundance of these fishes was noted as early as 1671, by Baldeus, a Dutchman, who had travelled extensively in the East. In Chapter LI, p. 826 he states ' Ceylon produces great plenty of fish, as *Cacap*, Plaice, Crabs, Pikes, *King-fishes*, *Sail-fishes*, Craw fishes, Haddocks, Galleon-fishes, Sharks, Orados, *Sardins*, large Smelts, *Bat-fishes*, Seals, Oisters, Muscles, Shrimps, Pampus, Barbels, *Bonitos*, Corquados, etc.'.

It is certain that the fifth, sixth, and twenty-first names refer to specimens dealt with in this article. The ninth may refer to *Makaira* or to *Rhineodon typus* Smith, which is not uncommon off Ceylon. The ninteenth may refer to the ' Pampanos ' or Carangidae while the last may be a name for the Coryphaenidae.

KEY TO SOME LARGER RHEGNOPTERI OF CEYLON

*Rostrum* not spear-shaped
(*a*) Dorsals separate, finlets present—series Scombriformes
I. Teeth compressed
(1) teeth separate . . . . . . . . . . . *Scomberomoridae*
(2) teeth contiguous . . . . . . . . . . . *Acanthocybiidae*
II. Teeth conical . . . . . . . . . . . *Thunnidae*
(*b*) Dorsal continuous, its origin on head—series Coryphaeniformes
*Rostrum* spear-shaped—series Xiphiiformes
(*a*) ventrals spike-like . . . . . . . . . . . *Istiophoridae*
(*b*) no ventrals . . . . . . . . . . . *Xiphiidae*

## Family Scomberomoridae

Maxillary exposed and with a single supplementary bone. Jaw teeth compressed, uniserial, separate, partly hidden by a labial fold. Gill membranes separate, gill lamellae free, gill rakers present. Caudal

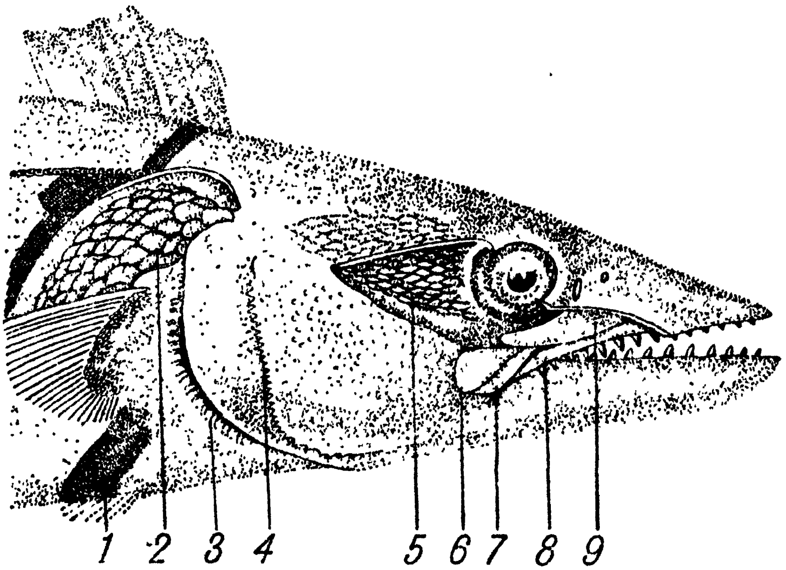

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Fig. 1. Dissection of adolescent *Scomberomorus* (*S*) *commersoni*. 1. External scales, 2. Subcutaneous corselet scales, 3. Cleithral venules, 4. Dermal lappets, 5. Subcutaneous scales, 6. Supplementary bone, 7. Maxillary, 8. Premaxillary, 9. Preorbital.

peduncle with a single lateral keel. A spinous and soft dorsal, the latter broken into finlets posteriorly as is anal. Scales greatly reduced or vestigial with patches of enlarged subcutaneous ones. Those under the annular gelatinous eyelid and on caudal keel are elongate. A subdermal rudiment of enlarged pectoral corselet scales extends from base of pectoral to lateral line and covers an area less than pectoral fin and becomes reduced with age. Lateral line scales feebly enlarged. Body compressed in young, less so in adult. Bones porous, light, intramuscular bones inserted on vertebrae.

### Genus **Scomberomorus** Lacépède

Maxillary reaches to middle or behind eye and extends as far back as premaxillary. Median spines of first dorsal much shorter than anterior ones; second dorsal and anal moderate, caudal crescentic. Gill membranes free from isthmus. Nostrils less than an orbit length from each other. Eye with an annular, gelatinous lid. Branchiostegals seven. Tongue and palate generally dentigerous. Upper jaw pointed, lower boat shaped, undershot. Hind edge of preopercle more or less emarginate. Lateral line with developed or rudimentary tubules. Hepatic caeca numerous, short Two subgenera. Air bladder present in *Scomberomorus*, air bladder absent in *Sawara*.

The sier fishes, or Spanish mackerel, rank among the foremost of marine food fishes. David Starr Jordan (1925) considers some of them as sixth in point of flavour among the World's best food fishes. Such popular names as poisson-de-roi (French), Konings-visch (Dutch) and king fish (English) testify to the esteem in which they are held. The name ' Sier ' is derived from the Spanish or Portuguese name ' Sierra ', by which name they are known in America.

They are essentially pelagic and swim in shoals and as many as 166 individuals were taken in a drift net set overnight near Jaffna. However they often come so close to land as to be caught in seine nets. Sinhalese fishermen state that they do not ' bite ' during moonlight but on dark nights are easily taken by trolling with small fish or squid. When brought on board they die soon but snap viciously while life lasts. Their leaping powers are remarkable, and on calm days they often rise to 7 or 8 metres in the air.

The stomach contents are usually Pteropods, Foraminifera (*Lagena* sp.), cuttle fishes and small fishes, rarely prawns. They are in prime condition by November and December. Young ones about 140 mm. are also common in the markets during October.

KEY TO CEYLON SPECIES OF *Scomberomorus*

1. Gill rakers 3-5, vertical bands on body .......... *S. commersoni*
2. Gill rakers 8-10
   (a) Profile straight. Short horizontal bars on body . . *S. interruptus*
   (b) Profile convex. Spots on body .......... *S. guttatus*

## **Scomberomorus (Scomberomorus) commersoni** (Lacépède)

Plate I, Fig. 1

*Scomber commerson* Lacépède 1800. *Hist. Nat. Poiss.* II.

*Local names* : Ahin thōra, thōra, thōra anjilāva (Young) (Sinhalese), Arakula (Tamil), Striped sier (English)

*Fins.* I D XV-XVI, II D 3.13-14, dorsal finlets IX-X, A 3.14, anal finlets IX-XI, P 23, V 1.5.

*Scales.* Developed on opercle and preopercle in young, vestigial in adult. Each lateral line scale enlarged but smaller than a tooth. Subcutaneous pectoral corselet scales enlarged and in 3 or 4 subequal rows followed by 3 or 4 rows of less enlarged ones. Fig. (1) shows the corselet of an adolescent which is considerably reduced in the adult.

*Measurements.* Head 4.5-4.75, eye 5.9-7.6, interorbit 1.6-2, snout 2-2.75, gape 1.9, depth of body 5.4-6, pectoral 6.7-7 in entire length. Snout subconical with straight profile; interorbital space flat. Eye closer to snout tip than to gill cleft. Maxillary reaches hind edge of orbit or beyond it. A frontal stria runs from origin of dorsal almost to eye. Gape rather oblique. Width of opercle contained about 1 5 in width of preopercle which has a fringe of small, acute, dermal lappets on its hind edge. Venules on cleithrum distinct. Gill rakers 3-5 rarely 6. Pectoral as long as head minus snout. Origin of spinous dorsal slightly closer to snout tip than to second dorsal. Anterior third of spinous dorsal higher than remainder which is distinctly continued to origin of second dorsal.

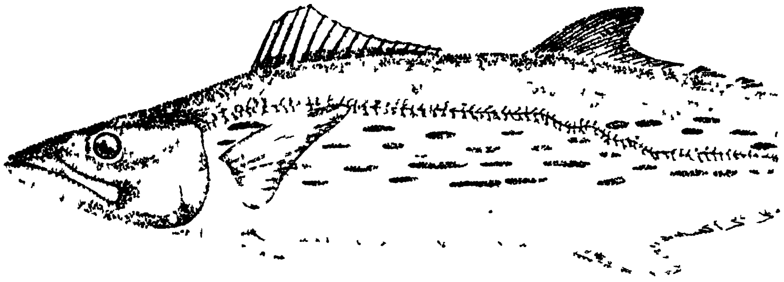
Lateral line with numerous vestigial branches best seen in adult spirits specimens. Behind soft dorsal it undulates and descends to ventral half of body and when under fifth dorsal finlet ascends and continues along middle of caudal peduncle. Air bladder present. Jaw teeth rather larger posteriorly and directed slightly anteriorly, 18-24 on each premaxillary and mandibular. Palate and tongue with granular teeth. Vomerines a bluntly triangular patch. Two thin palatine bands diverge posteriorly from this patch. Pterygoids with numerous small polygonal patches of granular teeth. Weight of fish 20 lb. Length 1,000 mm. rarely longer.

*Colours.* (Young up to 400 mm. length). Numerous vertically oval dark blotches as large as eye which tend to fuse to form cross bands.

(Adult). In life a more or less uniform greenish blue dorsally, silvery sides and belly with a dark diffuse shoulder blotch. After death 27-34 wavy, transverse dark bands appear. These are below lateral line on body but cross it on tail. First dorsal black anteriorly, white posteriorly but becomes a uniform dark grey with age. Ventrals and anal finlets white. Pectorals, soft dorsal with its finlets, anal and caudal dark.

*Distribution.* The largest and best flavoured Ceylon seer; common. The only species in the market at **Pānadure** (W. P.) on 15.3.27 and at **Tañgalla** (S. P.) on 10.4.28. An Indo-Pacific form.

Ceylon, India, South China, Japan, Cape of Good Hope, Samoa, New Guinea, Australia.



P D del

Fig 2 *Scomberomorus (S) interruptus* × ¼

### **Scomberomorus (Sawara) interruptus** (Cuv. et Val.) Fig. 2

*Cybium interruptum* Cuv. et Val 1831 *Hist. Nat Poiss* VIII

*Local names*. Alu thōra, Gânu thōra, Haru mas thōra, Sekkal thōra (Sinhalese), Pulli arakula (Tamil)

*Fins.* I D XV-XVII II D 5 13-15, dorsal finlets IX-X, A 4.16, anal finlets IX-X, P 23, V 1.5.

*Scales.* Scales on preopercle and opercle similar to body scales. Each lateral line scale enlarged but smaller than a tooth. Subcutaneous pectoral corselet of enlarged scales in 2 or 3 rows followed by 3 or 4 rows of smaller ones about one-fifth as large.

*Measurements.* Head 4.5-5, eye 5-6.75, interorbit 1.5-2, snout 1.75-2, gape 1.8-2, depth of body 5.2-5.9, pectoral 6.75-7.5 into entire length. Snout conical, profile straight, interorbital space flat. In dorsal view the sides of snout are rather concave. A frontal stria runs from origin of dorsal nearly to eye. Eye in middle of head. Maxillary barely reaches under hind edge of orbit. Gape faintly oblique.

Width of opercle contained 2.5 in width of preopercle and has a fringe of small, acute, dermal lappets on its hind edge. Gill rakers 8 or 9 about one-third of orbit in length. Pectoral contained 1.5 in head.

Origin of spinous dorsal midway between snout tip and soft dorsal which originates close to middle of back. Anterior third of spinous dorsal much higher than remaining two-thirds which are vestigial for a snout length in advance of second dorsal. Distance between caudal lobes as long as 1.5 times head length.

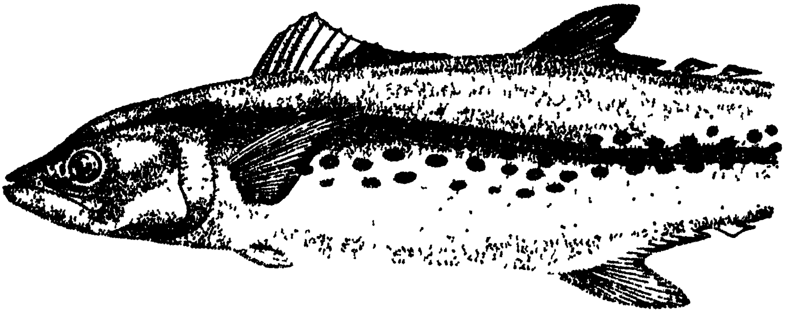
Lateral line with numerous tubules, it descends posterior to second dorsal in three undulations and runs along middle of caudal peduncle. Air bladder absent.

Jaw teeth smaller anteriorly, curved slightly inward. 16-25 on each maxillary, 13-17 on each mandibular. Palate and tongue with granular teeth. Those on vomer granular and in a rhomboid or triangular patch towards which converge the two palatine bands. These are of subequal width in adults. Pterygoids with numerous elongate, oval patches of granular teeth. Length of fish 630 mm.

*Colours.* Dorsally bluish grey with purple reflections, ventrally white which changes to a dirty grey after death. Spinous dorsal white, its base black. Soft dorsal, pectorals and caudal brown, ventrals white, anal yellowish green. Dorsal finlets grey, anal ones white. Four lateral longitudinal rows of horizontally elongate yellowish brown bar-like spots which are below lateral line anteriorly. Posterior to soft dorsal, three rows lie above lateral line.

*Distribution.* A common form which appears to have been confused by Day (1878) with *S.* (*S.*) *guttatus*.

Ceylon, India, China, Japan.



P. D. del.

Fig. 8. *Scomberomorus* (*S*) *guttatus* × ½

**Scomberomorus (Sawara) guttatus** (Bl. et Schn.) Fig. 3

*Scomber guttatus* 1801. Bloch et Schneider 23, Taf. 5.
*Local names :* **Bambara thōra** (Sinhalese)

*Fins.* I D XV-XVI, II D 4.14-16, dorsal finlets VIII-IX, A 4.16, anal finlets VIII-IX, P 20-23, V 1.5.

*Scales.* On preopercle and opercle similar to body scales. Each lateral line scale as large as a tooth. Subcutaneous pectoral corselet scales enlarged, subequal, in 2 or 3 rows.

*Measurements.* Head 4.25, eye 4.2, interorbit [1] 1.5, snout 1.25, gape 2., depth of body 4., pectoral 6.4 into entire length. Snout short with concave profile, interorbital space strongly convex. In dorsal view sides of snout nearly convex. Eye in anterior half of head. Maxillary barely reaches hind edge of orbit. Preorbital bone covers two-thirds of the depth of maxillary bone. Gape strongly oblique. Preopercle twice as wide as opercle, its angle acute. Margins of both faintly crenulate. Gill rakers 8., about a third of orbit length. Pectoral as long as head minus snout. Origin of spinous dorsal slightly closer to soft dorsal than to snout tip. Anterior third of spinous dorsal much higher than rest of fin, the third and fourth spines most elongate. Remaining two-thirds of fin vestigial for a snout length in advance of second dorsal. Caudal proportionately larger than in other species; distance between tips of caudal lobes equals 1.5 times head length.

Lateral line with numerous tubules anteriorly each as long as eye. These slope almost horizontally and end very close to lateral line. Lateral line slopes gradually to mid body behind soft dorsal and is without marked undulations. Air bladder absent. Jaw teeth subequal directed anteriorly 15 on each maxillary, 12 on each mandibular. Palate and tongue with granular teeth. Those on vomer granular and in a triangular patch directed anteriorly. Two narrow palatine bands which are wider anteriorly, converge towards it. Pterygoids with numerous elongate oval patches. Length of fish 600 mm.

*Colours.* (In Spirit). Dorsally dark, sides silvery with three rows of almost circular, horizontal spots as large as pupil of eye. Anteriorly they are below lateral line but rise above it when it descends under second dorsal. First dorsal dark with a white base to its posterior third. Soft dorsal, dorsal finlets and caudal dark. Other fins yellowish grey.

*Distribution.* Not common.

Ceylon, India, Japan, Australia.

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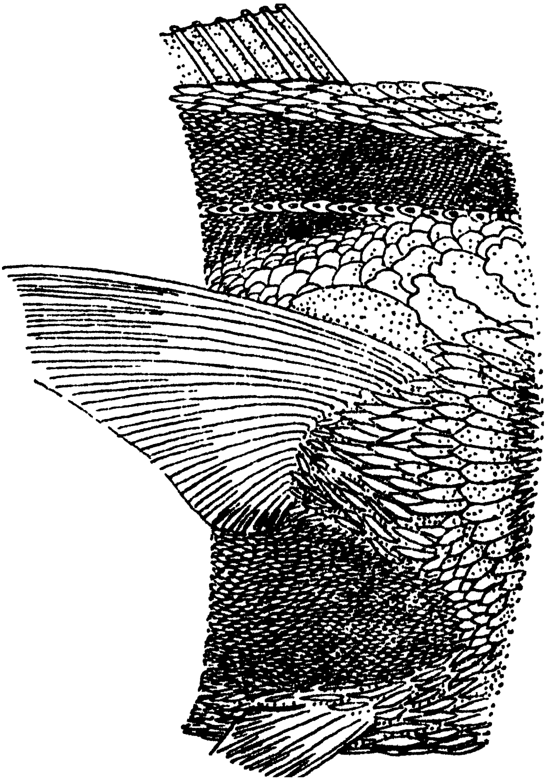
[1] Interorbit and snout in fractions of 'orbit'.

## Family Acanthocybiidae

Maxillary, with a single supplemental bone, completely hidden by preorbital which borders gape. Jaw teeth compressed, uniserial, contiguous. Gill membrances separate, gill lamellae connected to form a net, no gill rakers. Caudal peduncle with a single lateral keel. A spinous and soft dorsal, the latter broken into finlets posteriorly as is anal. Scales small, elongate, with patches of enlarged subcutaneous ones around eyes and on pectoral corselet which extends from ventral fins to lateral line. Fig. 4. Exposed, enlarged scales on nape of neck, caudal keel and lateral line. Body subcylindrical. Bones solid. Intramuscular bones inserted on ribs. A single genus.

### Genus **Acanthocybium** Gill

Maxillary reaches to front of orbit, premaxillary as far. Median spines of first dorsal as long as its anterior ones. Second dorsal and anal small, caudal semi-lunate. Gill membranes free from isthmus.



P. D. del.

Fig. 4. Subcutaneous corselet of *Acanthocubium solandri*

Anterior nostrils an orbit length from posterior ones. Branchiostegals seven, tongue and palate dentigerous. Jaws acutely conical, undershot. Hind edge of preopercle curved, feebly serrate. Lateral line with long vertical tubules. Hepatic caeca numerous short. Air bladder elongate. A single species according to some, three according to others.

An interesting fish. Anatomical features connect it with the *Scomberomoridae*, *Thunnidae*, and *Xiphiiformes*. In spite of its Scomberomoriform shape, the absence of gill rakers, the presence of connected gill lamellae, the elongate scales and the solid consistency of its bones denote its relationship to the last series of fishes. The developed pectoral corselet, the strong lateral caudal keel with depressed peduncle and the lunate caudal fin show a resemblance to the *Thunnidae*.

### **Acanthocybium solandri** (Cuv. et Val.) Plate I, Fig. 2

*Cybium solandri* Cuvier et Valenciennes 1831. *Hist. Nat. Poiss.* VIII.
*Acanthocybium sara* Jordan et Starks 1917. Fishes from Ceylon. *Ann. Carnegie Mus.* Vol. XI, No. 3-4
*Local names :* **Hēra** maha, Pirimi thōra, Thal thōra (Sinhalese), **Savara** (Tamil), King Sier, Peto. (English)

*Fins.* I D XXIV-XXVII, II D 3.9, dorsal finlets IX, A 2.10, anal finlets VIII, P 21, V 1.5.

*Scales.* Minute, elongate. Patches of enlarged subcutaneous ones around eyes and on pectoral corselet which extends from ventral fins to lateral line. (Text fig. 4). Exposed, enlarged scales on nape of neck, caudal keel, lateral line and its tubules.

*Measurements.* Head 4.3-4.4, eye 7-8 5, interorbit 2.5-3, snout, 3-4, gape 2, depth of body 5.75-6.5, pectoral 9.2 into entire length.

An elongate subcylindrical fish with acutely conical close fitting jaws and snout. Posterior third of spinous dorsal as high as its anterior third. Second dorsal and anal reduced. Lower jaw prominent, chin conical, anterior nostril an orbit in advance of posterior one which is close to eye. An annular gelatinous lid around eye which is in posterior half of head. Maxillary reaches to under front edge of orbit and is hidden by the large preorbital which borders gape. Preopercle as wide as twice orbit, its posterior margin curved and faintly serrate. Opercle as wide as orbit. Branchiostegals seven, gill rakers none. Branchial lamellae joined to each other by cross bars forming a single reteform structure as in *Xiphiiformes*. Pseudobranchiae small. Pectoral fin as long as head minus snout. Spinous dorsal developed, long and of almost uniform height until just near its end; upper margin of fin convex. Soft dorsal low, small and slightly anterior to anal which is of equal dimensions. Base of soft dorsal as long as distance between the two dorsals. Caudal strong, lunate, with a prominent lateral keel between two faint ridges on its peduncle. Lateral line curves strongly downward between tenth and fourteenth dorsal spine and runs along middle of caudal peduncle; it gives off numerous long tubules which are at right angles to it. Tail short and rather flattened ventrally, its peduncle thick and depressed. Jaw teeth uniserial, triangular in young, ovate in adult; contiguous and stronger posteriorly. Their number decreases with age from 50 to 25 on each side. Teeth of upper jaw more conspicuous than those of lower. Vomerine teeth granular and in a rhomboid patch. A thin band of similar teeth on each palatine bone, converges towards vomerines. An inconspicuous patch of granular teeth on tongue. Length of fish 2,000 mm.

*Colours.* In fresh dead specimens a strong contrast between back and sides. Back dark, slaty blue with 30 light silvery double bands which are vestigial and reduced to 7 in adult. Sides and belly a light bluish grey. Cheeks silvery blue, hind edge of preopercle with a black serration, spinous dorsal blue, soft dorsal blue black. Ventrals pale bluish.

Specimens dead some time are a uniform dark leaden blue with metallic blue reflections.

*Food.* Fishes and cuttle fishes.

*Distribution.* Circumtropical. A fast swimming pelagic form which appears off the coasts of Ceylon chiefly from September to January. Taken on line by trolling. On calm days may be seen leaping to a height of about 6 or 7 metres.

Ceylon, Japan, Phillippine Islands, Tahiti, Hawaiian Islands, Loo Choo Islands, South Sea Islands, West Indies.

## Family Thunnidae

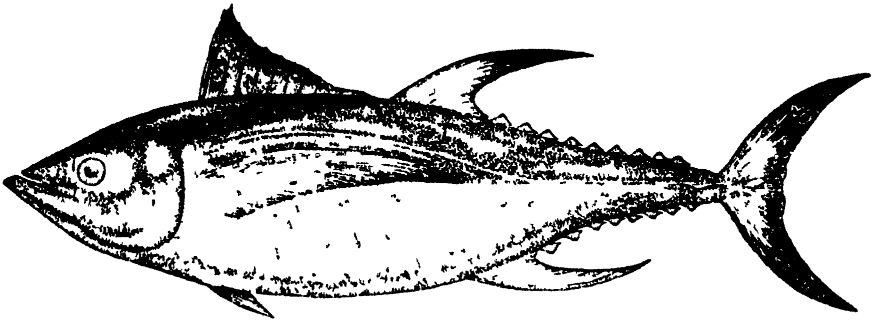
Maxillary exposed, scarcely reaches mid eye and has a single supplemental bone. Jaw teeth conical, uniserial, separate. Gill membranes separate, gill lamellae free, gill rakers present. A spinous and soft dorsal, the latter broken into finlets posteriorly as is anal. Caudal peduncle with a single lateral keel. Scales greatly reduced with patches of subcutaneous, elongate scales under eyes and on caudal keel. A corselet of enlarged subcutaneous scales on pectoral area forms a wide more or less continuous ring round body and has posterior extensions dorsally, ventrally and laterally. Lateral line present. Body short, robust, fusiform. Bones of skeleton solid.

### KEY TO GENERA OF CEYLON *Thunnidae*

| | |
|---|---|
| 1. Body scales distinct (*a*) air bladder present | *Thunnus* |
| (*b*) air bladder absent | *Neothunnus* |
| 2. Scales on corselet only, air bladder absent | *Euthynnus* |

## Genus **Thunnus** South

Maxillary barely reaches pupil, extends as far back as premaxillary. First dorsal slopes down to origin of second. Teeth conical on jaws, granular on vomer and palate. Air bladder present. Two subgenera. Fins short, pectoral does not reach under second dorsal which latter does not reach dorsal finlets (*Thunnus*). Fins elongate, pectoral reaches to under second dorsal which latter reaches dorsal finlets (*Germo*).



P. D del.

Fig. 5. *Thunnus (G) macropterus* × $\frac{1}{16}$

### **Thunnus (Germo) macropterus** Temminck et Schlegel Fig. 5

*Thunnus macropterus* Temminck et Schlegel 1842 *Fauna Japonica. Poiss.*

*Local names :* Kelavalla, Äs gedi kelavalla, Bandi thonda kelavalla, Hōvalla, Kendhi kelavalla, Pihātu kelavalla (Siṅhalese), Keluvallai (Tamil), Yellow finned albacore (English)

*Fins.* I D XIII-XIV, II D 3.12, dorsal finlets IX-X, A 2.12-13, anal finlets IX, P 31-34, V 1.5.

*Scales.* Minute on body, elongate and subcutaneous round eye and on caudal keel. A subcutaneous ring of enlarged scales forms a pectoral corselet with four posterior branches.

*Measurements.* Head 3.25-4, eye 5-7, interorbit 1.25, snout 2.8-3, gape 2.7, depth of body 3.6-3.8, pectoral 2.5-3 into entire length. A stout bodied, fusiform fish. Jaws acutely conical, close fitting; lower jaw prominent with a conical chin in old specimens. Tip of maxillary exposed and ends under front of orbit. Preopercle twice as wide as opercle and with a curved posterior edge. Branchiostegals 7, gill rakers 20-23. Fins elongate, vary with age. Spinous dorsal sloping downwards to origin of soft dorsal and with its longest spine about three times height of orbit in adult. Origin of second dorsal anterior to anal, both elongate and strongly falcate. When adpressed, the dorsal reaches the fourth or fifth, the anal to between the sixth to eigth of their respective finlets. In old specimens the anal may even reach the caudal. Pectoral reaches at least to below second dorsal and in old specimens to beyond origin of anal fin. (*Pihatu kelavalla.*) Caudal widely crescentic with a prominent lateral keel on its strong peduncle which is depressed. Lateral line ascends opposite base of pectoral and descends to mid body when under base of soft dorsal. Air bladder present. Teeth uniserial, small, conical on jaws, granular on vomers, palatines and pterygoids. The usual weight is about 140 lb. but specimens occasionally scale three times as much. Length of fish 1,600 mm.

*Colours.* A deep prussian blue antero-dorsally, less intense postero-dorsally. A bright yellow patch round eye and on top of opercle. Sides an opalescent grey with 20 alternating transverse rows of narrow silver grey lines and spots, anterior to anal. Elongate light spots ventrally on tail. Interior of mouth blue black. Dorsal, pectorals and ventrals dusky, tinged with yellow which predominates with age. Anal, and finlets of dorsal and anal, a bright yellow with thin dark posterior margins. Flesh red.

*Distribution.* The largest Ceylon tunny. Common from October until May. Taken by trolling with *Caranx*, *Clupea spp*, *Anchoviella spp.* cuttle fish or half a tender coconut removed from the shell. Flesh well flavoured and employed for making ' Maldive fish '. An Indo-Pacific species.

Ceylon, India, Maldives, Japan, Hawaiian Islands, South California, Mexico, Galapagos.

## Genus **Neothunnus** Kishinouye

Second dorsal and anal slightly higher than first dorsal or as high. Pectoral reaches nearly to under end of first dorsal. Air bladder absent. Gill rakers fewer than in other Thunnidae.

### **Neothunnus rarus** (Kishinouye)

*Thunnus rarus* Kishinouye 1915. *Sui. Gak. Ho.* I. 28 Pl. 1.

*Fins.* I D XIII, II D 4 10, (first 2 spines small), dorsal finlets IX, A 2.10, anal finlets VIII, P 32, VI. 5.

*Scales.* Minute on body, elongate and subcutaneous under eye and on caudel keel. Enlarged and subcutaneous on corselet which forms a ring with four posterior branches round pectoral area.

*Measurements.* Head 3.4, eye 5.2, pectoral 3.9 into entire length Moderate body. First dorsal ends about 2/3 orbit in front of second dorsal.

Tip of maxillary exposed and ends under middle of orbit. Preopercle not quite twice as wide as opercle. Branchiostegals 7, gill rakers 17. Spinous dorsal as high as soft dorsal. Its longest spine 1.8 times height of orbit. Origin of second dorsal anterior to anal. Pectoral elongate but does not quite reach to under last spine of first dorsal. Lateral line straight until under third dorsal spine then rises a little, rather abruptly and gradually descends to mid body. Teeth uniserial, small, conical on jaws, granular on palate, a diamond shaped vomerine patch between two elongate palatine bands each followed by a long pterygoid band, behind which are numerous close set ellipsoid patches. No air bladder. Length of fish 530 mm.

*Colours.* Dorsally blue black to origin of second dorsal with a cobalt blue area along base of spinous dorsal. Light bluish brown above lateral line. Sides lighter brown or silvery sometimes with 2 or 3 longitudinal rows of elongate light spots posteriorly. Fins dark. Finlets tinged with yellow. Flesh pale pink.

*Distribution.* Not uncommon along the south coast during November and December and considered by the fishermen to be the young of *Thunnus* (*Germo*) *macropterus* to which it has a superficial resemblance. Ceylon, Maldive Islands, Japan.

## Genus **Euthynnus** Lutken

Maxillary reaches mid eye, extends as far back as premaxillary. First dorsal the highest single fin and is continued to second dorsal. Pectoral does not extend beyond middle of first dorsal. Second dorsal and anal low. Air bladder absent. Scales vestigial except the enlarged subdermal ones on corselet.

### KEY TO CEYLON SPECIES OF *Euthynnus*

| | |
|---|---|
| Gill rakers 35-39, black longitudinal ventral stripes ....... | *E. pelamis* |
| Gill rakers 22-24, belly white ....... | *E. alletteratus* |

## **Euthynnus pelamis** (Linné)

*Scomber pelamis* Linné 1758. *Syst. Nat.* ed. X.
*Katsuwonus pelamis* Kishinouye 1923. *J. Coll. Agric. Imp. Univ. Tokyo.*
*Thynnus vagans* Lesson 1829. *Dict. Class hist. nat.* Paris Vol. 15.
*Local names :* Baleya (Sinhalese), Ocean bonito (English)

*Fins.* I D XV-XVII, II D 3.12, dorsal finlets VIII, A. 3-4. 12-13 anal finlets VII, P 27-30, V 1.5, C 18.

*Scales.* Vestigial on body, elongate and subcutaneous under eye and on caudal keel. A subcutaneous ring of enlarged scales forms a pectoral corselet with four posterior branches. Largest corselet scales extend along base of first dorsal.

*Measurements.* Head 3-3.5, eye 5-7.75, interorbit 1.5-2, snout 1.5-2, gape 2.85, depth of body 3.25-3.5, pectoral 6-6.5, ventral 8.2 into entire length. Body fusiform, more convex dorsally than ventrally, jaws conical. Fins short; first dorsal has the first three spines close set and is nearly twice as high as second dorsal or anal or 2-3 times length of orbit. It is falcate and ends half an orbit anterior to second dorsal. Anal originates under middle of second dorsal both remote from caudal fin. Pectoral reaches to under 8-10 dorsal spine. Gape ends under mid eye. Preopercle about 1.4 times as wide as opercle. Opercle with a fine serrate dermal marginal fringe. Branchiostegals 7 gill rakers 35-39.

Lateral lines curves gradually down to mid body under base of soft dorsal. Teeth uniserial, on jaws only. Length 650 mm.

*Colours.* Dorsally dark prussian blue with indistinct light transverse marks. A black spindle shaped mark mid-dorsally from snout to dorsal fin. Sides and belly silvery with 4 to 6 dark longitudinal lateral stripes. Anal finlets white other fins and finlets dark. Flesh dark red and much prized for conversion into Umbalakada by boiling in sea water and smoking [1].

*Food.* Myctophiid fishes, *Anchoviella* spp., Euphausiids, crustacean larvae.

*Distribution.* A gregarious, circumtropical fish found in large shoals often numbering several hundred thousands of individuals. They surround shoals of *Anchoviella* spp. or other small fishes on which they prey. Taken on a naked german silver hook which is dropped into the sea with a handful of shrimps ' kooni ' or *Anchoviella.* Abundant

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[1] According to Kishinouye (1923) the Japanese quarter the fish, boil it, then smoke it to make ' katsuwobushi ' which is used as a condiment after shredding.

along the south and south-west coasts from November to February [1] and the most abundant fish noted in the market at Malé in the Maldives in December, 1932.

Ceylon, India, Maldives, Japan, Hawaiian Islands, Oceania, Cape of Good Hope.

### **Euthynnus alletteratus** (Rafinesque)

*Scomber alletteratus* Rafinesque, 1810. *Caratteri An. Sicil.* p. 46.
*Thynnus thunnina* Gunther, 1876. *Mus. Godeffroy, Journ. Vol.* 5.
*Local names :* Ātevalla (Sinhalese), Surai (Tamil), Bonito (English)

*Fins.* I D XIV-XV, II D 2.10, dorsal finlets VIII, A 3.11-12, anal finlets VII, P 28, VI 5, C 18.

*Scales.* Vestigial on body, elongate and subcutaneous under eye and on caudal keel. A subcutaneous ring of enlarged scales forms a pectoral corselet with four posterior branches. Largest corselet scales extend along base of first dorsal.

*Measurements.* Head 3.5-3.6, eye 5.6-6.5, interorbit 2.5, snout 1.5-2, gape 2.5-2.7, depth of body 3.6-3.75, pectoral 6-6.5, ventral 7.75-8 into entire length. Body fusiform and more elongate than in its relative. First dorsal separate from second dorsal by an orbit length and is nearly twice as high as this fin or anal. Pectoral as long as post orbital part of head. Gape ends under mid orbit. Opercular margin with a fine serrate dermal marginal fringe. Branchiostegals 7, gill rakers 22-24. Lateral line rises rather abruptly under third dorsal spine then slopes gently down to mid body. Air bladder absent. Teeth uniserial on jaws, vomerines and palatines. In some individuals vomerines absent. Length of fish 590 mm.

*Colours.* Dorsally dark blue with a deep prussian blue spindle shaped mark above eye from snout tip to origin of second dorsal about 12-16 oblique greenish blue lines run backwards from base of second dorsal.

A dark spot at top corner of gill cleft and 4-6 spots on chest. Sides silvery, belly white. Fins dusky, ventrals with a white margin.

*Distribution.* Circumtropical. Large shoals abound in 12-30 fathoms in the Gulf of Mannar in March and April. Common along the west and south coast from November to May.

Ceylon, India, Hawaiian Islands, Japan.

The series Xiphiiformes include the swiftest and largest Pisces. They are occasionally seen leaping out of the water often covering

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[1] Fowler (1928) says that this fish abounds at Honolulu in November, December, and January. He also states that a shoal of this fish 90 miles long 10 miles broad has been recorded.

distances of about 15 metres but seldom rise to more than 1 metre above the surface unlike the smaller Scomberomoridae and *Acanthocybium* which rise to heights of 7 metres but do not appear to cover long distances in their leaps. The elongate rostrum is essentially a modification for stream lining and according to fishermen never employed in deliberate stabbing, although it is occasionally driven into the side of a canoe as the hooked fish dashes about. It also unwittingly comes into violent contact with ships before the swift swimming fish can check itself, a mishap which generally results in a fractured rostrum. On one such occasion the 'Dreadnaught' while on her way from Colombo to London had her copper sheathing punctured through. As captured specimens sometimes show partially healed fractures of the rostrum the length of this member is unreliable as a specific character.

The body shape varies but little throughout the genera but the fins alter considerably with age, so that juvenile members of one genus may closely resemble the adults of another from which they can be more easily distinguished by the size of the individual rather than shape, *e.g.*, *Tetrapturus* and young *Makaira*, Plate III.

The food of these fishes consists largely of small fishes which they kill by swimming into a shoal and striking sideways with the rostrum. The fishermen take them by trolling with *Trichiurus*, *Sardinella leiogaster*, *Anchoviella* spp, *Chirocentrus dorab* or half a tender coconut removed from the shell. They are most abundant in April and May along the south-west and south coasts of Ceylon, when at times specimens weighing 8 cwt. are taken.

There are two families. The Istiophoridae with cylindrical rostrum, ventral fins and two lateral caudal keels, and the Xiphiidae with depressed rostrum, no ventrals or scales and one lateral caudal keel.

## Family Istiophoridae

Upper jaw elongated into a beak-like rostrum. Maxillary exposed, reaches behind eye. Teeth cardiform on jaws, granular on palate and tongue. Gill membranes confluent, free from isthmus. Gill lamellae connected to form a net, no gill rakers. Caudal peduncle with two lateral keels on each side. Two dorsal and anal fins, the anterior of which together with the ventrals are retractile into grooves. Single rays of dorsals and anals thickly invested in connective tissue to form a lobe anteriorly in each fin. Ventrals spike-like connected at base and with one or two vestigial rays. Scales small, elongate, deeply embedded in skin. Lateral line present. Air bladder sacculate. Bones solid.

### KEY TO GENERA OF CEYLON ISTIOPHORIDAE

(A) Ventrals longer than pectorals
  1. Branched rays of first dorsal lower than its single ones . . . . . . . *Tetrapturus*
  2. Branched rays of first dorsal higher than its single ones . . . . *Istiophorus*

(B) Ventrals shorter than pectorals . . . . . . . *Makaira*

## Genus **Tetrapturus** Rafinesque

First dorsal with anterior branched rays as high as, and the rest shorter than, the single rays of its anterior lobe. Ventrals longer than pectorals and with one or two vestigial rays. The most primitive genus of this family.

### **Tetrapturus brevirostris** (Playfair)

*Histiophorus brevirostris.* Playfair 1866 *Fishes of Zanzibar.*
*Local names* : Kopera, Mudu habera (Sinhalese)

*Fins.* I D III. 33, II D 1.6, I A III. 10, II A 1.6, P 19, VI. 1.

*Measurements.* Head length from tip of chin to hind edge of opercle exceeds height of lobe of first dorsal fin which equals length of pectoral and also the body depth, which is contained 5.6 into entire length without caudal. Ventral 1.4 times as long as pectoral and consists of a long spike with a vestigial inner ray.

Nostril about half an orbit anterior to eye Free part of maxillary extends for about an orbit behind eye which is contained 12.5 in head and rostrum or about 5 in post orbital part of head. First dorsal with a straight margin which slopes posteriorly from the anterior lobe. Last dorsals rays contained about 2.5 in anterior lobe. First dorsal separate from second dorsal which is above second anal. First anal under about the twenty-sixth branched ray of first dorsal. Lateral line descends to mid body under about the eighth branched ray of first dorsal. Teeth cardiform on jaws and along sides of rostrum to its tip, granular on vomer, palatines and pterygoids. Length of fish 8 ft. 8 in. or 2640 mm.

*Colours.* Dorsally dark slaty blue with light cross bands. Sides and belly leaden grey. Dorsal fin a uniform deep prussian blue.

*Distribution.* Ceylon, India, Cape of Good Hope, Indian Ocean.

## Genus **Istiophorus** Lacépède

First dorsal with some of its branched rays higher than the single ones of its anterior lobe. Ventrals longer than pectorals and with one or two vestigial rays. Gill membranes free from isthmus. Branchiostegals 7.

## **Istiophorus gladius** (Broussonet) Plate II

*Scomber gladius* Broussonet 1786. *Mem. Acad. Sci.*
*Histiophorus indicus* Cuv. et Val. 1832. *Hist. Nat. Poiss.*
*Histiophorus immaculatus* Tennent Sir E. 1861. *The Natural History of Ceylon* p. 330 with fig.
*Local names* : Thalapatha (Sinhalese), Myl min (Tamil), Sail fish (English)

*Fins.* I D IV. 40-44, II D 1.6, I A III. 10-12, II A 1.6, P 15, VI. 1-2.

*Measurements.* Head length from tip of chin to hind edge of opercle equals height of lobe of first dorsal fin, rostrum about the same or a little shorter; pectoral fin considerably less and contained 6.2-7 in entire length omitting caudal fin. Ventral 1.6-1.9 times length of pectoral. Nostril about half an orbit anterior to eye.

Free part of maxillary begins under nostril and extends an orbit length behind eye which is contained 2.5-3 in width of preopercle and 2-2.5 in width of opercle. Gape rather less than length of pectoral. Body depth 5.5-6 into distance from chin to base of caudal. First dorsal fin completely retractile into a slot its single rays loosely woven together with connective tissue into an anterior lobe. Behind this lobe the fin is gently emarginate, then ascends to form a right angle which descends to the second dorsal with which it is more or less contiguous. In old specimens the last two or three rays of first dorsal reduced to vestigial stubs. Second dorsal with an anterior lobe, emarginate upper margin and an elongate posterior ray which does not reach caudal fin. Ventrals retractile the outer ray, elongate spike-like bordered on its inner edge with a membraneous fringe and one or two vestigial rays. This fin occasionally reaches cloaca generally not as far.

First anal retractile with a high anterior lobe and strongly falcate. Second anal under second dorsal its last ray similarly elongated. Lateral line bends angularly then descends to mid body, near the fifth branched ray of first dorsal.

Teeth cardiform on jaws and along sides of rostrum to its tip; granular on vomer, palatines and pterygoids. Length of fish 2,210 mm.

*Colours:* Dorsally a slaty purplish blue, sides and belly a leaden grey. Iris pale blue. Body with light cross bands which increase from 12-22 with age and are generally broken up into spots of varying length. Dorsal fin a dark prussian blue with circular black dots somewhat smaller than eye. These increase in numbers and intensity with age. A specimen 1,490 mm. long only had 7 or 8 distinct spots between each pair of dorsal rays the others being indistinct whereas larger specimens have as many as 25; ventrals and caudal black, first anal bluish with a dark blue tip.

*Reproduction.* A quarter ripe female 232 cm. long (with rostrum) at Gandera (S. P.) Dec. 2, 1932. According to the fishermen there a shoal of young specimens each about 33 mm. long and 'resembling butterflies with beaks,' were scooped up in a hand net and brought ashore two years previously.

*Distribution.* Probably circumtropical and subtropical. Definitely known only from the Indian Ocean. Common at about 6 kilometres from shore. On calm days its dorsal fin is occasionally seen above the surface. Copepods of the genus *Penella* often attached close to the first anal fin.

Specimens examined at Negombo, Colombo (W. P.), Väligama, Gandera (S. P.), sections of what appeared to be this fish seen at Mālé in the Maldive Islands in December, 1932.

Ceylon, Maldive Islands, India, Port Stephens in New South Wales, Indian Ocean.

### Genus **Makaira** Lacépède

First dorsal with all its branched rays shorter than the single rays of its anterior lobe. Ventrals shorter than pectorals and with or without a single vestigial ray. Fins alter greatly with age.

### **Makaira indicus** (Cuv. et Val.) Plate III

*Tetrapturus indicus* Cuvier et Valenciennes 1831. *Hist. Nat. Poiss.* VIII.
*Local names :* Ahin kopera, kalu kopera, Dhapera, Makera (Sinhalese), Marlin, spear fish (English)

*Fins.* I D III. 33-34, II D 1.6, I A III. 10-11, II A 1.6, P 15, VI. 1.

*Measurements.* Head length from tip of chin to hind edge of opercle exceeds height of lobe of first dorsal fin but equals length of rostrum. Pectoral fin about the same length and contained 5 in entire length without caudal. Ventral 2.3 into length of pectoral. Nostril about half an orbit anterior to eye. Free part of maxillary begins under nostril and extends an orbit length behind eye which is contained 3 in width of preopercle, 2.5 in width of opercle. Gape contained 1.75 in length of pectoral. Body depth 4.75 in distance from chin to base of caudal. First dorsal fin completely retractile, its single rays strongly woven together to form an anterior lobe. The last of these is the highest and is as wide as orbit. Behind this lobe the fin is falcate gently in young, strongly in the adult in which the eighth branched ray shows above the dorsal slot for a height equal to or less than an orbit, whereas in the young, the median rays are contained 1.5 in the anterior lobe. Plate III, Fig. 1.

First dorsal low and separated from the second by a space as wide as an orbit in young, or equal to width of opercle in adult. Second dorsal with a strong anterior lobe and an elongate posterior ray, which does not reach caudal. Ventrals with a single vestigial inner ray, vary with age; in young only slightly shorter than pectoral, in adult 2-3 in pectoral but 2-5 in depth of body which also varies with age. Lateral line curves gently upward then downwards a post-orbital head length from gill cleft.

Teeth cardiform on jaws and alongsides of rostrum, villiform and in juxtaposed, hexagonal patches on its oral surface; granular on vomer, palatines and pterygoids. Length of fish 2,800 mm. The largest specimen taken at Gandera (S. P.) was said to have weighed 8 cwt.

*Colours.* Dorsally dark, slaty blue with about 17 indistinct light cross bands which fade after death. Sides and belly a silvery purple in young, leaden grey in adult. Dorsal fin a uniform deep purplish blue. Pectorals, ventrals and caudal black.

*Distribution.* The largest of the Ceylon Istiophoridae. While there may be several species, the shape of the fins and body depth are so variable with age that for the present only one is established. Copepods of the genus *Penella* generally attached all over the body.

A form known only from the tropical regions of the Indian Ocean.

Ceylon, Sumatra.

## Family Xiphiidae

Upper jaw elongated into a beak-like rostrum. Gill membranes confluent, free from isthmus. Gill lamellae connected to form a net, no gill rakers. Caudal peduncle with a single lateral keel. Dorsal continuous in young, divided into two in adult. In first dorsal only anterior lobe persists, second dorsal reduced to a finlet. No ventral fins or scales. Body of young with spinose tubercles. A single genus and species.

### Genus **Xiphias** Linné

Rostrum depressed, elongate. First dorsal with only the anterior lobe in adult, second dorsal a finlet. Pectoral length equals height of dorsal lobe. No ventrals. Teeth disappear with age. The most specialized member of the series. A single cosmopolitan species. Tropical and temperate waters.

### **Xiphias gladius** Linné

*Xiphias gladius* 1758 Linné *Syst. Nat.* Ed. X.
*Local names :* Kadu Kopera, Kiyath kopera (Sinhalese), Sword fish (English)

No Ceylon specimens seen by me. According to fishermen of the south coast it is a rare visitor which they distinguish by its depressed rostrum from which the Sinhalese names meaning ' sword ' and ' saw ' *makaira* are derived.

Haly who reported *Histiophorus brevirostris* from Ceylon in 1883 and was familiar with the generic differences of these fishes writes in 1887:—

' But the most remarkable addition is the sword of a *Xiphias* which was caught at Hikkaduwa in January. The fishermen had fortunately preserved the sword, and also made me an excellent drawing of the fish from memory. It is probably the common Mediterranean species, and must have come either through the Suez Canal or round the Cape; probably the former '.

## Family Coryphaenidae

Head elevated supraorbitally with age, maxillary partially exposed, does not reach behind eye. Teeth small, pluriserial, on jaws, vomer, palatines and tongue. Gill membranes free from isthmus. Gill rakers present. Body compressed, moderately elongate. Dorsal fin originates above eye, and is continuous, anal shorter. Pectorals falcate, ventrals originate under pectorals, partially retractile. Caudal deeply forked. Scales small, strong cycloid no subdermal pectoral corselet. Lateral line present. Air bladder and pseudobranchiae absent. A single genus and two subspecies.

The Coryphaenidae popularly known as ' dorados ' or ' dolphins ' are brightly coloured tropical and subtropical fishes. There are two forms which resemble each other closely. The shape of the head alters remarkably in the larger form by the development of a high osseous frontal crest. Because both forms show a great resemblance to each other when of equal dimensions it is proposed to lower the smaller form to subspecific rank as the larger form is the genotype.

### Genus **Coryphaena** Linné

Profile more or less variable with age owing to increase of head depth. Pupil elongated anteriorly in life. Gape rather oblique, does not end behind orbit. Maxillary partly exposed, with a single supplementary bone. Teeth on jaws, vomer, palatines and tongue, cardiform, with outer row feebly enlarged, conical and recurved on jaws. Branchiostegals 7.

Lateral line bends down over pectoral and continues along mid body. Dorsal nearly as deep at middle as anteriorly. Caudal scaly other fins scaleless. Pyloric caeca numerous. Pigmentation alters markedly with age. Pseudobranchiae and air bladder absent. Two subspecies. Tropical and temperate seas.

KEY TO SUBSPECIES OF *Coryphaena hippurus*

1. Eye contained 3.5-4 in supraorbital part of head. Dorsal 58-60 ....... *C. hippurus hippurus*
2. Eye contained 2.5 in supraorbital part of head. Dorsal 53-58 ....... *C. hippurus equisetis*

### **Coryphaena hippurus hippurus** Linné Plate IV

*Coryphaena hippurus* Linné 1758. *Syst. Nat.*, ed X.
*Local names :* Dhiya vannāva, Gal vannāva (Sinhalese), Ailai (Tamil), dolphin fish, dorado (English)

*Fins:* D 4.54-60, A 2.24-26, P 2.18., V 1.5.

*Scales.* Small strong cycloid. Ltr $\frac{35}{55}$ before bend of L L. and $\frac{38}{39}$ above origin of anal.

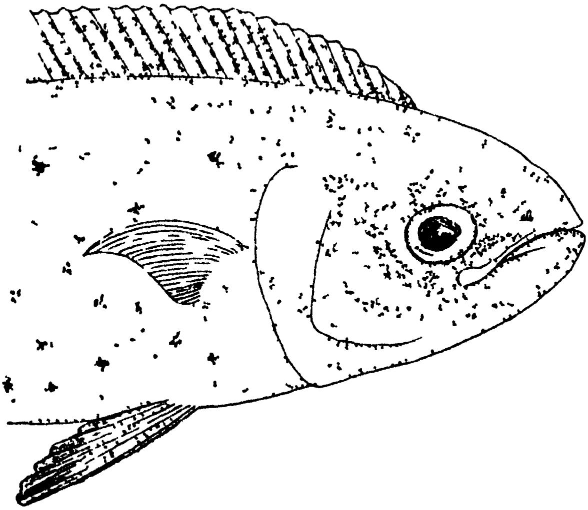
Scales elongate and enlarged on vertex, nape and along base of dorsal, absent from anterior of head, jaws and opercle.

*Measurements.* Head 4.5-4.8, eye 4.5-6, snout 1.5, gape 2.1, depth of body 4.5, pectoral 6.5 into entire length. An elongate, compressed fish with high frontal crest which increases with age so that in adults the eye length is contained 3.5-4 in supra-orbital depth of head. Profile strongly arched. Mouth moderate, lower jaw prominent with age, gape oblique. Dorsal continuous, originates above hind margin of preopercle in adolescents, above eye in adults; and its median height is not much less than its anterior height. Anal shorter, continuous. Caudal scaly, no lateral keel on peduncle, deeply forked. Lower jaw rather prominent maxillary reaches as far as hind edge of orbit and has a small supplemental bone. Eye free and in anterior half of head. Preopercle as wide as 1.8 times orbit, its posterior margin slanting obliquely downward. Width of opercle 1.3 times orbit at top, narrower below. Branchiostigals 6-7, gill rakers 9, short, spinose. Pseudobranchiae none. Pectoral fin inserted under sixteenth dorsal ray, as long as head minus snout; ventral somewhat longer. Origin of anal under thirty-sixth dorsal ray. Lateral line bends upward over mid pectoral then descends and runs at mid body. Caudal peduncle deeper than long. Dentition on jaws, vomer and palatine and tongue feeble, cardiform, recurved, with a slightly enlarged outer row on jaws. Tongue large and free. Length of fish 1,500 mm.

*Colours.* (Living) varying tints of bright green with yellow sides, dorsal dark green with lighter green spots Head, body and anterior of caudal with numerous caerulean blue spots Pectoral caerulean blue, anal yellow, caudal yellow with black margin When dying the fish turns silvery (Dead) greenish blue dorsally, sides yellow, body speckled with black, dorsal dark blue

*Distribution* A voracious fast swimming oceanic fish living in small shoals of 5 or 6 which prey largely on flying fishes, sardines, and *Chirocentrus* When hooked leaps 5 or 6 times to a height of about 2 metres. The Sinhalese fishermen distinguish two species the ' Dhiya **vannāva** ' which is said to have watery flesh and the ' Gal **vannāva** ' which is firm fleshed The watery flesh may possibly be the result of reproductive activity

Ceylon, India and all tropical and subtropical seas



P D del

Fig 6 *Coryphaena h equisetis* × ½

**Coryphaena hippurus equisetis** (Linné) Fig 6

*Coryphaena equiselis* [1] Linné, 1758 *Syst Na* , ed X

*Coryphaena equisetis* Jordan et Everman, 1930 *Check list of fishes of North and Middle America*

*Local names* **Vannāva** (Sinhalese) **Āla** (Maldivian) **lesser dolphin** (English)

The following description is based on a single specimen of this comparatively rare form taken at Gulifalu Island, Maldive Islands in December, 1932 This form is less specialized than its larger relative

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[1] An obvious error for *equisetis*.

and does not show any pronounced frontal enlargement. The adolescents of the larger form closely resemble the adults of this fish from which the chief point of difference is the larger number of dorsal rays.

*Fins.* D 4.50, A 2.24, P 18, V 1.5.

*Scales.* Small, cycloid, not markedly elongate or enlarged along base of dorsal.

Before bend of L L. the Ltr $\frac{24}{40}$ above origin of anal Ltr $\frac{30}{33}$.

*Measurements.* Head 4.5, eye 4, snout 1.1, gape 2.5, depth of body 3.9, pectoral 7.8 into entire length. Eye length contained 1.5 in supraorbital depth of head. Mouth moderate, terminal, gape oblique ending under anterior third of orbit. Tip of maxillary exposed. Dorsal originates over hind margin of orbit, continuous. Origin of anal under 33 rd. dorsal. Gill rakers 10. Posterior margin of preopercle oblique, top of opercle as wide as orbit. Dentition feeble, cardiform recurved on jaws, vomers, palatines, and tongues. An outer enlarged row on jaws. Pectoral shorter than head minus snout. Length of fish 410 mm.

*Colours:* (dead) Slaty blue with numerous small black spots, fins dark blue with a thin light margin to anal.

*Distribution:* A comparatively rare oceanic fish. All tropical and subtropical seas.

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## EXPLANATION OF PLATES

PLATE I

Fig. 1. *Scomberomorus commersoni* × $\frac{1}{7}$

Fig. 2. *Acanthocybium solandri* × $\frac{1}{13}$

PLATE II *Istiophorus gladius* × $\frac{1}{15}$

PLATE III

Fig. 1. *Makaira indicus* (Young) × $\frac{1}{8}$

Fig. 2. *Makaira indicus* (Adult) × $\frac{1}{19}$

PLATE IV *Coryphaena hippurus hippurus* × $\frac{1}{11}$

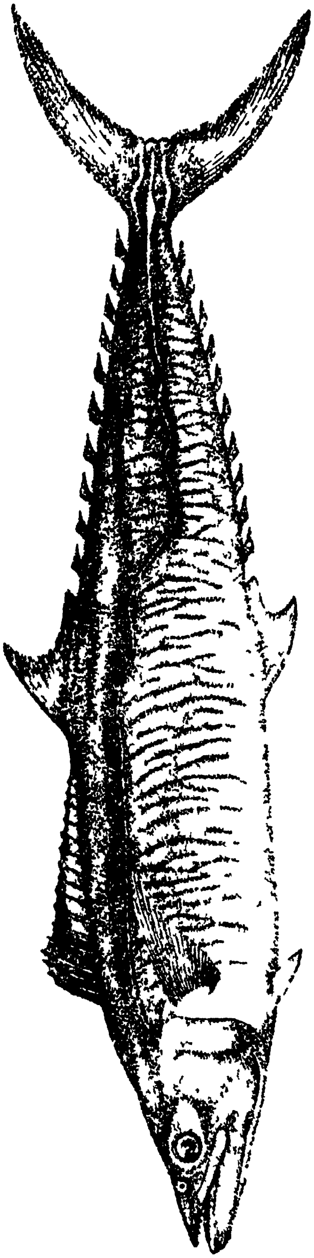

Fig 1 *Scomberomorus commersoni* × $\frac{1}{7}$

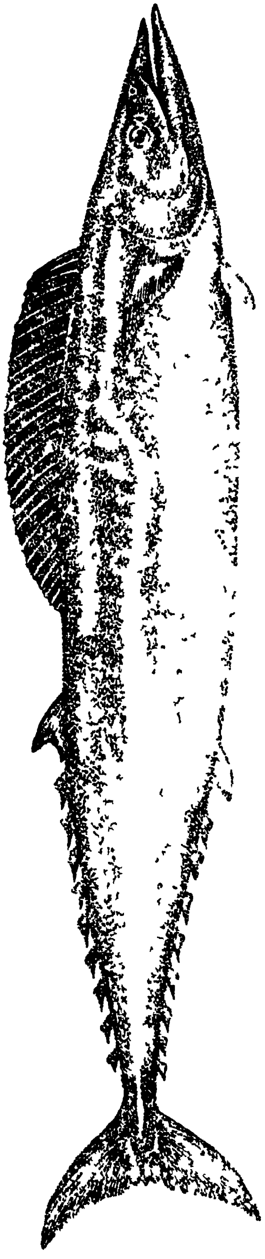

Fig 2. *Acanthocybium solandri* × $\frac{1}{13}$

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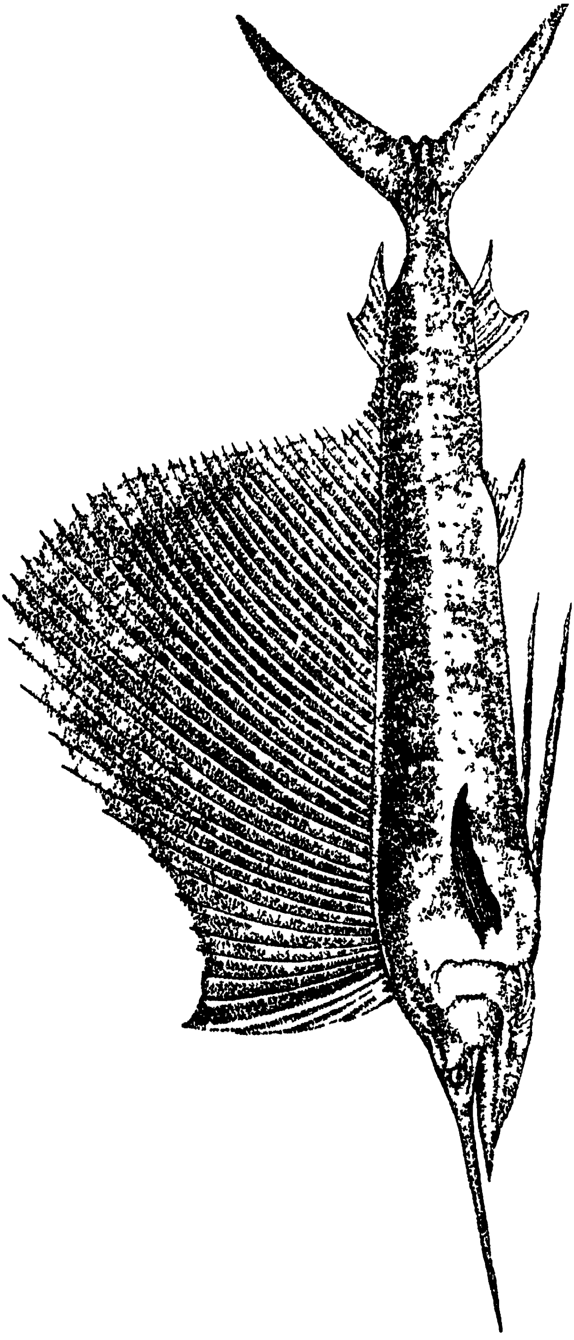

*Istiophorus gladius* × $\frac{1}{15}$

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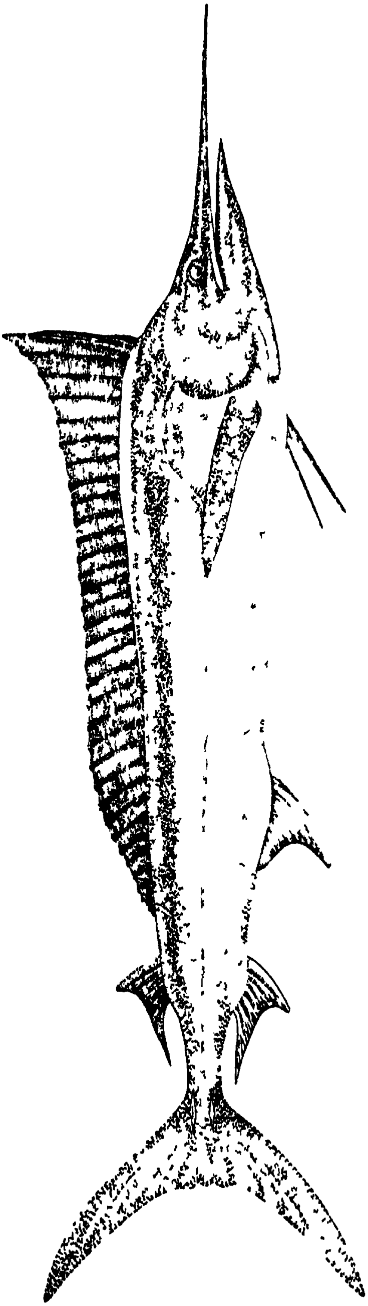

Fig 1 *Makaira indicus (Young)* × $\frac{1}{8}$

Fig 2 *Makaira indicus (Adult)* × $\frac{1}{15}$

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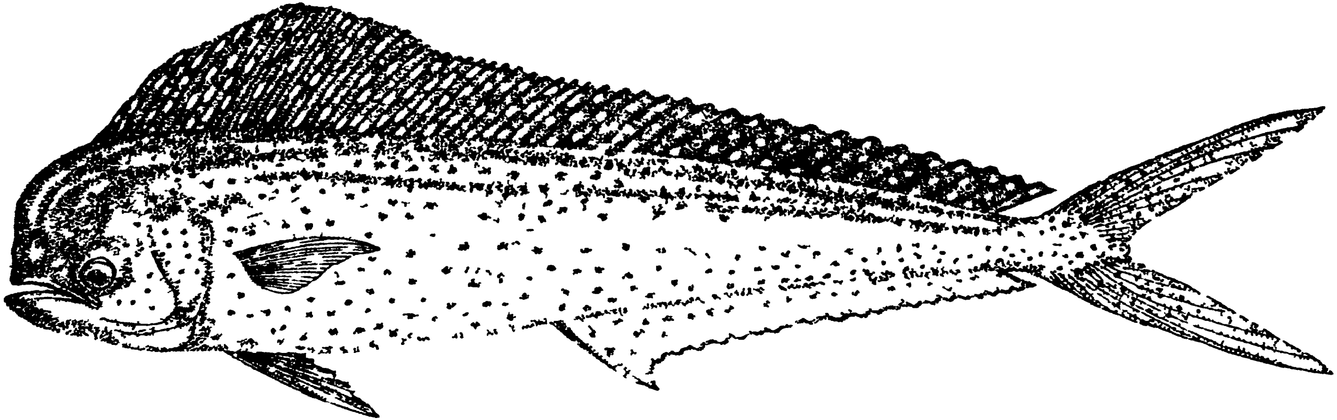

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*Coryphaena hippurus hippurus* × $\frac{1}{11}$

Ceylon J. Sci. (B) Vol. XVIII, Pt. 1. (*December 22, 1933*)

# The Loggerhead Turtles (Carettidae) of Ceylon

BY

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(With One Plate and Six Text Figures.)

Some herpetologists limit the genus *Caretta* Rafinesque, to a single cosmopolitan species while others subdivide it into three. The latter group consider *Caretta olivacea* (Eschscholtz) the sole representative of this genus in the Indo-Pacific (Smith 1931).

However, it is now discovered that *Caretta gigas* sp. nov. is not uncommon in the Indo-Pacific. Failure to recognize the co-existence of these two forms was probably the chief reason for divergent opinions concerning the number of species and also for attempts to explain how the so-called ' supernumerary ' scutes of the young changed into the ' normal ' number of the adult. The most important of such attempts was by Gadow (1899) who on the assumption that the genus consisted of a single species, suggested that in the Indo-Pacific more than elsewhere, the young of the loggerhead exhibited a variety of supernumerary costal scutes which were generally reduced to 5 pairs in the adult. He based this opinion mainly on a brood of 20 young *olivacea* from New Britain and had probably seen adults of both forms from the Indian Ocean as suggested by his list of specimens.

It is quite possible that he considered the apparent similarity in colour of the young of the 2 forms as conclusive ground for the opinion that there was only a single species which he termed *Thalassochelys caretta*. Examination of broods of both forms by myself (1930) and by Babcock (1930) show that the young of the 2 forms intergrade in external features. Some broods of *olivacea* possess a few individuals with 5 pairs of costal scutes while similarly broods of *C. caretta* from the Atlantic exhibit a few turtlets with more than 5 such pairs.

External examination at the time, failed to reveal any means of separating such young of one form from their counterparts belonging to the other and this suggested that their relationship was close, and indeed up till now *C. olivacea* appears to have been differentiated from *C. caretta* by the vague explanation that the former is the more variable of the two.

Examination of series of specimens shows that in the former species there is a small numerical excess of specimens with 18 inner carapace scutes over those with more or less scutes whereas in the latter species specimens with 15 inner carapace scutes numerically far exceed the others with more or less scutes.

Prior to publishing my paper on the Testudinata of Ceylon (1930) I examined 4 reddish brown loggerheads, which possessed only 5 pairs of costals each. Three of these were living adolescents at the Jaffna turtle sheds, the fourth was a larger specimen mounted at the Colombo Museum (Plate V).

In view of Gadow's theory and the intergrading of young from the Atlantic and Indo-Pacific these specimens were considered inseparable from the common Ceylon form and it was then thought that the loggerhead retained its infantile scutation in littoral waters and became olive dorsally while under oceanic conditions it reduced the costals to 5 pairs and became brown red.

Since then investigation of a series of adults as well as several experiments in rearing newly hatched young with 6 to 9 pairs of costals have definitely shown that olive pigment is constant and that the scutes suffer no reduction with age. See Deraniyagala (1932).

This induced me to re-examine the brown-red Ceylon form which local fishermen regard as distinct from the olive. Material for the purpose was collected in March, 1933, from an Island and two fishing villages in the Gulf of Mannar and comprised 10 skulls and 4 carapaces of the brown-red form and 6 skulls and 3 carapaces of the common olive form.

For further comparison Mr. C. Forster-Cooper of Cambridge was so good as to lend me a large *Caretta* skull from the collection of the University Museum while Mr. H. W. Parker of the British Museum kindly compared 4 features indicated in drawings I sent him, with 5 skulls of the Atlantic form.

Dr. A. Loveridge of Harvard also kindly sent me 2 Atlantic young with supernumerary costal scutes. This help enabled me to ascertain that in the Indo-Pacific there are at least 2 species of loggerhead turtle. One of these has hitherto been known only from the Atlantic and appears to grow to gigantic proportions in the tropics more than elsewhere.

Cytology has demonstrated that the component species of a genus differ from each other over a large number of genes which together with other differences generally render interspecific unions sterile. The exceeding paucity of specimens of *olivacea* with 5 pairs of costals as well as the extreme rarity of specimens with 15 inner carapace scutes in this turtle, apparently denote that the 2 Indo-Pacific forms do not interbreed, although they converge in most respects over a large series. Hence they are entitled to specific rank. Apparently in this region the linked characters of olive pigment and more than 5 costals are more successful than the linked characters of brown-red and 5 pairs of costals as the numbers of both forms would imply. The Atlantic forms seem to favour 5 pairs of costals and the 2 subspecies with this scutation are distinctly predominant in this region. In spite of this feature, both the most, and the least specialized species occur together in the Indo-Pacific in greater numbers than elsewhere, hence it is reasonable to assume that this is the original home of the genus *Caretta*.

The genus *Caretta*, (fully defined, Deraniyagala 1930), has 5 to 9 pairs of costal scutes of which the first are contiguous with the nuchal.

KEY TO KNOWN SPECIES OF *Caretta*

A. Total number of inner carapace scutes 15, enlarged inframarginals 6.
Costals commonly 5 pairs
(1) Carapace brown-red . . . . . . *C. caretta or gigas*
(2) Carapace dusky-grey . . . . . . . . . *C. kempi*[1]

B. Total number of inner carapace scutes 16-25, enlarged inframarginals 8.
Costals commonly more than 5 pairs
Carapace olive . . . . . . . . . *C. olivacea*

## **Caretta olivacea** (Eschscholtz) Figs. 1, 2, 3.

*Chelonia olivacea* Eschscholtz, 1829. *Zool. Atlas pt. I. pl. III.*
*Lepidochelys olivacea* Fitzinger, 1843. *Systema Reptilium.*
*Caouana olivacea* Günther, 1864. *Reptiles of British Ind.*
*Thalassochelys caretta* Gadow, 1899 (in part). *Zoo. Results* (Willey) *pt. III.*
*Caretta remivaga* Hay, 1908. *Proc. U. S. Nat. Mus. Vol. 34, p. 194.*
*Caretta caretta* de Rooij, 1915 (in part). *Reptiles of Indo-Austral. Archipel. Vol. I.*
*Caretta caretta* Deraniyagala, 1930 (in part). *Ceylon J Sci.* (*B*) XVI. Pls. XII, XIII.
*Caretta caretta* var. *olivacea?* Deraniyagala, 1930. *Ceylon J. Sci.* (*B*) XVI, pp. 82-83.
*Caretta caretta olivacea* Smith, 1931. *Fauna of British India.* Reptilia and Amphibia, Vol. I.
*Local names :* **Mada käsbäva = mud turtle, Gal käsbäva = rock turtle, Kanādi käsbäva = spectacled turtle, Eramudhu käsbäva = myrtle tree turtle (Sinhalese), Kangamattaiāmai (Tamil).**

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[1] The specimen examined by me in 1930 at the London aquarium, in a tank labelled *C. kempi* was probably *C. c. caretta* with which it agreed in all respects. According to de Sola (1931 and 1933) *C. c. kempi* (Garman) is dusky brown, has 5 pairs of costals, 3 claws on each fore limb and a bony ridge across its palate. See Hay (1908). It is the smallest subspecies and is about 2 ft. long. Habitat Gulf of Mexico.

## *The Olive Loggerhead Turtle.*

To scale with skull of *C. gigas*

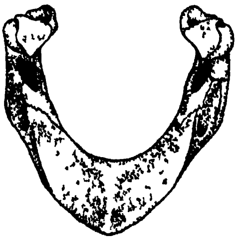

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Fig. 1. Lower jaw of *Caretta olivacea* × ½

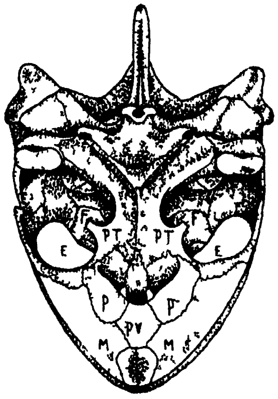

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Fig. 2 Skull of *Caretta olivacea*, ventral view × ½

F = frontal, PT = pterygoid, E = eye, PV = prevomer, M = maxillary.

Dorsally adolescents and adults are a uniform olive, ventrally white or pale yellow; scutes thin, usually 17-23 on carapace with the costals generally in 6-9 pairs or in an odd number; vertebrals 5-9 usually 6-7. Skull more or less obtusely triangular generally neorbital, rarely palaeorbital,[1] its prefrontal suture contained 2.5-6 times in frontal suture, fronto-parietal suture ' V ' shaped. Maxillaries separated by

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[1] One out of 6 skulls was palaeorbital

premaxillaries and prevomer. Posterior width of choanal opening equals distance from this opening to tip of premaxillaries. Each pterygoid expanded anteriorly and with a strong ectopterygoid process. Parasphenoid low, in an obtuse angle, basioccipital with thick lateral wings. Jaws convex externally. Eight enlarged inframarginals.

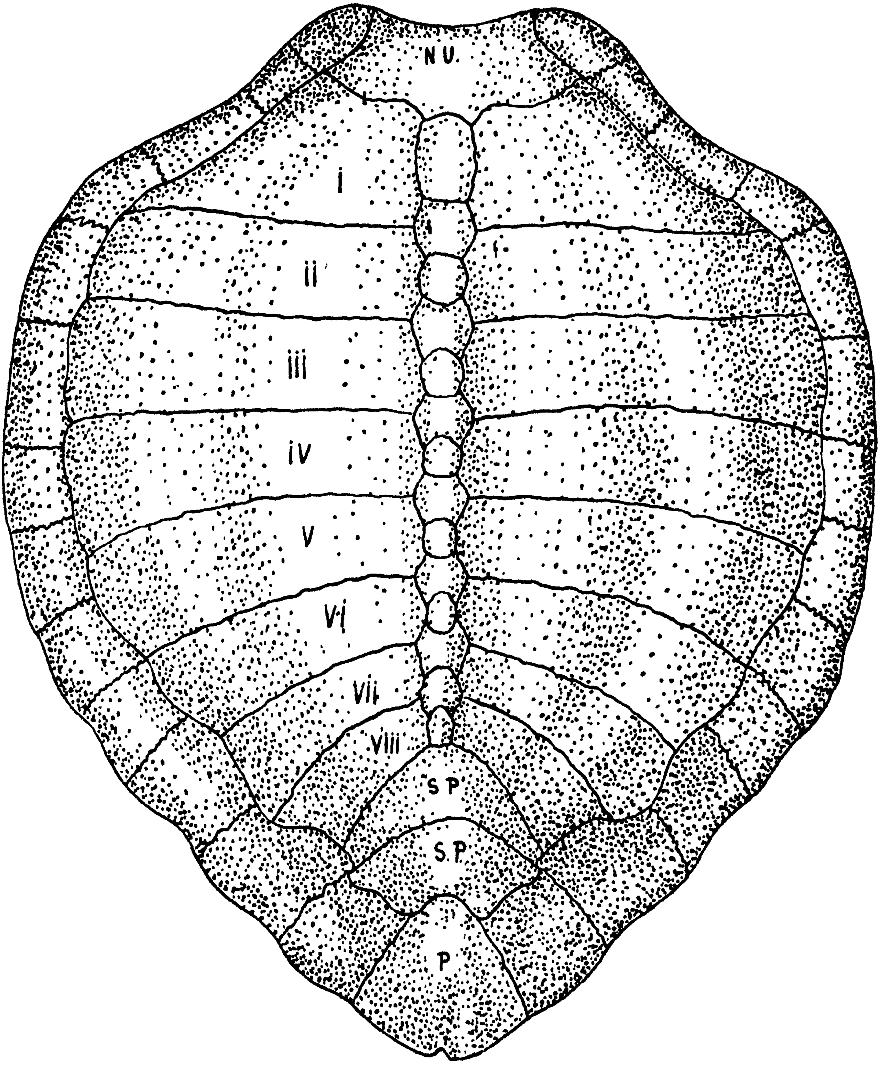

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Fig 3. Carapace of *Caretta olivacea* × $\frac{1}{5}$
NU = nuchal, SP = suprapygal, P = pygal. Roman numerals on costal plates

Carapace cordate, more circular in some than in others; generally with 13-15 neural plates [1] in a continuous series between nuchal and the 2 suprapygal plates. Generally 3 neurals between each 2nd to 6th pairs of costal plates, 2 between the others. Costal plates 8 pairs.

*Dimensions.* (Ordinary adult) skull length to end of supraoccipital, 187 mm., straight carapace length 720 mm. Costoperipheral fontanelles completely obliterated. Some adult skulls showing length into width in mm. are as follows:

175 × 125, 185 × 120, 195 × 120, 196 × 133.

Average size 187.75 × 124.5 mm.

*Reproduction.* Eggs and young common in Ceylon, Maldives and Japan. Diameters of eggs 42-44 mm.

*Distribution.* Definitely known from tropical and temperate regions of the Indo-Pacific and East Atlantic, Ceylon, India, Japan, Phillipines, China, Ventosa Bay (West Mexico). Baur (1890) says he examined a skull from West Africa. This would extend its habitat to the Atlantic. It is quite possible that *C. olivacea* worked its way down the East African coast to the East Atlantic and probably the so-called abnormal specimens of *Caretta caretta* from Banana, Congo, mentioned by Babcock (1930) belong to *olivacea*.

*C. remivaga* Hay (1908) is doubtless a synonym for this turtle. The presence of this turtle (*C. remivaga*) in Ventosa bay and the occurrence of *Caretta kempi* (Garman) which resembles *C. olivacea* to a remarkable degree, in the Gulf of Mexico suggests that the ancestral stock of both forms was originally Indo-Pacific and entered the Gulf through a former strait across Panama. After the strait disappeared this stock gradually gave rise to *kempi* which appears to be restricted to the Gulf region.

## **Caretta gigas**, sp. nov. Plate V. Text Figs. 4, 5, 6.

*Thalassochelys caretta* Gadow, 1901 (in part). *Cambridge Nat. Hist.* Vol. VIII.
*Caretta caretta* de Rooij, 1915 (in part). *Reptiles of Indo-Austral. Archipel.* Vol. I.
*Caretta caretta* Deraniyagala, 1930 (in part). *Ceylon J. Sci.* (*B*) XVI.
*Caretta caretta* var. *caretta?* Deraniyagala, 1930. *Ceylon J. Sci.* (*B*) XVI, pp. 82-83.
*Local names:* Olugedi käsbäva = large headed turtle (Sinhalese), Perunthalai pankini āmai = large headed turtle, Nāi āmai = dog turtle (Tamil).

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[1] This number is rarely equalled by the most primitive fossil testudinates, yet *C. kempi* has 11-14 neurals. (Hay 1908.) Hence both may be placed in the genus *Lepidochelys* Fitzinger.

## *The Brown-red Loggerhead Turtle.*

*To scale with skull of C. olivacea*

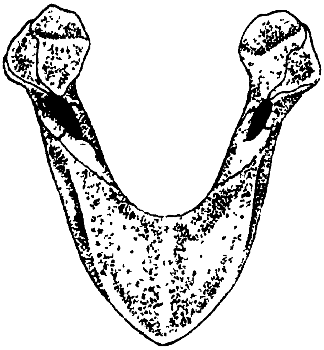

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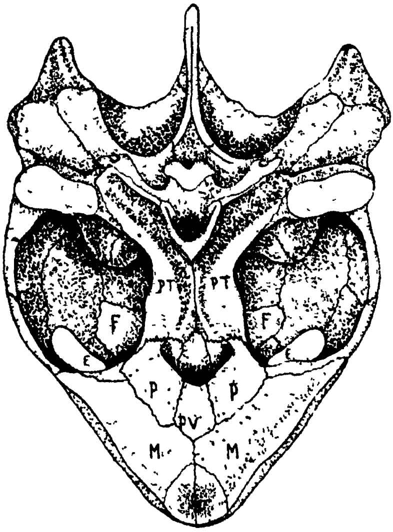
Fig. 4. Lower jaw of *Caretta gigas* × ½



P. D. del.

Fig. 5. Skull of *Caretta gigas*; ventral view × ½

F = frontal, PT = pterygoid, E = eye, PV = prevomer, M = maxillary.

Dorsally adolescents and adults are a uniform yellowish or reddish brown, occasionally the two colours may be mixed with very indistinct black streaks visible in the dried scutes removed from the carapace. Ventrally a pale orange. Scutes strong, usually 15 on carapace. The costal scutes generally in 5 pairs,[1] rarely more, while there is a tendency for the nuchal to be occluded from the costals in some few specimens. Skull generally palaeorbital [1] its prefrontal suture contained 1.75 to 2.5 times in frontal suture. Fronto-parietal suture comparatively straight. Maxillaries contiguous. Posterior width of choanal opening contained at least twice into distance from this opening to tip of premaxillaries.[2] Pterygoids usually not expanded anteriorly and usually without a prominent ectopterygoid process. Parasphenoid high, in an acute

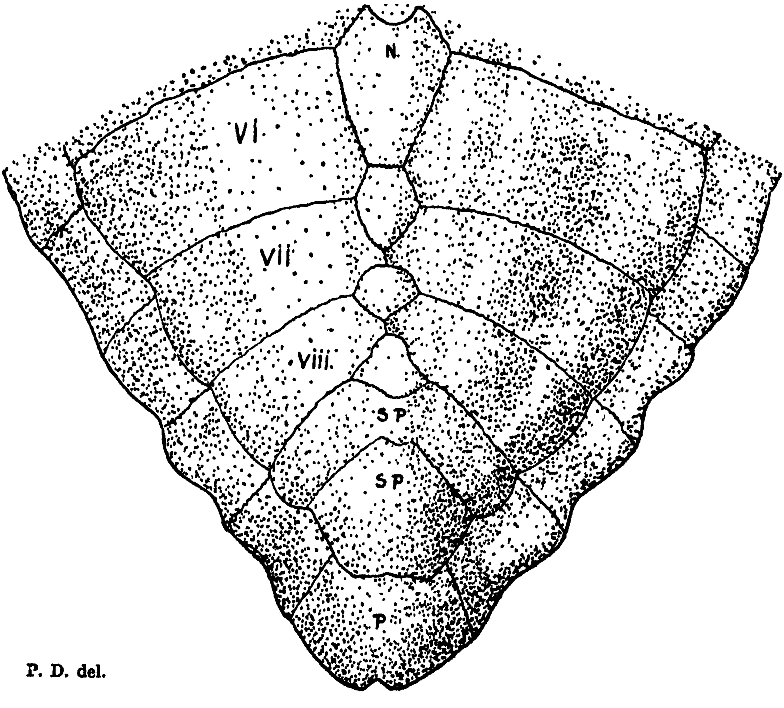


Fig. 6. Posterior end of carapace of *Caretta gigas*, sp. nov.

N = neural, SP = suprapygal, P = pygal. Roman numerals on coastal plates.

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[1] No Ceylon specimens examined were otherwise, although I have seen Atlantic forms which differed.

[2] The skull of a large adult from Australia? in the Cambridge University Museum shows this width contained 2.75 times.

angle. Basioccipital with thin lateral wings. Jaws rather compressed anteriorly, the lower comparatively elongate, its sides straight or feebly concave externally. Six enlarged inframarginals.

Carapace more or less cordate and in young generally inclined to be somewhat narrower at its anterior and posterior extremities and more serrate along the posterior margin than in *C. olivacea;* generally with 9 or 10 neural plates between nuchal and the 2-3 suprapygal plates. The last 2 or 3 neurals are generally separated from each other by contiguous costals.[1] Generally 2 neurals between each pair from 2nd to 8th costal plates, 1 between first 2 costals.

*Dimensions.* (Ordinary adult) skull length 255 mm., straight carapace length 870 mm. A mounted specimen in the Colombo Museum with costoperipheral fontanelles incompletely closed measured as follows:—Head length 250 mm., straight carapace length 900 mm., carapace width 700 mm., plastral length 630 mm., axilla to groin 280 mm. (Plate V).

An adolescent with large costoperipheral fontanelles has a carapace length of 670 mm. Measurements of skulls showing length x width in mm. are as follows:—

255 x 182, 268 x 191, 270 x 188, 275 x 182, 285 x 214.
Average skull 270.6 x 191.4 mm.

The Ceylon and other tropical skulls appear to be larger than the usual subtropical skull. The large skull from the Bell collection (1856) at Cambridge University is thought to be Australian. It measures 355 x 285 mm.

The large skull (*b*) from Mr. Parker's list is from British Honduras while the largest skull examined by Hay (1908) p. 193, came from the Caribbean sea.

The dimensions of the carapace before closure of the costoperipheral fontanelles is further indication of the large size attained to in the tropics. This feature and the separation of the last neural plates by the costals [1], a feature uncommon in the Cryptodira may eventually place the tropical loggerhead in a separate race *gigas*. Fig. 6.

*Reproduction.* Unknown from Ceylon, although both eggs and young of its relative *olivacea* are very common. Local fishermen state that ovigerous females are sometimes taken in the Gulf of Mannar where the animal is not uncommon as seen by the skulls and carapaces

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[1] The last neurals were separate in all the Ceylon carapaces examined. Since this article went to press Mr. C. de Sola informs me that '*Caretta caretta* specimens taken from the Atlantic have an uninterrupted series of neural bones'. This ranks the Indo-Pacific form as a new species, which I now name *Caretta gigas.* The type, head 178 mm. and carapace 660 mm. long will be in the British Museum.

10——J. N. 30204 (6/33)

collected. *Caretta gigas* and *Chelonia mydas* a common Ceylon form are the only marine turtles which do not breed on the Ceylon beaches except possibly on rare occasions.

The eggs of both seem to occur frequently at the Maldives. In December, 1932, I examined 2 nests of a large turtle on Gulifalu island (Maldives). One nest had 124 eggs which were 42-44 mm. in diameter. As I had already obtained young and eggs of *Chelonia mydas* from Minicoy comparison showed that the latter eggs were larger being 47-48 mm. The dimensions of 42-44 mm. agreed with the egg diameter in *C. olivacea* (Deraniyagala 1932). As the flipper tracks indicated a much larger turtle than this species it could have been none other than *Caretta gigas.*

*Distribution.* Cosmopolitan, in all tropical and temperate seas. It is probable that the tropical form may eventually rank as a separate. giant race. Not uncommon in the Gulf of Mannar. Seldom seen in the markets as the fishermen affirm that the flesh of both loggerheads possesses a fishy odour and fetches poor prices. They consequently keep them for their personal use. The brown-red snaps viciously and is termed Nāi āmai, a name descriptive of its ferocity. The size of this animal makes it a dangerous companion in a canoe and it is usually stunned before it is taken aboard. As a result, the majority of skulls were fractured on one side.

This turtle appears to range across the Indo-Pacific; de Rooij (1915), fig. 117, shows a specimen with 5 pairs of costals. As she only recognized a single species it is not known whether this is an Atlantic specimen or no.

Babcock (1930) mentions 3 young from Shark's Bay, Australia, which had 5 pairs of costals. These probably belonged to this species while the large skull kindly sent me by Mr. C. Forster-Cooper of Cambridge University is also thought to be from Australia. Skulls and carapaces were obtained from Karaduva Island, Mariccukkaṭṭi and Talaimaṉṉār in the Gulf of Mannar, Ceylon.

## **Caretta** skulls.

*British Museum* specimens listed by Mr. H. W. Parker.

(*a*) Locality ? Atlantic.

(1) Frontal, excluded orbit*, (2) Pt. process not well developed, (3) approximately twice, (4) Fr-par. suture straight.

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* (1) Nature of orbit, (2) Pt. = pterygoid, (3) choanal width into distance from choana to end of premaxillaries, (4) Fr-par. = Fronto-parietal suture.

(*b*) British Honduras, (Belize) ? (very large)

(1) Frontal, excluded orbit, (2) Pt. process not well developed, (3) Approximately 2½, (4) straight.

(*c*) El Arish, Levant.

(1) Frontal entering orbit at a point, (2) Pt. process not well developed, (3) Approximately twice, (4) Fr-par. straight.

(*d*) Locality ? Atlantic.

(1) Frontal, excluded orbit, (2) Pt. process not well developed, (3) Twice, (4) Fr-par. slightly curved.

(*e*) Locality ? Atlantic.

(1) Frontal, excluded orbit, (2) Pt. process moderately well developed, (3) 2½, (4) Fr-par. straight.

(*f*) Ceylon.

(1) Frontal entering orbit at a point, (2) Pt. process well developed, (3) 1½, (4) Fr.-par. curved.

*Cambridge University skull.*

Bell collection 1856.
Locality Australia. ?
Numbered 176. R. 4606.
Size of skull 355 × 285 mm.

Choanal width contained 2.75 in distance from choanal opening to tip of premaxillaries. Skull palaeorbital, no ectopterygoid process, height of nasal opening contained 2 in length of premaxillary suture.

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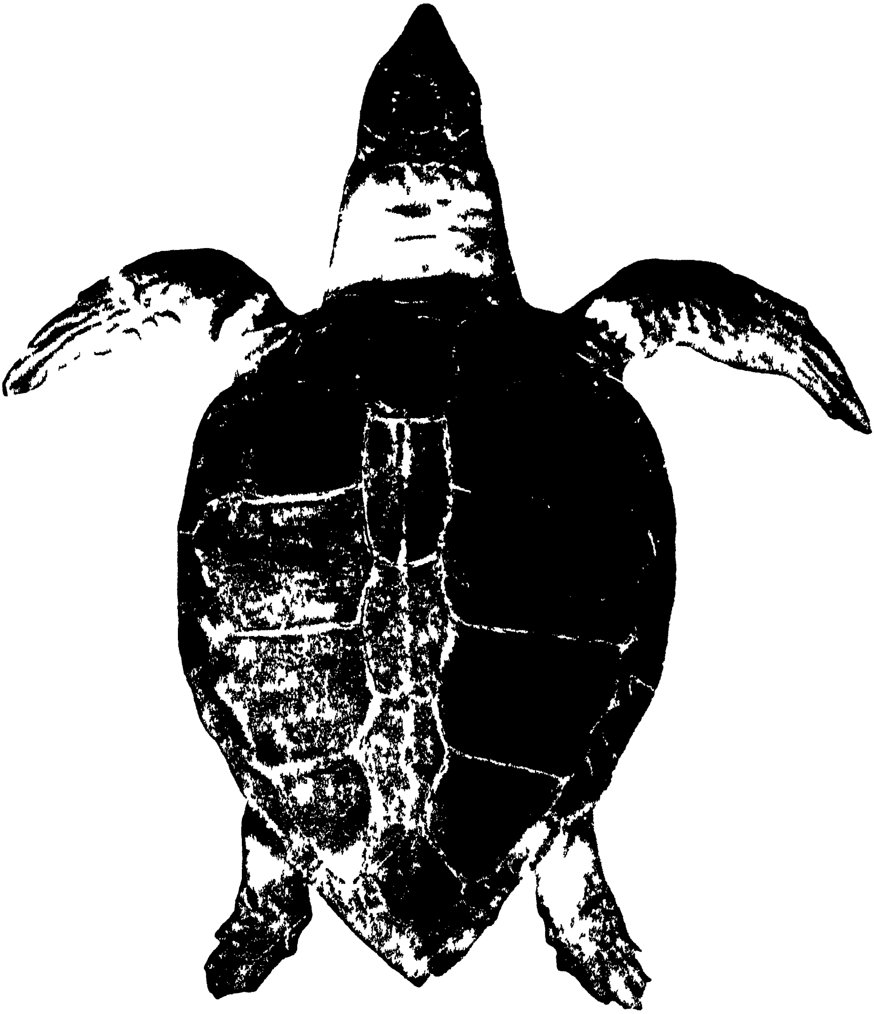
## EXPLANATION OF PLATE V

PLATE V. *Caretta gigas*, sp. nov., specimen mounted in Colombo Museum × $\frac{1}{10}$



*Caretta gigas* sp nov × $\frac{1}{10}$

CEYLON J. SCI. (B) VOL. XVIII, PT. 1. (December 22, 1933)

# Nycticebus malaianus Anderson
# A Dissection of the Abdomino-pelvic Viscera

BY

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(With One Plate and Nine Text Figures.)

## INTRODUCTORY

The present work was suggested owing to a discussion with a wild animal dealer in Singapore regarding the sex of certain animals I wished to purchase. I wanted equal numbers of males and females but as the specimens sent me all apparently possessed a genital tubercle of equal length, I returned the animals. The Asiatic dealer was satisfied that some were females but he could not tell which. However to make perfectly sure he obtained a specimen which was still suckling a young one and sent it to me. I was surprised to find that this animal also possessed a well-marked genital tubercle and no obvious sign of a vagina.

*Nycticebus* is a small animal allocated to the group of Prosimians and the family Lorisidae and is closely allied to *Tarsius spectrum.* In contrast with *Tarsius* the tail of *Nycticebus* is rudimentary, in the form of a very short stump which scarcely covers the anal orifice. The body from rump to crown is about 12 inches in length. The head is piriform in shape, somewhat owl-like when seen at night; forehead broad with large, round, staring eyes, and the nose sharp and pointed. The auricles are very short and nearly hidden in the fur which is short and thick and of a light brownish shade. A well-marked narrow darker band runs along the whole length of the mid-line of the back. There are 5 digits on each limb. The forefinger of the fore-limb is very short as if it had been cut off at the proximal interphalangeal joint. All the digits are supplied with nails. In the case of the hind limb the digits are all well developed and possess nails except the second toe which is apparently supplied with a claw resembling in appearance the claw of the cat. On closer examination however the claw is found to be hollow and is really an elongated nail with the margins rolled in to resemble a claw. Both hallux and pollex are opposable.

The normal mode of progression is extremely slow, in fact all their movements, even feeding, are painfully slow, but when surprised or frightened they can move with considerable agility. In their natural habitat they are chiefly insectivorous, but they may also capture small birds of which the brain is a particular delicacy to them; hence the skull is always bitten off first. In captivity they can make shift with bananas and certain berries and fruits and are said by some observers to lap up milk, though none of my animals would touch it. They particularly relish grasshoppers, locusts, and preying mantises, and will accept moths, spiders, and the variety of cockroach which feeds on our envelopes, clothes and books; but they refuse the large flying cockroaches which are found in drains, so that they show a certain amount of discrimination in their choice of food. They do not appear to drink water as I have not yet seen the water dish touched. As an experiment I kept them for a week without water, but they did not seem to mind and were none the worse for the experience. Even when water was supplied to them they did not rush for it as one would expect a thirsty animal to do and although I watched them for some time they made no attempt to drink. They are rather timid, ill-tempered creatures and, although they soon learned to expect my nightly visit with their food, yet I could not make pets of any of them. At most they will only allow one to stroke the back or head for a short time. As in the case of most night animals there are many tales of folk-lore concerning them. The Malays throw pepper in the eyes of *Nycticebus* and collect the tears which result, using the fluid for a love-philtre. Another belief is that their bite is poisonous and fatal; but as I have been bitten on many occasions by one or other of my animals and suffered no ill-effect the superstition is disproved. Yet another belief is that there is a layer of subcutaneous fat which is distasteful to predaceous animals and accordingly *Nycticebus* enjoys considerable freedom from attack. Unfortunately for the animal the belief is a myth.

*Nycticebus* appears to be equally comfortable in any position; in feeding a favourite attitude is, suspended head downwards by the toes from the roof of the enclosure, holding the prey in one or both hands. Relatively they have enormous strength in their limbs as, not infrequently, they can be seen holding on to a branch with the feet, supporting the body in a horizontal position for quite a long time. They have a peculiar attitude in sleep. They prefer to wedge the rump into the fork of a tree and roll themselves into a ball by arching the back until the head, sharply flexed, rests between the two thighs. The forelimbs are then folded round the knees making them appear just like a ball of fur. I have also seen them sleeping suspended by one hind limb from the roof of the enclosure after the manner of a bat. Mostly, when accustomed to their surroundings, they are very sound sleepers and are not disturbed by adventitious noises. About half an hour before sunset they open their large sleepy eyes and slowly perform their toilet with the forelimbs and tongue just like a cat. When darkness falls, which in the tropics is only a few minutes after sunset, they set out in search of food, and move about restlessly all night. Just before dawn they return to roost and appear to have a distinct homing instinct as each returns to the same site in the enclosure every morning. Originally I had the enclosure fenced in with 1½ inch wire netting. The baby *Nycticebus* was fully half grown when I received it. All day it slept closely enfolded in its mother's arms so that one could not distinguish mother from offspring. At night he used to disappear from the enclosure but had always returned by morning. I filled all possible gaps but for a long time I could not find out how he was escaping so I christened him ' Houdini ' One night I set a watch and discovered he could get through the mesh of the wire netting. I watched him pass into a clump of bushes and travel along the hedge and up a palm tree at least a hundred yards from the enclosure. I watched him for several nights, but one morning he failed to return and I presume he made an excellent meal for some prowling cat. The incident however shows that these creatures have a marked sense of direction and are controlled by the homing instinct.

Two of my animals died from beri-beri due I believe to an insufficient supply of insects. Another I had to destroy as it was constantly fighting with the others. One I have had in captivity for over 18 months and another for 9 months.

## GENERAL ARRANGEMENT OF THE ABDOMINO-PELVIC VISCERA

The present work is based on a dissection of what transpired to be three females. On opening the abdominal wall I found several small round worms free in the abdominal cavity. These worms were about 2 cms. in length and ½ mm. in diameter. I asked the bacteriologist for an opinion and he diagnosed them as " dog-worms " but how the infection took place I am quite unable to say. Extending from the lower border of the liver half way down the abdominal cavity was a pad of fat as shown in Fig. 1.

Fig. 1. The abdominal cavity opened to show the viscera in situ.

The symphysis pubis has been cut through and the pubic bones widely separated.

A = *Falciform ligament.*
B = *Gall bladder.*
C = *Liver.*
D = *Appendix caeci.*
E = *Pad of fat.*
F = *Caecum.*
G = *Small intestine.*
H = *Suspensory lig. of ovary.*
I = *Ovary.*

J = *Left horn of uterus.*
K = *Rectum.*
L = *Vagina.*
M = *Right Ureter.*
N = *Femoral nerve.*
O = *Bladder.*
P = *Urinary tubercle.*
Q = *Anus.*

On dissecting away the fat the large intestine is exposed in the form of a complicated loop. On the right side on a lower level than, and posterior to, the colon are coils of small intestine while on the left side this situation is occupied by the terminal part of the large intestine running down the posterior abdominal wall to the anus. The bladder just above the pubis is piriform in shape and behind the bladder is the vagina from the upper extremity of which emerge the two horns of the bicornuate uterus.

## ALIMENTARY TRACT

The oesophagus pierces the diaphragm posterior and to the left of the inferior vena cava. Its abdominal course is very short and is contained in a horse-shoe shaped hiatus in the liver so that the abdominal portion of the oesophagus is completely surrounded by liver tissue. The oesophagus then enters the upper border of the stomach a little to the right of its mid-point. The stomach is a pear-shaped viscus lying in the concavity of the liver having its long axis nearly horizontal. The horizontal measurement is 4 cms., its vertical diameter 3⅓ cms. and antero-posteriorly 2½ cms. with a capacity of 10 ccs.

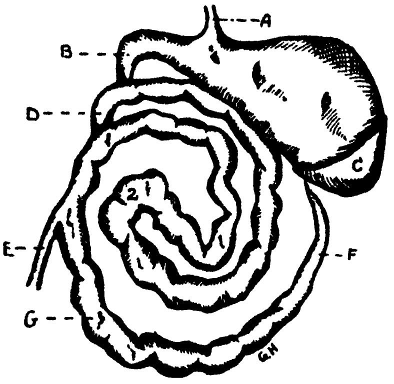

Fig. 2. Arrangement of stomach and large intestine

A = *Oesophagus.*
B = *Duodenum.*
C = *Spleen.*
D = *Descending colon continuous with rectum.*
E = *Ileum.*
F = *Appendix caeci.*
G = *Caecum.*

The pylorus is distinctly thickened and very muscular and is actually on a slightly higher level than the entrance of the oesophagus, a point however, which is of little importance considering that the animal is equally comfortable in any position. Along the left inferior border of the stomach the spleen fits on like a cap. The stomach is entirely covered in front by the liver and spleen while posteriorly it is in relation with the liver over the greater part of its extent and with the pancreas along a narrow strip at the lower border. The duodenum is continued from the right extremity of the stomach, makes a right-angled bend and runs a straight course downwards on the posterior abdominal wall on the right side of the abdominal cavity for 6 to 8 cms.

The gut then forms a series of six irregular loops. The final loop is directed downwards reaching nearly to the apex of the bladder, then turning upwards with a slight obliquity to the left, opens into the right posterior border of the large intestine at a very obtuse angle so that the terminal portion of the ileum and the commencement of the colon are almost in the same straight line. The duodenal and final loop of the ileum have a definite position, but the arrangement of the intervening loops have, in all probability, an adventitious arrangement. The greater part of the small intestine lies between the descending portion of the colon on the posterior abdominal wall and the loops of the large intestine and caecum in front. The diameter of the small intestine is about 5 mms. and the total length from pylorus to ileo-caecal junction is 46 cms. while the length of the large gut from ileo-caecal junction to anus is 42 cms. The diameter of the large intestine averages twice that of the small.

From the ileo-caecal junction the large intestine passes upwards and slightly to the right (Fig. 2). In front of the upper portion of the duodenum the colon bends to the left and turning downwards runs almost parallel with the right inferior border of the stomach. The gut then turns sharply to the right and upwards forming a U-shaped loop. The ascending or right limb of this loop then turns acutely downwards and to the left and running concentrically with the primary loop forms a secondary U-shaped loop outside the primary. The left or ascending limb of the secondary loop then arches posteriorly behind the loops of large intestine and between the left border of the commencement of the duodenum and the right margin of the stomach to reach the posterior abdominal wall where it pursues a straight course to the anus along the median line. The caecum is relatively a very long structure. From the ileo-caecal junction it turns downwards and to the left making a very acute angle with the termination of the ileum, so that it is difficult to understand how the contents of the gut can pass into the caecum unless, as in the cat. the intestine undergoes antiperistaltic movements. The caecum encircles the secondary loop of large intestine, is 5½ cms. long, and is contained in the mesentery of the gut. Beyond this point the caecum is continued as a blind conical diverticulum, 3½ cms. long, which is free and does not possess a mesentery. This is the appendix caeci which has only a small fold of peritoneum along its inner border carrying the vascular supply to the structure. The apex of the appendix is tucked in under the lower border of the liver as shown by the dotted line in Fig. 1 having the spleen as its left relation. It is, to my mind, surprising to find such a long caecum and appendix in an insectivorous mammal, and it is in marked contrast to the bat in which the caecum is very short indeed and the appendix as such is non-existent, the bat being the only other insectivorous mammal with which I have practical experience. The total length of the large intestine in *Nycticebus* including caecum and appendix is 51 cms. or 5 cms. in excess of the total length of the small intestine.

## THE LIVER

The liver is irregular in shape, conforming somewhat to a dome, the apex directed upwards and forwards, the base or visceral surface extremely concave with sharp inferior border all round separating it from the diaphragmatic surface. The liver is entirely covered by peritoneum the lines of reflection from the posterior and superior aspects forming a distinct Y-shaped figure having the single limb of the 'Y' on the superior aspect and the diverging limbs running along the superior and on to the posterior surface thus forming the ligament corresponding to the coronary ligament of man. At the point of junction of the three limbs emerges the upper end of the inferior vena cava. Posteriorly there is a deep horse-shoe fissure which gives passage to the oesophagus and the median dorsal mesentery which suspends the entire gut to the posterior abdominal wall. The inferior vena cava is a thin-walled vessel of 4 mms. diameter, the hepatic portion of the vessel being entirely embedded in the liver substance on the right side of the median horse-shoe fissure.

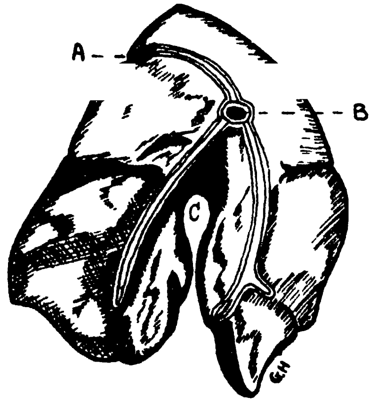

Fig. 3. Posterior and superior aspects of the liver.

*A = continued as falciform ligament.*
*B = Inferior Vena Cava*
*C = Fissure for oesophagus.*

For purposes of description the liver can best be divided into three main lobes, a superior, a right and a left lobe. A fissure, nearly horizontal in the erect attitude, almost entirely cuts the liver into a superior and an inferior portion. The fissure is complete except for a very small amount of liver substance posteriorly which surrounds the right and left hepatic veins and the branches of the portal vein, hepatic artery and bile duct, connected with the corresponding lobes of the liver. The concavity of the visceral surface is so great that it cuts into the horizontal fissure, thus separating the right and left lobes from one another. On the visceral surface, between the adjacent margins of the right and left lobes, can be seen a small area of the gall bladder. The peritoneum extends into the fissures, completely covering the adjacent surfaces of the lobes. A small subsidiary lobe is cut off from the left lobe by a fissure on its postero-medial aspect. From the right lobe posteriorly a tongue-like process projects downwards along the inferior vena cava. The vena cava then enters the liver substance, in the fissure separating the medial surface of this process from the right lobe, carrying the peritoneum of the lower end of the right half of the coronary ligament into the fissure.

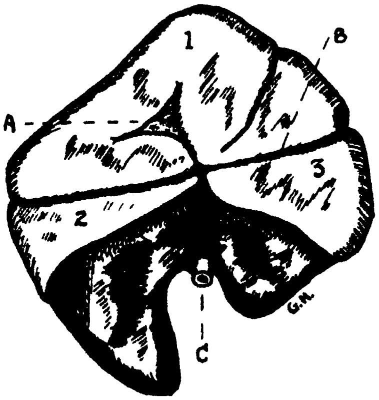

Fig. 4. Anterior surface of the liver.

*1 — Superior lobe.*
*2 — Right lobe.*
*3 — Left lobe.*

*A — Ant. surface of gall bladder.*
*B — Horizontal fissure.*
*C — Inferior vena cava.*

The upper lobe is cut on its anterior surface by two fissures which pass deeply into the liver substance (Fig. 4). The fissure to the left of the median plane is occupied by the falciform ligament while the fissure which is placed more to the right has a triangular fossa at its upper part, this being occupied by the gall bladder and the fundus of the gall bladder being level with the surface and therefore in contact with the diaphragm in the living state.

The visceral surface of the liver is deeply concave and is occupied mainly by the stomach, a small area on the right posterior aspect being in relation with the duodenum and one on the left with the spleen. The anterior portion of the lower border of the liver overlaps the large intestine on the right side while on the left side the appendix is tucked up under the lower margin and to the left of the spleen. The gall bladder is relatively much larger than in man.

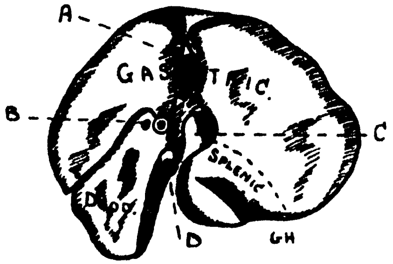

Fig. 5. Visceral surface of the liver.

A = *Gall bladder.*
B = *Hepatic artery and portal vein.*
C = *Oesophageal fissure.*
D = *Inferior vena cava*

The greater part of the gall bladder is covered by peritoneum. Only a small part at the neck is uncovered and in this situation it is bound to the liver by delicate connective tissue. The portal vein enters the liver a little to the right of the oesophageal fissure and is separated from the oesophagus by a thin layer of liver tissue.

## THE SPLEEN AND PANCREAS

The spleen is liable to considerable variations in size as in the case of man living in tropical climates, but whether the variations in the case of *Nycticebus* are due to malaria I am not prepared to say. The organ is somewhat crescentic in shape, and applied to the left half of the inferior aspect of the stomach. Anteriorly the spleen is in relation with the appendix and colon, laterally with the visceral aspect of the liver and the lateral abdominal wall, posteriorly with the visceral aspect of the liver and posterior abdominal wall. In one specimen, however, the spleen is entirely under cover of the liver and does not project below its lower border and I believe this is the usual condition when the spleen is normal in size. In the other two specimens the spleen is rather larger and projects below the lower margin of the liver. The extremity of the pancreas is in contact with the deep aspect of the spleen in the neighbourhood of the hilum.

The spleen possesses two surfaces an antero-lateral applied to the liver and the lateral abdominal wall and a postero-medial. The latter surface is divided by a prominent ridge into a superior part, concave and applied to the stomach, and an inferior part, also concave, to the anterior part of which the appendix is in relation, the posterior half being related to coils of the small intestine. The spleen is enclosed in peritoneum reflected from the anterior and posterior walls of the stomach. The postero-inferior border of the spleen is flattened and in contact with the left suprarenal.

The pancreas is a narrow ribbon of tissue set horizontally in the abdominal cavity extending from the medial aspect of the duodenum to the hilum of the spleen. Above it is in contact with the inferior aspect of the stomach and below with the colon and small intestine. It opens by its duct into the duodenum about half a centimetre from the pylorus. It is enclosed in the dorsal mesentery.

## UROGENITAL SYSTEM

The kidneys are placed in the loins, the left on a much lower level than the right so that the upper pole of the left kidney is at the level of the hilum of the right. The kidney is cylindrical in shape with rounded ends, measuring 2¼ cms. in length by 1 cm. in diameter. The surface is perfectly smooth without any trace of lobulation. On the medial side of each is the hilum, represented by a small depression. The right renal artery comes off from the aorta a short distance above the level of the upper pole of the kidney and runs obliquely downwards to enter the upper part of the hilum above and behind the corresponding vein. The right renal vein is a short structure passing horizontally from the anterior portion of the hilum to the inferior vena cava. The ureter leaves the hilum below and behind the vein. On the left side the renal vein is about 2 cms. long and runs obliquely across the aorta to join the inferior vena cava 1 cm. above the right renal vein. The adrenals are not in contact with the kidneys, but are placed on a higher level and separated by a distance of 1 cm. from the upper pole of the corresponding kidney.

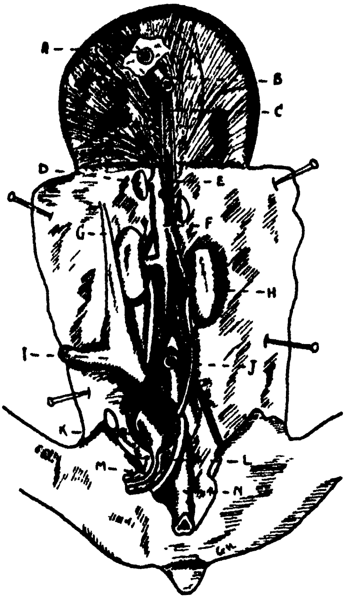

Fig 6 Dissection to show the structures on the posterior abdominal wall. The uterus has been detached on the left side and thrown over to the right to display the descending colon

A = *Inferior vena cava*
B = *Oesophagus*
C = *Mesentery*
D = *Right suprarenal*
E = *Aorta*
F = *Inferior vena cava*
G = *Suspensory lig of ovary*
H = *Left kidney*
I = *Uterus*
J = *Left ureter*
K = *Bladder*
L = *Vagina*
M = *Urethra*
N = *Rectum*

The kidney is invested by a fibrous capsule which is easily stripped off. On longitudinal section through the kidney the kidney substance is seen to be composed of cortex and medulla. The cortex is deeply marked by medullary rays, the medulla being much deeper in colour and easily differentiated from the cortex At first sight it would appear that the kidney was unipyramidal but a closer inspection shows that the apparent single papilla is actually double being divided by a small fissure.

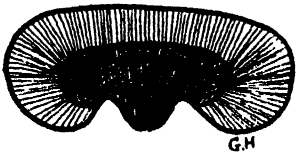

Fig. 7. Arrangement of cortex and medulla of kidney.

The bladder is distinctly piriform in shape with the apex directed upwards. Owing to variations in the thickness of the wall it can be divided into two portions, an upper conical half, of which the wall is thick and muscular, and a lower bulbous portion having a thin membrane-like wall. The junction of the two parts is marked by a slight circular constriction. The ureters open into the lower half at the postero-lateral aspect 3 mms. below the junction of the two chambers. The capacity of the bladder is about 1½ drachms. The urethra is short, about 1½ cms. in length. It tunnels the urinary papilla and opens on the surface of the papilla by a ' Y '-shaped orifice.

The vagina may be divided into two segments, a short lower and a long upper portion. The lower segment is about 1 cm. in length and is almost horizontally placed. It is thick-walled measuring 1.5 mms. in thickness. The remainder of the vagina is vertically directed making an angle of 110° with the lower segment, while the wall is only one-third as thick, about 0.5 mm. At the junction of the two segments there is a distinct thickening or prominence on the anterior wall projecting into the lumen. The lumen is flattened antero-posteriorly along the whole length of the canal, the mucous membrane of the upper segment being thrown into delicate longitudinal folds.

The vagina opens by a lunate slit at the inferior aspect of the base of the urinary tubercle. The orifice is transversely placed and is very difficult to locate. The upper margin of the opening is formed by the base of the urinary tubercle, the lower edge being a thin rounded margin with the fur of the perineal region extending right up to the orifice, obscuring it from view. The anus is triangular in outline and somewhat depressed. The tail is short and rudimentary but the ventral surface of the tail has a pad-like arrangement which closes the anal orifice.

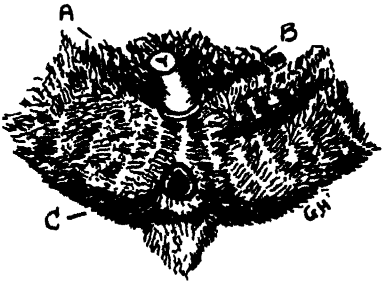

**Fig. 8.** Arrangement of the structures in the perineum.
*A = Urinary tubercle.* *B = Vagina.* *C = Anus.*

The uterus opens into the upper end of the vagina, each horn opening independently and having a common medial wall. Near the union with the uterus the wall of the vagina is slightly thickened. Each horn of the uterus neasures 1 cm. in length by ½ cm. in breadth and a similar amount antero-posteriorly. The round ligament is a delicate thread-like structure which crosses the external iliac vessels and enters the inguinal canal. The ligament passes from the antero-lateral aspect of each horn nearer the lower part, and, owing to the height of the uterus in the abdominal cavity the ligament runs obliquely downwards and outwards for 17 mms. before entering the internal abdominal ring. It is accompanied into the canal by a very delicate nerve. The uterine tube has a fimbriated extremity which grasps the anterior or free surface of the ovary. The ovary is a small flattened body somewhat reniform in shape measuring in the formalin-injected specimen 4 by 3 mms. and 1 mm. in thickness. It is suspended by the long suspensory ligament from the posterior abdominal wall. The ovarian artery passes from the aorta and runs in the suspensory ligament to the ovary.

The uterine artery is a conparatively large vessel arising from the common iliac before its bifurcation into internal and external iliacs. It crosses to the uterus anterior to the ureter of the corresponding side.

## THE PERITONEUM

The arrangement of the peritoneum may be aptly described as one of complicated simplicity. Its simplicity lies in the fact that a continuous mid-dorsal mesentery extends from the diaphragm to the pelvis suspending stomach, spleen, and intestines. From the right half of the antero-inferior border of the stomach the peritoneum passes off to form the gastro-colic omentum, a structure, however, which cannot be compared to the similarly-named structure in man. The two layers from the anterior and posterior surfaces of the stomach respectively, pass to the ascending limb of the secondary loop of large intestine, enclose it and are continued to the caecum and ascending colon. With the elongation of the gut to form the caecum and appendix the blood vessels carry the peritoneum in the form of a mesentery to the caecum, but the appendix is free having only a small fold along its medial border in which the appendicular vessels run. From the ascending colon the peritoneum is carried as a double layer on to the small intestine, forming the mesentery of the small gut, the mesentery being continuous at the duodenum with the anterior and posterior layers of the stomach and therefore with the gastro-colic omentum already mentioned. The loop of gut (marked '2' in Fig. 2) has been rotated with the elongation of the gut so that it has been laid over on the mesentery stretching between the caecum and ascending colon on the one side and the ascending limb of the secondary loop on the other side and has fused more or less completely with it so that a potential space exists between the loop marked 2 in front and the mesentery of colon and caecum behind. From the left side of the antero-inferior border of the stomach the anterior layer of the peritoneum passes to enclose the spleen, while the posterior gastric layer reaches the spleen at the hilum, and forms a double, free fold, which is wrapped round the spleen like an apron. Perhaps a clearer idea of the colic peritoneum may be obtained if we consider that the portion of the primitive gut which is to form the large intestine suspended by its mesentery becomes elongated into a long U-shaped loop directed upwards and forwards. With the closure of the anterior abdominal wall the gut is withdrawn into the abdominal cavity and the whole loop is rotated to the left as indicated by the interrupted line in Fig. 9.

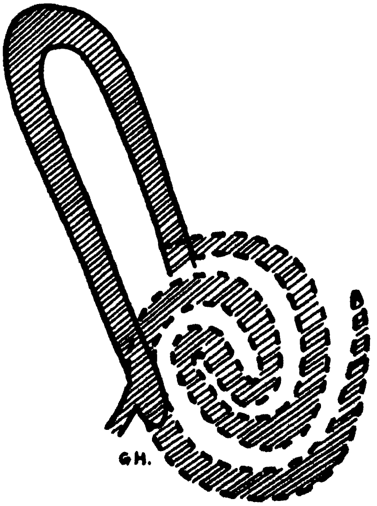

Fig. 9. Diagram to indicate how the loops of large intestine have been produced. The black line shows the elongation of the gut to form a primary developmental loop and the interrupted line shows the direction in which the loop has been rotated to bring it into its definitive position.

The anterior layer of the gastro-colic omentum is of course continuous with the peritoneum surrounding the spleen. The peritoneum on the posterior wall of the stomach passes on to the posterior abdominal wall. On the left side it passes to the left of the descending colon and a deep conical peritoneal pouch is formed extending upwards along the left side of the colon for a distance of 12 mms. The mouth of the fossa is directed downwards and is 3 mms. in diameter, the left margin of the fossa passing as a small peritoneal fold on to the anterior surface of the upper pole of the kidney. This indicates that the flexure between the ascending limb of the secondary loop and the descending colon is on a higher level than it was in the early embryonic stage. There is no corresponding fossa on the right side.

The peritoneum covers the anterior surface of the kidneys and is raised into a double fold commencing at the postero-lateral aspect of the abdominal cavity 1½ cms. above the upper pole of the kidney. The fold runs obliquely downwards from without inwards, crossing the outer border of the kidney at the junction of the upper and middle thirds; passes across the anterior surface of the kidney to the mid point of the lower pole. This fold forms the suspensory ligament of the ovary and is continued down to enclose the corresponding horn of the uterus and, uniting with its opposite fellow,.also encloses the vagina. The line of attachment of the ligament is continued down the lateral pelvic wall thereby forming the broad ligament of the uterus and vagina. An additional fold is carried by the round ligament of the uterus downwards, forwards and outwards from the uterus to the internal ring. Crossing the lower border of the ring is a small vessel which corresponds to the deep epigastric, turning upwards on the deep aspect of the rectus abdominis, a muscle which is exceedingly well developed.

## EXPLANATION OF PLATE VI

PLATE I. *Nycticebus malaianus*. The abdominal cavity opened to show the abdominal viscera in situ. The bladder has been slit open and behind it is the vagina and rectum. At the left inferior border of the liver the tip of the spleen can be seen and immediately to its right the extremity of the appendix caeci projecting upwards under the inferior margin of the liver. The falciform ligament is also visible. Note the short index finger of the hand and the modified black nail, resembling a claw of the second digit of the foot.

*Nycticebus malaianus*

CEYLON J. SCI. (B) VOL. XVIII, PT. 1. (*December 22, 1933*)

# A Monograph on the Genus Loris

## With an Account of the External, Cranial and Dental Characters of the Genus: a Revision of the known forms; and the Description of a new form from Northern Ceylon

BY

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(With Five Plates and Eight Text Figures.)

## HISTORICAL INTRODUCTION

The animals commonly termed Slender Lorises have been known for a very long time; and, on account of their strange appearance and primitive structure, have been of considerable interest to scientists. Their rarity, nocturnal habits, and restricted geographical range, however, have prevented them from being studied as closely as they deserve. These animals were first described scientifically by Linnaeus in 1758, but they appear to have been recognized much earlier by Ray and Seba. Buffon also knew of their existence, and was the first to use the name ' Loris ' in scientific literature. The name is derived from the Dutch term *loeris* which means ' a clown ', and is itself derived in turn from the French *lourd* and the Latin *luridus* meaning ' wan '. The discoverer of the Loris is unknown, but was probably one of the earlier Dutch voyagers to the far East, *e.g.*, Vosmaer (1720-99) by whom these animals were mentioned (*vide* Jones, 1799). At first there was probably no distinction made between the Slender Loris and the Slow Lorises of Malaya.

Linnaeus (1758 and 1766) made the Slender Loris the type of his genus *Lemur*, giving it the title *L. tardigradus*. The specimen upon which his description was founded is stated by Oldfield Thomas (1911) on the authority of Lönnberg, to be still in the museum at Stockholm. There seems to be no doubt, as shown by Stone and Rehn (1902) and later by Thomas (1908 and 1911) that the specimen came from Ceylon.

A Ceylonese animal therefore is to be regarded as the typical form. By common consent the Slender Lorises are now given separate generic rank apart from all other Lemuroids. This genus should strictly be labelled *Lemur*, but, on account of the long association of this term with the well known Madagascar animals, it would be unwise to press the rule in this instance. The first generic name given to the Slender Lorises as a separate group was *Tardigradus*, applied by Boddaert in 1784. This, however, could not stand as the same name had been used earlier (1762) by Brisson for a group of Edentates. The name *Loris* as a generic title was first advocated by E. Geoffroy in 1796. By some error, however, this author unfortunately transferred the specific title *tardigradus* to the Malayan Slow Loris, which for many years afterwards was known to writers as *Nycticebus tardigradus*. At the same time Geoffroy invented the specific title *gracilis* for the Slender Loris. It has been known by this title almost till the present day. Other early systematists who mentioned these animals were Lacépède, Fischer-de-Waldheim, Illiger and Rafinesque-Schmalz. Lacépède (1799) used the spelling *Lori* for the generic term, Fischer (1804) reverted to *Lemur*, but later (1829) placed the Slender Lorises in the genus *Nycticebus*. Illiger (1811) invented a new generic name, *Stenops*, and by this the animals were known for many years by numbers of important writers, including Kelaart (1852). Rafinesque-Schmalz (1840) added yet another name, *Loridium*, to the already heavy list of generic synonyms.

Kelaart (1852) gave a fine description of the typical Ceylonese Loris under the name *Stenops gracilis* and was the first to mention the possibility of the existence in Ceylon of more than one form of Loris, a red one and a black one. He was followed by Tennent (1861).

When and by whom the Slender Loris was first discovered to inhabit South India is unknown. Jerdon (1874) was the first to discuss this in a faunistic work, and he was followed by Blanford (1888). Jerdon knew of Kelaart's statement about two Ceylonese forms, but thought the black one was probably a Slow Loris. Neither Jerdon nor Blanford distinguished between the Ceylonese and the Indian animals. This was undoubtedly through lack of living material. Those working in Europe with merely a handful of skins to guide them could do still less. It is not surprising therefore that it was not till 1904 that Lydekker first pointed out that the Indian Slender Loris differed in several respects from the insular form. Lydekker had no use for nomenclatural purists and accordingly, in describing his new form, made sad havoc with the terminology, which, as seen above, was already in confusion. Lydekker made the mistake of imagining that the Indian animal was the genotype, and described the Ceylonese form as new. His descriptions, though short were, as far as they went, correct. His figures were poor; his terminology shameful. He labelled the Indian Loris as *L. gracilis typicus* and the island form, *L. g. zeylanicus*. Lydekker was perhaps premature in ranking the two forms as subspecies of a single species. No intermediates were definitely known, and he would not have been blamed for ranking them as specifically distinct. This was actually done by Cabrera (1908) who rectified Lydekker's nomenclatural errors by giving the Ceylonese animal its proper name and coining the term *L. lydekkerianus* for the South Indian Loris.

The only systematic treatises on the Primates worthy of mention are those of Forbes and Elliot. Forbes' (1896) account is the better of the two, but considered only one type of Slender Loris, the description of which was based chiefly on the accounts given by Kelaart, Tennent, and Blanford. Elliot's monograph (1913) included a description of *L. lydekkerianus* whilst his account of the Ceylonese animal was based solely on the examination of the type of Lydekker's *L. gracilis zeylanicus* in the British Museum. He made the glaring mistake of recording the two forms as being ' about the same size '.

On account of the absence of complete specimens, Pocock (1918) was unable to record details concerning the external characters of *Loris* in his useful paper on Lemuroids. No living specimen seems to have been imported into Europe up to that time,—no doubt on account of the difficulty of keeping the animal alive on the voyage. Skins too seem to have been a great desideratum, as is usually the case with small nocturnal mammals. Consequently no further contribution either to the systematic study or to the anatomical peculiarities of these interesting animals was made until the last few years. Subba Rau and his colleagues (1930-1931) have recently written a number of short papers on parts of the anatomy of the Indian Loris, but the descriptions are incomplete and in parts inaccurate, while the figures are atrociously bad. The figures of the male and female genitalia, a knowledge of which is badly needed to supplement Pocock's work on other Lemuroids, are quite unrecognizable in the paper by Subba Rau and Hiriannaiya (1930). Subba Rau had previously (1928) collaborated with J. P. Hill in a study of the early embryonic stages of *Loris lydekkerianus*, and Hill (1932) has since incorporated this work into his valuable Croonian Lectures on the developmental history of the Primates.

With regard to geographical distribution only vague statements were made in the earlier works. Jerdon and Blanford (loc. cit.) made more detailed statements regarding the distribution of Lorises on the mainland. In an important paper (1901) on the faunal geography of the Oriental region Blanford made some further statements on the Lorises. The next step was the Bombay Natural History Society's Mammal Survey of India, the results of which, as far as Lorises were concerned, proved interesting. These results were reported by Wroughton (1915, 1917 and 1918) and by Miss Ryley (1913A and B). For the first time scientific proof of the existence of the Slender Loris in the wet Malabar district was forthcoming, and Wroughton (1917) was able to describe this animal as a new species under the name *Loris malabaricus*. As far as Ceylon was concerned collections were made by Major E. W. Mayor (1915). Only four specimens of *Loris* seem to have been procured, and all of these were from the northern dry part of the island. Two of them have been kindly loaned to the present writer by the Bombay Natural History Society, and they prove to be atypical, although apparently accepted as typical *L. tardigradus* by Wroughton (1917).

Last year (1932) W. W. A. Phillips in collaboration with the present writer described for the first time a large dark grey Loris from the hills in Central Ceylon. The form was ranked as a subspecies and named *L. tardigradus grandis*. In the paper on this animal numerous remarks on Lorises in general were made.

The number of forms of Slender Loris was thus brought up to four. Three of these had received the rank of full species, whilst the remaining one was considered merely a race of one of the others. The extreme forms appear to have been the two discovered first, namely, *L. tardigradus* and *L. lydekkerianus*. *L. malabaricus* Wroughton would appear to be the mainland counterpart of *L. tardigradus*, but no form has yet been described as an insular counterpart of the dry-zone-inhabiting form *L. lydekkerianus*. Since the paper on *L. t. grandis* was written, a considerable amount of living material from the northern dry area of Ceylon has come to hand. The specimens collected by Mayor in the same area suggested that further material would prove to be different from the typical Loris of the western lowlands of Ceylon. The new material amply proves this to be the case. The new form is more akin to *L. lydekkerianus* than to *L. tardigradus*, and really serves to fill the gap between *L. t. grandis* and the Indian animal. The new form, however, is distinct from the Indian animal in a number of points. It is manifest therefore that the best way of treating the Slender Lorises in view of the discovery of a third form in Ceylon,—intermediate between the other Ceylonese types and the Indian animals,—is to regard all five as races of a single species. It becomes necessary therefore to revise the whole genus in the light of this discovery. All Slender Lorises are here regarded as comprising a single species which must be known as *Loris tardigradus* (Linn.). This species is represented by the following five geographical races in the different parts of its range:—

| | | |
|---|---|---|
| 1. | *Loris tardigradus tardigradus* (L.) | South-west Ceylon |
| 2. | *L. t. grandis*, Hill & Phillips | Central Ceylon |
| 3. | *L. t. nordicus*, subsp. nov. | North Ceylon |
| 4. | *L. t. lydekkerianus*, Cabr. | Mysore |
| 5. | *L. t. malabaricus*, Wroughton | Malabar tract |

## The Genus **Loris** Geoffr.

The genus *Loris* comprises the Slender Lorises only, the Malayan Slow Lorises being relegated to the genus *Nycticebus* E. Geoffroy. The Slender Lorises are the most primitive of all the non-Malagasy Lemuroids, and form the type-group of these Lemuroids, which thus collectively become known as Lorisoids. Besides the Asiatic tailless forms, the Lorisoids are represented on the African mainland by the large group of long-tailed Galagos (*Galago* and *Euoticus*) and by the short-tailed Pottos (*Perodicticus*) and Angwántibos (*Arctocebus*). All agree in certain characters by which they are recognized as more generalized than the true Lemuroids of Madagascar. In some respects they come nearer to the important group of Tarsioids,—represented to-day by the genus *Tarsius* only. The genus *Loris* is nearer to *Tarsius* than any of the others,—hence its importance in studying the evolution of higher Primates. The genus, however, is not to be regarded as archaic, no more than is *Tarsius*. Just as *Tarsius* has specialized along its own lines (particularly with regard to its mode of progression), and thus departed somewhat from the simpler type portrayed by the Eocene Tarsioids; so also *Loris* has departed from its ancestral type by the elongation of its lumbar region and of its limbs,—again to fit it for its peculiar mode of progression. Compared with the other Lorisoids, however, a complete study of the structure of *Loris* should yield some interesting and important results.

### *Characters of the genus*

The genus *Loris* is characterized by the following:—

Body long and slender; head rounded with a short, sharp muzzle, very large eyes and moderately-sized, almost naked ears; tail absent; limbs very long and slender; index finger short; coat short and woolly; rhinarium, tips of ears, and palms and soles (except heel region), naked.

Of internal characters the following apply to the genus:—

Skull short and round; anterior nares lying anterior to upper alveolus; orbits very large and close together, separated only by a thin bony septum; palate extending behind last upper molar. Upper incisors small and subequal, last upper molar with four cusps; last lower molar with five cusps.

Vertebrae;—cervicals 7, thoracics 15 or 16, lumbars 8 or 7, sacrals 3, caudals 6-8.

Certain regions of taxonomic importance may be discussed here more in detail as Pocock (1918) was unable to do this in his paper on the external characters of the various Lemuroid genera.

*Rhinarium* (see Figs. 1 and 2).

The rhinarium in *Loris* at first sight appears to be intermediate between that of *Tarsius* and that of *Nycticebus*. It is, according to the nares, however, a Lemuroid rhinarium, and not a true nose as in *Tarsius*.

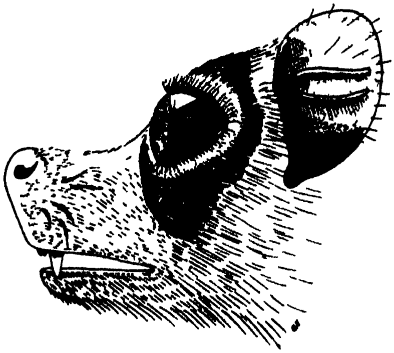

Fig. 1. Characters of the head of *Loris*

The *Loris* rhinarium is narrower, but more prominent than that of *Nycticebus* or *Tarsius*. The nares are comma-shaped, with the large end directed forwards and downwards. In size they are both relatively and absolutely much smaller than in *Nycticebus*. The two nares are separated and surrounded by a patch of smooth, moist, naked skin. At the apex of the snout this is slightly depressed in the midline, and from the depression a slight groove passes downwards towards the upper lip. There is no cleft of the upper lip as seen in *Nycticebus*. On either side of this groove is a narrow tract of naked skin continuous with that around the nares. Below, this tract becomes continuous on either side with a narrow, naked muco-cutaneous margin of the upper lip. (Figs. 1 and 2.) The character as well as the shape of this smooth skin of the rhinarium is different in *Loris* from that in *Nycticebus*. In the latter the skin is definitely papillated, whereas in *Loris* under ordinary low-power magnification it is perfectly smooth. Higher powers show it to be extremely finely papillated.

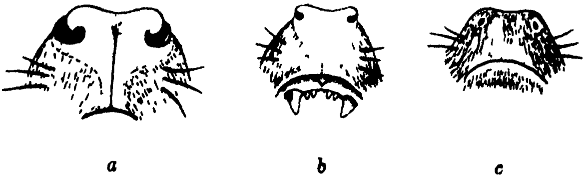

Fig. 2. Anterior view of the rhinarium in *a. Nycticebus*, *b. Loris and c. Tarsius*

The specialized naked skin of the rhinarium is met on all sides by normal hairy skin. This occurs therefore on the dorsum nasi, and on the sides of the muzzle above the naked margin of the upper lip. Most of the hairs of these regions are almost microscopic in size, but among them are a few longer, coarser hairs belonging to the category of sinus-hairs. In both *Loris* and *Nycticebus* there are only three such hairs lateral to the rhinarium, and usually about two more further back on the muzzle. Compared with the sinus-hairs of most Lemuroids these in Lorisoids are both short and scanty *Loris* appears to have no other groups anywhere on the head, whilst *Nycticebus* has, in addition, a couple of longer sinus-hairs in the interorbital region. The interramal group is unrepresented and the same applies to all the other groups so constantly met with in other Lemuroids. In this respect therefore the Lorisoids are more specialized than most Lemuroids.

### *Eye region*

The eyes in *Loris* are considerably larger than in *Nycticebus* absolutely and relatively, though not so large as in *Tarsius*. The eyes are directed straight forwards in opposition to the statement made by Wood-Jones (1929) to the effect that this is not the case in any Lemuroid. The cornea forms a prominent convexity and is the only part of the eyeball visible ordinarily. The iris is a uniform chestnut-brown tint and is marked by delicate radial striations (due no doubt to the radial fibres of the dilator pupillae muscle). The pupil when light-adapted is a vertical or nearly vertical slit, slightly wider above than below, and slightly nearer the median line below than above. In the dark the pupil becomes circular, and the retina reflects a beautiful golden-green or reddish-golden light, The palpebral fissure is placed obliquely, with the inner canthus below the level of the outer. It averages 12 mm. in length from inner to outer canthus. In preserved specimens the opened fissure presents an elliptical outline, but when fully opened in the living animal it becomes practically a circle. The lower lid is the more extensive and movable of the two. It was noticed by Baird in *Nycticebus* as early as 1829 that the eyelids close diagonally, the lower lid having the greater excursion, and passing diagonally upwards and medially over the globe to meet the less excursive upper lid. The same is much more obviously the case in *Loris*.

Both lids are provided with eyelashes. There are two or three rows of them, all placed nearer the superficial margin of the free edge of the lid. Those in the outermost row are the longest, and of these, the ones near the outer end of the upper lid are longer than the rest. The other rows of lashes are short and placed in between the longer hairs of the front row. Lashes are absent from the innermost portion of the lower lid. There may be pigment on the free edge of the lids, and also on their ocular aspect, but this is restricted to certain races. At the inner canthus the two lids are shaped as in Man. There are the two puncta lachrymalia in the usual position, but they are different in shape from those of Man. In *Loris* the puncta are placed near the deep margin of the lid. They are elongated and valvular. There is a lacus lachrymalis between the two lids at the inner canthus. It is surmounted by a few short, pigmented hairs. Deep to this is a moderately developed nictitating membrane, the edge of which is pigmented in some races.

The conjunctival sac is naturally an extensive structure. It is made up of the usual palpebral and ocular walls, the former of which may be pigmented, whilst the latter may be pigmented at the inner and outer canthi, but not elsewhere.

The skin of the lids is clothed with delicate hairs, almost white in colour. Beyond these the skin is clothed with a circumocular field of longer, darkly-coloured hairs. The fields of the two sides are separated, as in *Nycticebus*, by a white interocular stripe. The coloration of these parts varies in the different races of *Loris*, and also at different stages of the life-history.

### *Mouth region*

The opening of the mouth is relatively larger in *Loris* than in *Nycticebus*. The upper jaw, and its lip overhang the lower. The edges of the lips are covered with naked skin, continuous in the middle of the upper lip with that of the rhinarium. In some specimens the upper canines project downwards and are visible even when the mouth is closed. The upper lip is tethered to the alveolus by a frenum. The upper incisors are separated in the mid-line by a wide gap, through which is visible an oval pad at the anterior end of the palate,—probably associated with the organ of Jacobsen. The lower incisors are not so separated, whilst the lower canines are incisiform. The other dental characters are considered below, p. 107.

The hard palate is traversed by a series of transverse ridges. The first one or two of these form segments of circles, with the convexities anteriorly. The remaining four or five form double arches, *i.e.*, a segment on either side of the mid-line. The soft palate is quite smooth.

The buccal portion of the tongue is relatively longer and narrower than in *Nycticebus*. Its dorsum is almost flat, and evenly covered with fairly large filiform papillae. A few fungiform papillae occur in the middle of the dorsum, but not apparently at the edges. The under surface of the tongue is smooth, and almost everywhere in contact with the large sublingua. In the mid-line there is a small frenum, between the tongue and the sublingua. The sublingua in *Loris* is evidently more like that of the *Lemuridae* than the other Lorisoids judging from Pocock's account. According to him the sublingua in *Nycticebus*, *Perodicticus* and *Galago* is broad, especially at the apex. In *Loris* it is long and narrow. It ends anteriorly in a sharp apex. On either side of this the free border is armed with a series of five or six denticles, some of which may be bifid. Both *Perodicticus* and *Nycticebus* have more denticles than this. The under surface of the sublingua is in relation with the floor of the mouth. In the middle line it presents a distinct ridge. There is another frenum in the mid-line attaching the sublingua to the mucous membrane. This frenum is a broader structure than the one between the tongue and the sublingua. The distance from the apex of the sublingua to its point of attachment to the tongue is about 5 mm., whilst the distance to the point of attachment to the floor of the mouth is about 12 mm.

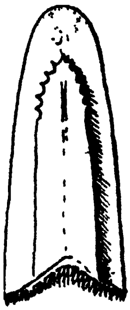

Fig. 8. The tongue and sublingua in *Loris*

*The External Ear* (see Fig. 4).

The ear in *Loris* is quite different from that of any of the other Lorisoids. In general shape the pinna is cochleariform, and has a broad area of attachment to the skull. The free margin is prominent and projects considerably from the side of the head, whereas in *Nycticebus* the auricle is smaller and hidden almost completely by the surrounding fur. Moreover the auricle of *Nycticebus* is itself well clothed with hairs, whilst in *Loris* the organ is only sparsely haired near the margin, and on certain processes mentioned below. The free margin is smooth and entire. There is no apex or Darwin's tubercle. The most projecting part of the pinna of *Loris* resembles that of *Galago* in being capable of folding at the will of the animal when the latter prepares for sleep. The amount of folding is not so much as in *Galago*, but the folding occurs in the same manner, *i.e.*, across the long axis of the ear. On awakening the organ is unfolded very slowly.

In the nature of the concave surface of the ear, *Loris* stands quite apart from other Lorisoids and also from *Tarsius*. According to Pocock the most primitive ears from this point of view are those of the genera *Lemur* and *Cheirogaleus*, whilst the ear of *Tarsius* is an advanced type. He further states that the above forms are linked by intermediate types found in *Galago* and *Microcebus*. *Loris* fills this gap even more completely, for next to *Tarsius*, it has the most specialized pinna of any of the group. In *Loris* the concavity of the shell of the ear has in its upper part two prominent shelf-like processes projecting horizontally outwards parallel to one another. The upper shelf is flat, the lower is a little more extensive and generally convex superiorly. Both are provided near their free margins with a few long wiry hairs. In *Nycticebus*, there are suggestions of these processes, but here they form rounded folds of skin at most, whereas in *Loris* they project into the shell of the ear for 4 or 5 mm. In both *Loris* and *Nycticebus* the

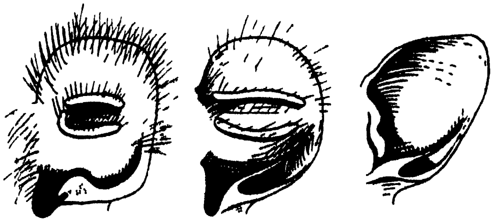

Fig. 4. External ear in *Nycticebus*, *Loris* and *Tarsius*

tragus is absent. *Loris* has no antitragus either, though this is present in *Nycticebus*. At the lower part of the hinder margin of the pinna there is a valve-like arrangement called a supratragus, formed by a fold passing vertically parallel with the free border. Between this and the main border is a deep pouch or bursa. A less advanced form of the same structure is also to be found in *Tarsius*.

*Limbs*

*Loris* stands apart from all other Primates in the grotesque elongation of its limbs. The queerness, however, is due just as much to their extreme thinness as to the elongation. The bones supporting these limbs are themselves very long and thin, and but poorly clothed with muscle and tendon. One wonders how a Loris can live long without getting its limb bones fractured. Evidently their natural elasticity is sufficient to overcome any tendencies in this direction. The elongation affects both pairs of limbs, but the hinder pair are a little in excess of the front pair. Actual measurements are given under the heading of the different races

Both limbs are covered, except on the palm and front part of the sole by ordinary hairy skin. The hair gets very short and scanty as the wrist is approached, especially in lowland forms, and to a less extent also as the ankle is approached on the hind-limb. There are no carpal vibrissae, and no specialized glandular areas on the limbs, such as occur in *Lemur* and *Hapalemur*.

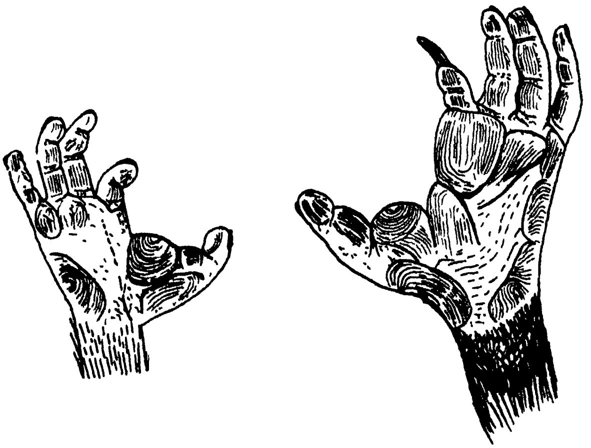

Fig. 5. Drawings of the hand and foot of *Loris*

Of the extremities the hand is much smaller and less heavily built than the foot (see Fig. 5). On the hand the dorsum is hairy, as far down as the penultimate segment of the fingers. The final segment of the dorsum of the fingers, and the whole of the palmar aspect of both digits and hand is naked, and, in some forms pigmented. The arrangement of the pads, fissures and the very delicate papillary ridges is best made out from the diagrams in Fig. 5.

The fourth digit is usually the longest, though it may be hardly longer than the medius. The fifth comes third, whilst, except for the thumb, the index finger is the shortest. The index finger has one phalanx less than usual. All the digits of the hand are tipped dorsally by flat nails similar to human nails. The thumb is widely opposed to the other digits, and a thick padded mass intervenes between it and the index finger. A rudimentary post-minimus was present bilaterally in the type specimen of *L. t. nordicus*. It had no nail and no bony support on either side.

The foot is more heavily built than the hand. Dorsally it is haired as in the hand, but more heavily, especially in the larger races. Hair also occurs on the plantar aspect of the heel region. The rest of the plantar surface of the metatarsal region and toes is naked, and usually unpigmented. The plantar pads are arranged as shown in the diagram,—a large pad opposite the hallux and three smaller ones at the bases of the other toes. Each of these is marked with fine papillary ridges as shown in the diagram. The three outermost toes are subequal in size, with the medius usually slightly the longest and the other two decreasing in size towards the post-axial side. The index digit of the foot is like that on the hand in having one phalanx short. This digit is therefore much shorter than the others, but to make up for this it has an elongated claw-like appendage at the end. This is not really a claw, as already shown by Harrower (this Journal, p. 74) in *Nycticebus*. It is an elongated nail with a rolled-over margin. It is used as a toilet digit. All the other digits, including the hallux, have normal nails. The hallux is a short, broad, heavily-built structure. The four post-axial digits on both hand and foot are permanently semiflexed at the first inter-phalangeal joint. This renders it impossible to straighten out the digits fully in preserved or freshly dead specimens. It is therefore difficult to decide exactly which digits are longer than others.

### *Anus*

The anus in *Loris* is either circular or triangular. If triangular it presents a posterior and two antero-lateral margins. The skin is hairy right up to the anal margin. The margin is puckered, and passes imperceptibly into the smooth mucous lining of the anal canal. A paired perineal gland was found on dissection on either side of the anus in the ischio-rectal fossa. No such gland has been noted in other Lorisoids. No external opening has been seen, chiefly because of the long hair in the neighbourhood. The living animal when handled imparts a musky odour to the hands, and this is probably due to a secretion from the gland just described, as no other cutaneous gland is present on the body that could be regarded as the source of such odour.

The anus is separated from the tip of the coccyx posteriorly by a transverse groove or dimple. The tip of the coccyx forms a superficial bony landmark, and occasionally, as in Wroughton's type of *L.malabaricus*, forms a definite, rudimentary external tail. Anterior to the anus in the female is a median groove running across the perineal body to the hinder margin of the vagina.

Fig. 6. Os Penis of *Loris* from the left side

*Male genitalia* (see Fig. 7)

The external genitalia of the male consist of the penis and scrotum. The penis is long and narrow and therefore in contrast with that of *Nycticebus.* It is supported by a baculum or os penis. The organ is surrounded by a prepuce. This is hairy throughout, but usually fails to cover the glans. The glans is naked, and, towards its dorsal portion, the os penis projects as a superficial bony tubercle. The bone is roughly 10 mm. long, varying slightly in different races. It is rounded at the tip, sinuous in the shaft, and rough at its pubic end, where it is attached to the symphysis by ligament (see Fig. 6). The urethra opens beneath the tubercle formed by the free tip of the os penis.

As noted by Subba Rau (1930) the testicles are not normally in the scrotum. They descend when the animal is sexually active. Whether there is any constant period of sexual activity does not seem to have been ascertained. Normally, when not in the scrotum, the testes lie in the inguinal canal, where they can be felt through the abdominal parietes as elongated, flattened, oval structures. The scrotum consists of very thin, mobile skin, hairy externally. In position it lies as much to the side of the penis as behind, thus agreeing with the condition seen in *Tarsius*. The scrotum is pigmented, the pigment being best visible on the deep aspect of the scrotal skin. The pigment is arranged in a honeycombed pattern on either side, with a non-pigmented strip in the mid-line. Pigment is more heavily developed in some races than others.

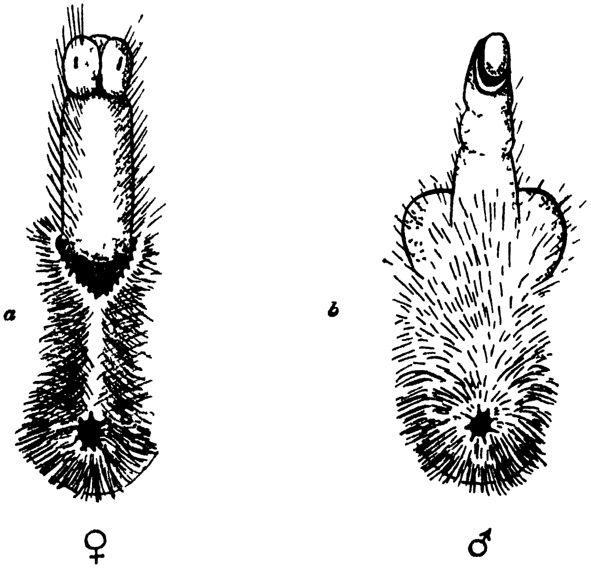

Fig. 7. External Genitalia in *Loris*, *a*. female; *b*, male

*Female genitalia*

The female external genitalia consist of the clitoris and the external opening of the vagina. There are no labia such as occur in *Tarsius*. The clitoris is characteristic. It is almost as long and much thicker than the penis of the male. It has, however, no bony support. Skin clothes the organ up to the neck of the glans, which is naked. The skin is hairy on the dorsal and lateral aspects of the organ, but a hairless tract occurs along the ventral surface, extending from the introitus vaginae to the glans. The glans is bifid, ending in two swollen protuberances lying side by side and separated by a deep cleft. In the bottom of this cleft and towards the dorsal side lies the external opening of the urethra, which has travelled beneath the hairless tract of skin on the corpus clitoridis to reach this position. In *Loris*, therefore we have the complete degree of tunnelling of the clitoris by the urethra. This was noted as early as 1870 in the catalogue of the Royal College of Surgeons Museum. Since then it has been assumed that this arrangement was true of all Lemuroids, but, as Pocock pointed out, true Lemuroids do not present the condition in so complete a degree. At the tip of each of the swellings on the end of the clitoris is a glandular pocket, one on each side of the urethral opening. Each of these is a vertically-elongated structure with the lateral lips in contact. Pocock has described similar, but apparently single glandular pockets at the end of the clitoris in *Nycticebus* and *Galago*, and also mentions their occurrence in the Indrisoid group of Lemurs. Dorsal to the two pockets in *Loris* there is a tuft of long hairs on each side of the glans.

The vaginal opening is a triangular aperture at the base of the clitoris posteriorly. One side of the triangle is formed by the base of the clitoris, the other two sides being formed by the skin of the perineum. The skin on these two sides is hairy right up to the margin of the opening.

The mammary glands were first shown to be four in number in *Loris* by Willey (1905). There is the usual pectoral pair and an additional pair below. In this respect *Loris* seems to differ from all other Primates except *Tarsius*, *Nycticebus*, and *Chiromys*. .

*Reproductive processes*

It is possible that the male Loris is subject to a rutting season, since the testes have been described as descending into the scrotum at certain times, returning afterwards to the inguinal canal. These statements need confirmation. Narayan Rao (1927 A and B) has also described an oestrous cycle occurring in the female of *L.lydekkerianus.* According to this author, *Loris lydekkerianus* breeds twice a year the sexual season falling (i) in April or May and (ii) October or November. A prooestrous sanguineous discharge is described, accompanied by a swelling of the clitoris and surrounding tissues. This stage lasts from 7 to 10 days, at the end of which the female receives the male. Several males are described as endeavouring to cover a single female at one and the same time! Oestrum is said by the same author to last about a week. A peculiar odour is said to develop at this period. Pregnancy is stated to last five or six weeks. None of the statements made by this author have been corroborrated by me. Some of them are undoubtedly wrong. Although I have examined the same female in captivity over periods exceeding twelve months, I have not yet observed any oestrous phenomena, and certainly no bleeding. I do not deny, however, that some form of cycle occurs in a state of nature. As regards the odour mentioned by Narayan Rao, I have already indicated that this is to be found at all times, and in both sexes. With regard to pregnancy, the estimate of this author is undoubtedly erroneous. As no instance of a Slender Loris breeding in captivity has yet been recorded, I fail to see on what grounds this estimate is based. Pearless (1909) recorded that he purchased a female Loris in August of that year. She was kept in captivity alone and gave birth to a young one on November 19th. Pregnancy must last therefore at least three months, and is probably much longer. I have not kept any female as long as this alone, but have had several that were obviously pregnant when received, and which gave birth to young at intervals varying from a few days to a month after being made captive. Twins are occasionally born (Kinnear, 1919; J. P. Hill et al., 1928). Moreover a female Loris may become pregnant again whilst still nursing a young baby. A specimen of *L.t.grandis* was recently received from Mr. W. W. A. Phillips from Gammaduwa. It was a mature female carrying a baby half as big as herself. The baby leaves his mother each evening, but still partakes of the breast occasionally. He is estimated at about twelve months old. On the day after her capture this female had a miscarriage, being delivered of a foetus corresponding in development to a human foetus of five months old. It is evident therefore that lactation does not prevent the recurrence of the ovarian and uterine cycles in *Loris*.

Lactation lasts a long time,—roughly for a year. Narayan Rao (loc. cit.) describes a yellow secretion coating the mammary area during lactation. The nipples swell and elongate and the surrounding hair falls out leaving a bare area around each nipple (*vide* Willey, 1905). The baby clings to the mother's fur and remains for many months in this position. Even after the child is feeding itself, it still returns to the mother's breast to sleep during the day. I received one such female in August, 1931. She was carrying a baby about a quarter-grown. After about three months he was feeding himself, but he still returned to his mother occasionally even twelve months after. At this time he was a little over half-grown, and was subsisting mainly on his own.

*Skull* (see Plates IX to XI)

It is not intended to give here a complete account of the skull of *Loris*, but only to touch upon those aspects which are of systematic importance. A fragmentary account of the skull in the Indian form has been given by Subba Rau and Sahasrabudhe (1930), but this contains some errors and the figures given are very poor. It is hoped to deal with the skull in more detail in a later paper on the general anatomy of *Loris*.

Woollard (1925) made the generalization that no other Lemuroid but *Tarsius* presented the combination of a spherical brain-case and a shortened nasal region. He admits that *Otolicnus* (i.e., *Galago*) has the large eyes, but that the skull-form is in other respects like that of a typical Lemur. That may be true, but in *Nycticebus* and still more in *Loris*, the eyes and the skull-form approach those of *Tarsius*. Moreover, in *Loris*, the orbits are directed almost directly forwards, as in *Tarsius*, and in size they resemble those of *Tarsius* more than do those of any other Lemuroid. In the characters of its skull therefore *Loris* agrees with the suggestions made above in having a rank intermediate between the other Lorisoids and the Tarsioids.

The following details of cranial anatomy in the main tend to support this view:—

The frontal bone is generally double. Woollard says in *Tarsius* it is single, but in *Nycticebus* double. If *Tarsius* is examined young enough or *Nycticebus* old enough the bone will be either single or double according to circumstances. No doubt the same is true of *Loris*. The coronal suture is transverse, as in *Nycticebus*, thus differing from *Tarsius*.

There is never a sagittal crest, such as occurs in some forms of *Nycticebus* and *Galago*. In this respect the skull of *Loris* approaches the anthropoids. The lambdoid suture is shaped as in Man, but the angle is more open. The superior curved lines on the occipital bone run almost horizontally. They end laterally at the posterior edge of the external auditory meatus. About half way they are met superiorly by the posterior ends of the two temporal lines. These are better marked in males, and in the larger races. The foramen magnum is set further back than in *Tarsius*, but not so far as in *Nycticebus*. It is wider relatively from side to side than in *Nycticebus* or *Galago*.

In the temporal region of the skull, all the Lorisoids agree in having the ectotympanic element lying outside the bulla. In this character they differ from all the Madagascar Lemuroids, where the bone is enclosed within the bulla. This fact was first ascertained by Forsyth-Major (1901) and has since been commented on by Gregory (1916) and Pocock (1918) *Tarsius* seems to resemble the Lorisoids rather than the Lemuroids in this character. The bulla in *Loris* is more swollen than in *Nycticebus*, but not so much as in *Galago*. In outline it is oval, with the long axis parallel with that of the petrous temporal. According to Woollard (1925) the septum dividing the interior of the bulla into an anterior and a posterior chamber is complete in *Tarsius*, but incomplete in Lorisidae. The state of the bulla is not discussed by Subba Rau and Sahasrabudhe (1930), but in a specimen of *Loris tardigradus* examined by me Woollard's generalization was found to be correct.

On the facial part of the skull a number of characters of systematic importance have to be mentioned. The general form and lie of the orbits has already been alluded to. The orbital margin, as in all Lemurs, forms a complete bony ring, the orbital process of the malar meeting the external angular (post-orbital) process of the frontal. There is no supra-orbital notch in *Loris*. The same applies to *Nycticebus*, but not to *Galago* or *Lemur*. The infra-orbital foramen is single in all Lorisoids examined. In this they agree with *Tarsius* and differ from Lemuroids proper. The lateral wall of the orbit is relatively wider in *Loris* than in *Nycticebus*, and still more so than in *Galago*. But the widening is not sufficient to reduce the opening into the temporal fossa into a ' spheno-maxillary fissure ' such as is found in *Tarsius* and the Anthropoidea.

In the medial wall of the orbit, there is in all Lorisoids a large element derived from the ethmoid and generally known as the *os planum*. In *Loris* it is particularly large and is well seen in younger skulls; though difficult to define in older skulls on account of the disappearance of the sutures. The os planum is roughly quadrilateral in outline and articulates behind with the palate bone, above with the orbital plate of the frontal, in front with the lachrymal and below with the maxilla. The union with the maxilla is incomplete. A suture joins its posterior half to the maxilla as in human anatomy, but the anterior half is separated from the maxilla by a fissure, which may be labelled the ethmo-maxillary fissure. It is a large gap, but does not seem to be mentioned by Forsyth-Major (1901) or by Subba Rau (1930). It is necessary to discuss this fissure in some detail because it appears to be of some taxonomic importance. The main part of the fissure runs antero-posteriorly with the os planum medially and a thin plate of bone (derived from the roof of the infra-orbital canal) laterally. Medially the os planum descends into the hole and contributes to the formation of the wall of the nasal fossa. At the anterior end of the fissure there is a transversely running branch cutting into the orbital plate of the maxilla. This is bounded anteriorly by that portion of the maxilla which forms the lower margin of the orbital ring and which passes medially to unite with the lachrymal bone. There is thus formed, at the antero-medial angle of the fissure a cruciate arrangement of sutures, due to the union of the frontal, os planum, lachrymal and maxilla. The hole into which this ethmo-maxillary fissure gives entrance is large and undermines the orbital plate of the maxilla. It communicates by a small passage with the nasal fossa anteriorly, but has no connexion with the infra-orbital canal. The fissure differs in size and shape in the different races of *Loris*. It is present, in a different form, in the other Lorisoids (see Plate X, Fig. 2).

The lachrymal bone in *Loris* is very small, due to the encroachment of the two orbits on the inter-orbital region. It is situated on the orbital margin and separated from its fellow by the two nasal bones. The position and relations of the lachrymal fossa have been dealt with by Forsyth-Major (1901) who showed that the fossa is on the orbital boundary, and not outside on the face as it is in *Lemur*.

The premaxilla is a small independent bone of peculiar shape articulating with its fellow, and with the maxilla and nasal. It forms the greater part of the margin of the anterior nares. From the lower margin of the nasal opening the premaxilla recedes rapidly for 3 or 4 mm. to reach the alveolar margin. There is only the faintest indication of such recession in *Nycticebus*, and none at all in *Tarsius* or *Galago*. The maxilla is long antero-posteriorly, but narrow from side to side and from above down. It has a wide area of articulation with the malar. Its relations to the ethmoid have been considered above. It is traversed by the infra-orbital canal, whose posterior opening is large and anterior one small and single.

The mandible is slender, especially when compared with that of *Nycticebus*. The mental region recedes as in other Lorisoids. The coronoid process is long and thin. The angular process is better marked than in *Nycticebus*. According to Woollard (1925) the condyle is less prominent in *Loris* than *Tarsius*. This is true, but *Loris* is less unlike *Tarsius* in this respect than *Lemur* is.

The hyoid bone is of the usual Lemuroid type, with a long anterior cornu and a short posterior one.

*Teeth* (see Fig. 8)

The dental formula in *Loris* is i.$\frac{2}{2}$, c.$\frac{1}{1}$, pm.$\frac{3}{3}$, m.$\frac{3}{3}$. This differs from *Tarsius* in which the formula is i.$\frac{2}{1}$, c.$\frac{1}{1}$, pm.$\frac{3}{3}$, m.$\frac{3}{3}$, and also from certain specimens of *Nycticebus* in which the lateral pair of upper incisors is sometimes lacking. This latter fact was first made know by Lyon (1906) who showed that the differences among Slow Lorises were not due to age, but were probably of a specific or subspecific nature. No such loss of the lateral upper incisors has been observed in *Loris*.

The upper incisors, four in number, are minute peg-like teeth, all about equal in size. In the mid-line they are separated by a considerable interval. A similar, but relatively less wide interval, occurs in *Nycticebus;* and in this genus, when the lateral incisors are present, they are always smaller than the central pair.

The upper canines are long, conical teeth often projecting outside the mouth so as to form tusks. At the neck posteriorly they possess a sharp talon.

The upper premolars decrease in height from before backwards, the first approaching the canine in shape. All three are two-rooted. The first upper premolar is flattish on its buccal aspect, but convex on the lingual side. It has three cusps, a large one in the middle, and smaller ones in front and behind it, the posterior one being smaller than the anterior.

The second upper premolar is molariform in shape. It is enlarged on the lingual side where it presents another large cusp in addition to the three seen on the first premolar.

The third is still more like a molar, and still more enlarged medially. It presents the same arrangement of cusps as in the second, but the two central cusps are larger and more massive at the base.

The upper molars are very complicated teeth. The middle one is the largest and the third one smallest. The first two have cuboidal crowns, and the last one is elongated medio-laterally. The first has no less than nine cusps. These consist of four main cusps near the four corners of the crown, two small conical cusps one in front of and one behind the two main buccal cusps; a small cusp between the anterior buccal and anterior lingual main cusps; a central cusp in the depression between the four main ones; and finally one or two minute cusps, united by a bridge, behind the posterior lingual cusp.

The second upper molar is less complicated, but built on the same general plan as the first. Its occlusal surface is larger, being longer from before backwards and from side to side than that of m.1. The four main cusps are present, but the posterior ones are not so large as in m.1. The central cusp is absent. A cusp occurs at the anterolateral angle in front of the main anterior buccal cusp, but the one behind the posterior buccal cusp is missing. A small cusp occurs between the anterior buccal and the anterior lingual cusp, and there is a faint indication of the ridge behind the posterior lingual cusp.

The last upper molar is elongated from within out, but narrow antero-posteriorly. There are only four cusps on its crown. The posterior lingual main cusp is absent; the other three are all present. The fourth is the small one anterior to the anterior buccal cusp. The ridge on the posterior part of the lingual margin is present, but bears no cusps. The anterior lingual and the posterior buccal main cusps are connected by a low ridge.

The lower teeth are arranged to form a parabola. The incisors and canine are set close together, and are needle-shaped and procumbent. They are all very narrow from side to side, but deepened from above

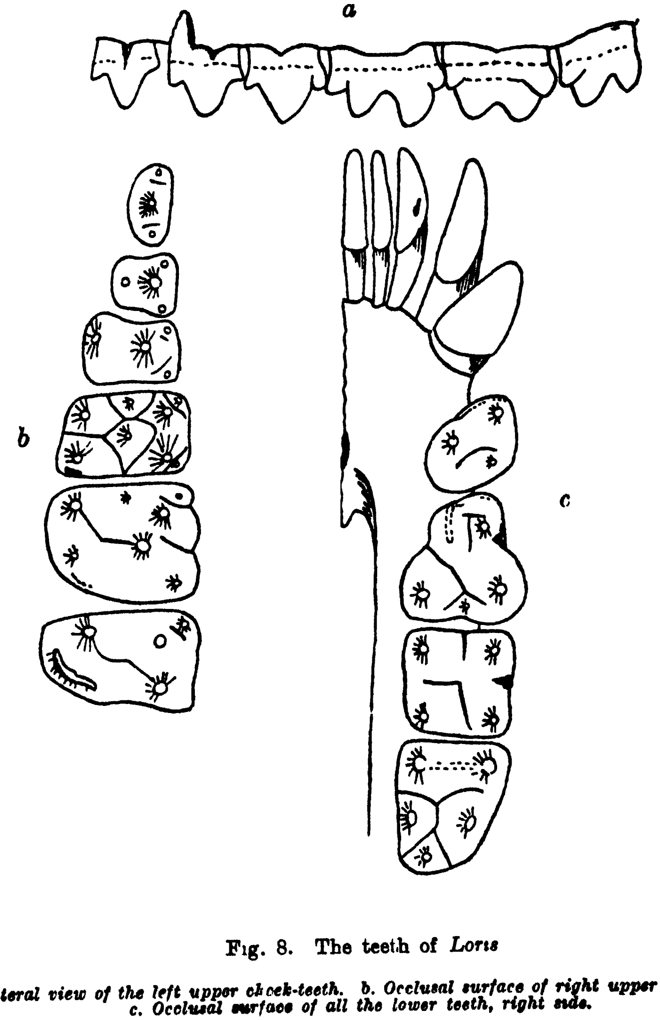

Fig. 8. The teeth of *Loris*

*a. Lateral view of the left upper cheek-teeth. b. Occlusal surface of right upper cheek-teeth. c. Occlusal surface of all the lower teeth, right side.*

down, *i.e.*, from lingual to labial aspect. The canine is the largest of the three, and has a prominent obliquely-placed neck. A slight diastema separates the canine from the first premolar. The first premolar is like a canine, and the second rather less so. They are set close together. The third premolar is molariform and set slightly apart from its predecessors. It bears two large cusps and one small one. The largest is at the antero-lateral extremity of the tooth; the next more medial and slightly behind; and the small one laterally and still further back. This small one is separated by an oblique depression from the two large cusps.

The lower molars are less complicated than the upper. The first has its crown narrow in front, but broad at the back, being constricted between the two portions. The anterior part bears one large cusp nearer its buccal margin, and a ridge curving round this on the anterior and lingual sides. The posterior moiety bears two large cusps, one on the buccal and one on the lingual side, separated by a depression. It also has a minute cusp posteriorly between the two large ones. The second molar is cuboidal and bears four subequal cusps at the four angles of its crown. The third molar has five cusps, four like those of its predecessor and a fifth large cusp behind the two posterior ones. The two anterior cusps are united by a ridge transversely. The remainder are separated by grooves.

## **Loris tardigradus** (Linn.)

### The Slender Loris

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Elliot, 1913. *Rev. of the Primates*, I, p. 18
Phillips, 1926. *Ceylon J. Sci.* (B), XIII, p. 281.

Sinhalese, Unahappuluwa; Tamil, Thevangu or Nama-thevangu; Tamil (in India), Kattu-papa or Kattu-pullaye; Kanarese, Kada papa or Adavi-papa; Telugu, Arawe-papa; Hindustani, Shermanda; Marathi, Wanur-manushya.[1]

As there is but the one species in the genus *Loris* recognized here the characters of the species are those of the genus. It is necessary here therefore to do no more than mention certain general points, and to give a key for the diagnosis of subspecies recognized.

*Loris tardigradus* resembles Man and many other Primates in its great variability. The variability affects its external appearance, especially its coat-colour and the pigmentation of its skin. It also affects bodily size. The variations are partly due to age and sex, but more particularly are they the result of climatic factors. Although the geographical range of the animal is comparatively limited (*vide* infra), yet within this range there occur a number of distinct climatic zones more or less sharply marked off from one another. The climate of the zones is produced by their geographical position, and also by altitude. The result is that the zones differ in rainfall and in

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[1] The Indian native names are taken from Miss K. V. Ryley's report (1913A).

temperature. Both these climatic factors seem to affect the external form and size of the animals living within them. How they do this is not precisely known, but the view of the writer is that this is brought about through an effect on the animal's ductless glands. Pigmentary variations are most likely to be effected through the activities of the suprarenal cortex. But at present this is only a theory. As a general rule altitude implies lower temperature, and the animals living at higher altitudes are larger in bodily size and more heavily clothed with hair. *Loris* is no exception. One of the most striking pigmentary variations is the exhibition of erythristic and melanistic phases. Several Primates such as the Lowland Gorilla (*G. gorilla*) and the Negro Langur (*Pithecus pyrrhus*) are known to present such phases. Although persistent reports of erythristic and melanistic Lorises living side by side in the North-Central Province of Ceylon have been received, no concrete evidence of this is forthcoming. So far as we know only one phase occurs in any one zone. As far as present evidence goes it can safely be stated that erythrism is the product of a damp lowland environment, and is more evident in the male sex than the female, and also in the adult rather than in the young. Highland animals are dark grey inclining to black; whilst dry areas, whether high or low, have so far been productive of only grey forms.

### *Geographical Distribution*

*Loris* is confined to Ceylon and South India. Details need further working out. As far as Ceylon is concerned the animal is probably sparsely represented all over the island, except on the highest slopes of the mountains. So far it has been reported only up to about 3,500 ft. It has not yet been collected from many parts of the hills nor from all parts of the low-country, but may safely be inferred to occur in all these places, for it is well known to natives in many of the places from which it has not actually been obtained. Climatically the island is now known to be divisible into three well-marked zones (see numerous papers by Phillips in this Journal). Each of these is occupied by a distinct race of *Loris* of which only two have hitherto been described. The race belonging to the northern dry zone is described for the first time below.

In India less is known of the details of distribution. It is possibly nearly, if not quite, the same as that of the South Indian Bonnet Monkey (*Macaca radiata*), *i.e.*, covering the whole of South India as far north as the Godaveri River. The animal is said to be common in Mysore and the Nilgiris. It was believed by Blanford to occur in the wet Malabar tract, but was not definitely proved to do so until the

Indian Mammal Survey obtained specimens. These Malabar specimens proved to be distinct and were described as *Loris malabaricus* by Wroughton in 1917. It is possible that further search in India will lead to the discovery of still more races.

The five races here recognized (see list on page 93) are to be identified by the following key:—

KEY TO THE IDENTIFICATION OF THE RACES OF LORIS TARDIGRADUS

| | |
|---|---|
| A. Total length of adult 205 mm. or under . . . . . . . . | *tardigradus* |
| B. Total length of adult over 205 mm. | |
| *a*. General colour reddish on upper parts . . . . . . . . | *malabaricus* |
| *b*. General colour greyish on upper parts | |
| $a^1$ Ventral hairs white throughout . . . . . . . . | *lydekkerianus* |
| $b^1$ Ventral hairs greyish on basal ⅓, white distally | *nordicus* |
| $c^1$ Ventral hairs black on basal ⅓, white distally . . . | *grandis* |

## 1. **Loris tardigradus tardigradus** (Linn.)

### The Slender Loris of South-western Ceylon.

*Lemur tardigradus*
Linnaeus, 1758. *Syst. Nat.* I, p. 29
idem., 1766. *Syst. Nat.* I, p. 44
*Tardigradus tardigradus*
Boddaert, 1784. *Elench. Animal*, p. 67
Stone and Rehn, 1902. *Proc. Acad. Nat. Sci., Philadelphia*, LIV, p. 136
*Loris gracilis*
Geoffroy, E., 1796. *Mag. Encycl., Ann.* 4, 1, p. 48 et al.
*Lemur ceylonicus*
Fischer, 1804. *Anat. Maki*, t. XII, p. 28
*Stenops tardigradus*
Illiger, 1811. *Prodr. Syst. Mamm.*, p. 168 et al.
*Stenops gracilis*
Kuhl, 1820. *Beitr.*, Bd. VI, pp. 37 and 37 et al.
*Nycticebus gracilis*
Blainville, 1841. *Ostéogr.*, Atlas Pl. H.
Schlegel, 1876. *Mus. Pays-Bas*, VII, p. 284
*Loris gracilis zeylanicus*
Lydekker, 1904. *P.Z.S.*, p. 345
*Loris tardigradus*
Thomas, 1908. *Ann. Mag. Nat. Hist.* (8), p. 469
idem., 1911. *P.Z.S.*, p. 129
Elliot, 1913. *Rev. of Primates*, I, p. 18
Phillips, 1926. *Ceylon J. Sci.* (B) XIII, p. 281
*Loris tardigradus tardigradus*
Hill and Phillips, 1932. *Ceylon J. Sci.* (B) XVII, p. 109

*Type:* In the Stockholm Museum (see p. 89). Sex and age unknown.

*Type-locality:* ' Ceylon '.

*Material examined:* Living and freshly dead material only. Skins in the Colombo Museum collection were examined for comparison.

*Characters: Adult male.* Size small,—the smallest of all the Slender Lorises,—under 200 mm., usually much less in total length. General character of fur woolly, with a minimum of true hairs, except on the face, where all the hairs are true hairs, but very short. General colour russet or reddish above, buff or yellowish below.

Muzzle narrow and pointed; dorsum nasi very feebly haired with whitish hairs. These pass superiorly into the white interocular stripe, which is usually not bifurcated though broadened at its upper end. Circumocular patches dark chestnut, paler on the eyelids. A pale brown tract in front of the ears, never white. Cheeks dark buff, never white. Throat pale buff, with the bases of the hairs grey.

Top of head russet with bases of hairs dark grey. Dorsal aspect of trunk and extensor surfaces of limbs similar to top of head varying to pale fawn in some specimens. Lumbar and sacral regions tend to be lighter and are sometimes frosted on the surface, but never as heavily as in the larger forms. A dark median dorsal stripe is frequent, but not constant, and never as dark as in *nordicus* and *lydekkerianus*. Hands and feet scantily clothed with short whitish hair. Ventral surface of trunk and flexor aspects of limbs covered with yellowish or buff woolly fur, with the component hairs dark grey at the base. On the flanks the dark dorsal and the light ventral hairs pass imperceptibly into one another.

Skin-pigmentation is variable, but there is usually some melanin pigment in the skin of the dorsal side of the body and extensor surfaces of the limbs. The dorsum of the nose is usually a dusky tint from scattered pigment. Lips and rhinarium are unpigmented as a rule. Eyelid margins are usually not pigmented, but may be a little dusky. The same applies to the palpebral conjunctiva. Margin of nictitating membrane usually slightly pigmented. Ears dusky near margin, otherwise yellowish. Hands and feet dusky, with a yellowish suffusion especially on palms and soles.

The possible nature of the yellow pigment has already been discussed by the present writer (1932). It seems to occur specially in *L. t. tardigradus*, and is best noted in the parts normally naked or nearly so. It develops more heavily in animals that have been long in captivity.

### Skull

Size small,—maximum length under 50 mm. Nasal bones shorter and broader than in other forms; frontals small; temporal lines wide apart anteriorly and still more so posteriorly, diverging rapidly in their course; parietals large; temporal fossae less roomy than in larger forms, with its sides forming an equilateral triangle; muscular ridges less marked than in other subspecies; orbital ring smaller and the rim less deep; ethmo-maxillary fissure hammer-shaped, with a narrow pointed sagittal stem and a short rounded transverse portion partially divided by a rounded spur of bone from its anterior margin; palate and posterior nares relatively broader than in *grandis*.

### Adult female

Larger than the male in all dimensions, reaching 200 mm. in total length and occasionally exceeding this by a millimetre or so. Less rufous in general colour of upper parts, being usually wood-brown, with a faint rufous tinge in some individuals, especially on the hinder parts. Frosting on lumbar region heavier than in the male. Skin-pigmentation as in the male. The mammary area becomes covered with yellow secretion during lactation.

### Young

The new-born of *tardigradus* is in general hue slate-coloured above and dirty-whitish below. Among the woolly hairs are numerous long wiry true hairs. Circumocular patches bright chestnut, darkening with age. The young assumes the adult coloration in about a year, the male resembling the female at first and becoming reddish later. Pigmentation is less evident in the earlier stages than in the adult.

The skull of the new-born *tardigradus* has a relatively more prominent muzzle region than in the adult. The orbital margins are less well developed and their lateral parts are more receding, so that the axes of the orbits do not look so directly forwards. The cranial vault is made up of a very extensive contribution from the parietal bones. The frontals are paired. The tympanic region is more primitive, the tympanic bone consisting of a ring only. The auditory ossicles are open to view and the bulla is undeveloped.

### Measurements

(*a*) Body weight

**Body weight of four living specimens—♂, 3 ozs.; ♂, 4½ ozs.; ♀, 4 ozs.; ♀, 3 ozs. (85, 127.5, 113.3, and 85 gms.).**

**Average, 3½ ozs. (102.4 gms.).**

Body weight of four preserved males, 90, 160, 125 and 155 gms.—average 130 gms.

Body weight of a preserved female, 145 gms.

(*b*) Linear body measurements

| *Locality* | *Altitude* | *Sex* | *Head and Body* | *Hind-foot* | *Ear* |
|---|---|---|---|---|---|
| Henaratgoḍa | .. Low-country .. | ♂ .. | 182 .. | 35 .. | 21 |
| Do. | .. do. .. | ♂ .. | 185 .. | 41 .. | 19 |
| Colombo | .. do. .. | ♂ .. | 196 .. | 42 .. | 22 |
| Do. | .. do. .. | ♂ .. | 183 .. | 38 .. | 22 |
| Do. | .. do. .. | ♂ .. | 199 .. | 39 .. | 23 |
| Matugama | .. do. .. | ♂ .. | 193 .. | 45 .. | 22 |
| Kitulgala | .. 900 ft. .. | ♂ .. | 187 .. | 44 .. | 23 |
| Average of 7 males | | | 189.2 | 40.5 | 21.7 |
| Henaratgoḍa | .. Low-country .. | ♀ .. | 204 .. | 44 .. | 20 |
| ? | .. do. .. | ♀ .. | 206 .. | 44 .. | 21 |
| Colombo | .. do. .. | ♀ .. | 196 .. | 40 .. | 23 |
| Average of 3 females | | | 202 | 42 | 21.3 |

(*c*) Skull measurements

| *Locality* | *Sex* | *Max. cranial l.* | *Max. cranial br.* | *Min. cranial br.* | *Across bullae* | *Palatal l.* | *Br. across m. 3* | *Upper tooth row (excl. incisors)* | *L. of mandible* | *Lower tooth row (excl. incisors)* |
|---|---|---|---|---|---|---|---|---|---|---|
| Henaratgoḍa | ♀ | 50 | 32 | 17 | 28.5 | 17 | 14 | 16 | 27 | 14 |
| Do. .. | ♂ | 50 | 31.5 | 17 | 28 | 19 | 16 | 16.5 | 28 | 15 |
| Do. .. | ♀ | 48 | 29.5 | 16 | 28 | 17 | 15 | 16 | 27 | 16 |
| Do. .. | ♂ ? juv. | 43 | 26 | 18 | 24.5 | 16 | 15 | 15 | 20.5 | 14 |
| Colombo .. | ♂ | 48 | 30 | 17 | 27 | 17 | 15 | 15.5 | 26 | 15 |
| Do. .. | ♂ | 47 | 29 | 17 | 27 | 17.5 | 14 | 16 | 26 | 14 |
| Do. .. | ♀ | 49 | 29 | 17 | 28 | 17.5 | 15 | 16 | 26 | 15 |
| Do .. | ♀ | 48.5 | 31 | 16 | 28 | 18 | 14 | 16 | 28 | 15 |
| Do. .. | ♂ newborn | 31 | 14 | 14 | 17 | 11 | — | 7 | 12 | 4 |
| Average of 7 adults | | 48.6 | 30.3 | 17 | 27.8 | 17.5 | 14.7 | 15.3 | 27 | 14.8 |

### *Distribution*

The type locality of *L. t. tardigradus* is unknown, but as all the earlier writers on *Loris* spoke of a reddish animal from Ceylon, they evidently referred to the form found in the wet western lowlands of the island, for a reddish form does not occur elsewhere in Ceylon as far as our present knowledge goes. This area is limited by the sea on the west, by the hills inland; whilst in the north and south the wet lowlands pass gradually into dry low-country. Actual localities from which this form has been obtained are as follows:—Colombo, Wellawatta, Nugegoda, Kesbewa, Cotta, Gampaha, Henaratgoda, and Matugama. This form ascends the hills up to about 1,000 ft., having been recorded from Kitulgala (900 ft.). Above this height it grades into the next form, intermediate types having been obtained from Peradeniya (1,540 ft.), and Balangoda (1,750 ft.). The Peradeniya specimen was scarcely different from the ordinary lowland variety, but the Balangoda form was to all appearances a *grandis*, except in colour (*vide* infra).

No specimens appear to have been examined from the most southerly part of the western wet zone, *i.e.*, from the Galle District. This is the wettest area in the low-country and may have produced its own race of *Loris* in the same manner as it has with the Purple-faced Monkey (*Pithecus senex*). *Loris* is known to occur in this area, one having been kept alive at Galle for some time by Rev. P. T. Cash.

## 2. **Loris tardigradus grandis** Hill et Phillips. Plate VII fig. 1, Plate VIII fig. 2

The Highland Slender Loris

Sinhalese, Kalu unahappuluwa

*L. t. grandis* Hill and Phillips, 1932. *Ceylon J. of Sci.* (B) XVII, p. 110

*Type:* Adult female in British Museum. Paratype (male) in Colombo Museum.

*Type-locality:* Gammaduwa, Central Province, Ceylon.

*Material examined:* Living and freshly dead material only. In addition to the specimens examined prior to the publication of the original description of this race, two intermediate types between *grandis* and lowland forms have been obtained. Evidence of the existence of *grandis* in several new localities has also been recorded, though specimens are not yet to hand.

### *Characters*

It is unnecessary here to do more than summarize the characters of this form since the original description has appeared so recently in this Journal.

*Adult male*

Size large, considerably over 200 mm. total length. General form more strongly built than in *tardigradus*. Coat thicker and woollier; extremities more heavily clothed. General colour of upper parts blackish or dark grey, usually heavily frosted, especially on the lower back. Sometimes slightly rusty on lumbar region. Under parts and inner aspects of limbs pure white, with the bases of the hairs black or dark grey; except on the throat, where the hairs are white throughout. White throat-hairs continued up on sides of cheeks, and in front of ears. Pre-auricular hairs continuous above with the white hairs derived from the bifurcation of the upper end of the interocular stripe; circumocular hairs black. Hands and feet well haired with white.

Skin pigmentation more evident than in *tardigradus*. Muzzle delicate pink, never pigmented; eyelids pigmented at the margin and on the conjunctival side; ocular conjunctiva pigmented opposite inner and outer canthi; nictitating membrane darkly pigmented; ears very dusky; scrotum pigmented; penis pink. Yellow staining if present is very pale, never deep as in *tardigradus*. It has been seen in mild form on the extremities, ears and genitalia.

*Skull:*

Larger than that of *tardigradus* and *malabaricus;* but smaller than in *nordicus* or *lydekkerianus;* total length over 50 mm. Nasals prominent, longer and narrower than in *tardigradus*. Orbital margin large, with a deep rim above and laterally; ethmo-maxillary fissure larger both absolutely and relatively, with a wide, elongated sagittal stem and a short, rounded transverse portion anteriorly; temporal fossae roomy, three-sided with the lateral side longest; temporal lines well-developed, but arranged on the same plan as in *tardigradus;* other lines of muscular attachment better developed than in *tardigradus;* palate longer and narrower; posterior nares narrower.

*Adult female*

Larger than the male; blacker in colour with no inclination to erythrism, but great tendency to frosting, especially on the lower back; skin-pigmentation as in the male.

*Young*

The only early stage of *L. t. grandis* at present known is the half-grown specimen mentioned on page 104. This animal differed but little from his mother. He had the characteristic woolly coat and facial apperance of *grandis*, but was if anything a little more brown and less black than the typical individuals of the subspecies.

*Measurements*

(*a*) Body weight

Two preserved specimens weighed 205 gms. (male) and 240 gms. (female), respectively. (Average 222.5 gms.) Two transitional forms weighed when alive 5½ ozs. (155 gms.) and 6½ ozs. (184 gms.), the former being a female and the latter a male.

(*b*) Linear body measurements

| *Locality* | *Head and Body* | *Hind-foot* | *Ear* |
|---|---|---|---|
| **Gammaḍuwa Average of 4 males** .. | **209.6** .. | **44.5** .. | **24.25** |
| **Gammaḍuwa Average of 4 females** .. | **222.3** .. | **44.75** .. | **25.75** |

(*c*) Skull measurements

| *Locality* | *Sex* | *Max. cranial l.* | *Max. cranial br.* | *Min. cranial br.* | *Across bullae* | *Palatal l.* | *Br. across m. 3* | *Upper tooth row (excl. incisors)* | *L. of mandible* | *Lower tooth row (excl. incisors)* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Gammaḍuwa (Type)** | ♀ | **50.5** | **30** | **17** | **30** | **19** | **16** | **17** | **27.5** | **15.5** |
| **Opalgalla** | ♂ | **52.75** | **28.5** | **17** | **28** | **19** | **15** | **17** | **28.5** | **15.5** |
| **Gammaḍuwa** | ♂ | **52.5** | **30** | **16** | **30** | **20** | **14.5** | **16.5** | **28** | **15.75** |
| **Average of 3** | | **51.9** | **29.25** | **16.6** | **29** | **19.3** | **15** | **16.8** | **28** | **15.6** |

*Distribution*

Typical specimens of *grandis* have so far been obtained only from the Gammaduwa district, the exact localities being mentioned in the original description (q.v.). Reports of large Lorises in other up-country districts have been obtained by Phillips, who tells me that they are known near Bandarawela and in the Badulla district. A specimen from the valley towards Elahera, north of Gammaduwa should be intermediate between *grandis* and the next form, *nordicus*, the first living specimen of which was obtained still further north at Sigiriya. But the Elahera specimen is almost identical with another transitional form from Balangoda (1,750 ft.) which appears to connect *grandis* with *tardigradus*. Both these specimens have the facial aspect of *grandis*, with the contrasted markings and the white throat and cheeks. They are also white on the ventral side, with the bases of the hairs dark. The upper parts, however, are dull fawn, and there is little frosting. Moreover both are smaller in size than typical *grandis*, though large for *tardigradus*. The Balangoda specimen (male) is the larger of the two.

### 3. **Loris tardigradus nordicus,** subsp. nov. Plate VIII, Fig. 1

The Northern Ceylonese Slender Loris

This is a large animal intermediate in size and characters between *L. t. grandis* and the mainland form, *L. t. lydekkerianus*, being closer to the latter than to the former. An animal resembling *lydekkerianus* does not seem to have been suspected in Ceylon before. Persistent reports from various sources had reached me concerning the occurrence of a different kind of Loris in the northern dry zone of Ceylon. In describing the subspecies *grandis* for the first time last year, it was thought that these dark animals might be those referred to by Tennent (1861) and Jerdon (1874) and were possibly identical with *grandis*. Meantime, the specimens in the Bombay Natural History Society's collection obtained in Ceylon by Mayor had been loaned to me. These were two in number, and had both been collected in the dry zone of the Island. They were obviously different from the ordinary Ceylonese Loris, although Wroughton (1917 and 1918) had apparently taken them to be typical Ceylonese Lorises, having no specimens of true *tardigradus* with which to compare them. Although Mayor's two specimens were in many points different from *grandis*, and resembled the Indian animals closely, it was not thought advisable on the strength of that material alone to separate them subspecifically. Recently, sufficient fresh material has come to hand to enable me to do this. The following description is based on this material:—

*Type:* Adult female from Talawa, North-Central Province, Ceylon. In accordance with the usual custom of the Colombo Museum, the type-skin and skull will be presented to the British Museum on publication of this paper.

*Material examined:* In addition to the type specimen, four living animals have been studied, and also a preserved juvenile specimen given to me by Rev. P. T. Cash of Jaffna. Mayor's two specimens have been studied for comparison.

*Characters: Adult male*

Very similar to *L. t. lydekkerianus*, but smaller on the average, and therefore intermediate between the latter and *L. t. grandis*. (Body weight averages about seven ounces as contrasted with ten ounces for *lydekkerianus*.)

General colour of upper parts cinereous grey, heavily frosted in some specimens, especially on the lower back and the mid-dorsal region as well as on the proximal parts of the extensor surfaces of the limbs. A darker median dorsal stripe is almost constant. Anteriorly this expands into a dark patch on the crown, though this is not constant. The constituent hairs of the dorsal regions are annulated with white, grey, brown, and black from below up. A terminal white tip occurs in the frosted hairs. The subterminal ring is buffy in some specimens, and a definite tawny colour sometimes develops beneath the frosting of the lower back. Ventral surface white; hair being white throughout on the throat, but slightly grey at the base on the trunk. Occasionally the trunk hairs are white throughout as in *lydekkerianus*. The white throat hairs pass forwards on to the cheeks as in *grandis*. From here they pass upwards as a rapidly narrowing tract in front of the ears, and usually meet the bifurcated upper end of the interocular white stripe. Circumocular patches dark grey, almost black in some specimens, but with a brownish wash in certain lights. Some short white hairs occur on the muzzle. Limbs brownish grey on the proximal segments, becoming whiter on the forearm and crus, and on the dorsum of the hand and foot. Fur on limbs mixed with numerous long, dark, wiry hairs.

Skin-pigmentation variable, but never as heavy anywhere as in *grandis*. Naked rhinarium pink; hairy part of snout sometimes dusky and also often with yellowish staining; ears blackish; eyelids pigmented at the margin and for a very short distance on the inner face; conjunctiva slightly dusky at outer canthus; nictitating membrane pigmented at margin; dorsum of hands and feet with dusky pigment often extending up to elbow or knee; soles and palms pink or yellowish; scrotum with honeycomb-like black pigmentation; penis pink or yellowish.

### *Skull*

Very large, larger than *grandis* and sometimes equalling *lydekkerianus;* total length up to 55 mm. Nasals long and narrow; orbital margin as in *grandis;* ethmo-maxillary fissure very large, due to the tendency for its lateral edge to be deficient, shape tending to triradiate, with the posterior radius large and wide; temporal fossae similar to those of *grandis*, but still larger; temporal lines well-developed and running parellel to one another in the greater part of their course,—not diverging so rapidly behind as in *tardigradus* and *grandis*; cranium relatively longer and narrower, and compressed dorso-ventrally; palate as in *grandis;* mandible more heavily built than in *grandis*.

### *Adult female*

In the series of animals examined the sexual differences were not marked. The females were not on the average any larger than the males. The largest specimen was Mayor's male from Wilachchiya. This was ticketed as weighing 1¼-1½lb.,[1]—a truly enormous animal. The largest female is the Tammanewa specimen also collected by Mayor. Of my own living specimens all the adults of both sexes weigh in the neighbourhood of seven ounces.

*Young*

The new-born is almost indistinguishable from that of *lydekkerianus*. In general colour it is silvery grey, with long soft fur, interspersed with longer, darker wiry hairs. The limbs, especially the distal parts, are clothed with white. Ventral surface also white. Circumocular patches chestnut, but darker than in *tardigradus*. On the lumbar region in the Jaffna specimen there was a distinct reddish tinge; whilst the immature specimen from Kekirāwa was decidedly rufous on the lower back, and bright yellow beneath.[2]

Nose pink, with a little pigment at the margins of the naked area; ears dusky; eyelids unpigmented; hands and feet unpigmented; clitoris pink.

*Measurements*

(*a*) Body weight

| *No.* | *Locality* | *Sex* | *Age* | *Weight ozs.* | *Weight gms.* |
|---|---|---|---|---|---|
| 1 | Sigiriya | ♂ | Ad. | 7.5 | 212.2 |
| 2 | Kekirāwa | ♀ | Juv. | 5 | 141.5 |
| 3 | Talāwa | ♀ | Ad. | 7 | 198.1 |
| 4 | Do. | ♀ | Ad. | 7 | 198.1 |
| 5 | Talāwa | ♂ | Subad. | 5 | 141.5 |
| 6 | Jaffna | ♀ | Newborn | 2.5 | 70.7 |
| 7 | Tammanewa (Mayor) | ♀ | Ad. | 12 | 339.6 |
| 8 | Wilachchiya (Mayor) | ♂ | Ad. | 20–24 | 566–679.2 |

**Average of 4 adults (excluding Mayor's Wilachchiya specimen)—8⅓ ozs. (235.8 gm.)**

(*b*) Linear measurements

| *Locality* | *Total l.* | *Brach.* | *Anti br.* | *Hand* | *Femur* | *Crus* | *Foot* | *Ear* |
|---|---|---|---|---|---|---|---|---|
| Sigiriya ♂ | 233 | 63 | 71 | 32 | 69 | 81 | 42 | 26 |
| Kekirāwa ♀ | 170 | 56 | 69 | 30 | 56 | 68 | 36 | 25 |
| Talāwa ♀ (Type) | 205 | 58 | 65 | 25 | 67 | 72 | 46 | 27 |
| Talāwa ♀ | 221 | 61 | 71 | 31 | 58 | 78 | 45 | 28 |
| Talāwa ♂ | 209 | 59 | 68 | 30 | 57 | 79 | 47 | 27 |
| Jaffna ♀ (newborn) | 100.5 | 33 | 39 | 18 | 38 | 39.5 | 30.5 | 18 |
| Tammanewa ♀ (Mayor) | 225 | — | — | 28 | — | — | 48 | 28.5 |
| Wilachchiya ♂ (Mayor) | 238 | — | — | 32 | — | — | 53.5 | 29.5 |

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[1] This is almost certainly an error and was probably computed purely by guesswork by Mayor.

[2] Since going to press this specimen has grown considerably and has assumed the adult coloration. The rufous tinge has disappeared from the back and the yellow from the ventral surface. This animal has been in captivity in Colombo during this period.

(*c*) Skull measurements

| *Locality* | *Sex* | *Max. cranial l.* | *Max. cranial br.* | *Min. cranial br.* | *Across bullae* | *Palatal l.* | *Br. across m. 3* | *Upper tooth row (excl. incisors)* | *Mandibular l.* | *Lower tooth row (excl. incisors)* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Talāwa (Type)** | ♀ | 50 | 32 | 18 | 31 | 20 | 17 | 16.5 | 30 | 14 |
| **Wilachchiya (Mayor)** | ♂ | 55 | 34 | 18 | 33 | 21 | 17 | 17 | 31 | 16 |
| **Tammanewa (Mayor)** | ♀ | 53 | 32 | 19 | — | 19 | 17 | 18 | 30.5 | 16 |
| **Average of 3** | | 52.6 | 32.6 | 18.3 | 32 | 21 | 17 | 17.1 | 30.5 | 15.2 |

### *Distribution*

All the specimens of *nordicus* that have so far come to hand have been from the dry northern lowland part of Ceylon. The first specimens recorded from these parts were those collected by Mayor for the Indian Mammal Survey. These were four in number and were obtained respectively from Mannar (N.-W.P.), **Anurādhapura** (N.-C.P.), Tammanewa (N.-C.P.), and Wilachchiya (N.-C.P.). All the living specimens sent to me have been from the North-Central and Central Provinces, namely, from **Sīgiriya** (C.P.), Kekirawa (N.-C.P.), and Talawa (N.-C.P.). One preserved specimen was sent from Jaffna (N.P.), and was declared to have been captured on the Peninsula. It is probably correct therefore to state that this form occurs sparingly all over the northern lowlands as far south as 7.75 degrees N. latitude. No specimen has recently been recorded from Chilaw, which is on the boundary of the dry northern lowlands and the wet western lowlands; but Tennent mentioned a red specimen from here. Possibly the typical form intergrades in the west with *nordicus* at about this region.

It is quite possible that *nordicus* also extends its range further down the eastern side of the Island, but no specimens have yet been procured from this tract. Oral reports of their occurrence are frequent. *Loris* is said to be common around Batticaloa and **Monarāgala**, and it is also known to the Veddahs in the Wellassa, Tamankaduwa, and Bintenne districts. It is very likely therefore that the distribution of *nordicus* will prove to be almost identical with that of the Ceylonese race of Madras Langur (*Pithecus entellus thersites*), in which case it will be the most widely distributed form in Ceylon.

### 4. **Loris tardigradus lydekkerianus,** Cabr Plate VII Fig. 2

### The Mysore Loris

*Loris gracilis typicus*
Lydekker, 1904, *P.Z.S.*, p. 345
*Loris lydekkerianus*
Cabrera, 1908. *Bol. Soc. Españ. Hist. Nat.*, p. 135
Thomas, 1908. *Ann. Mag. Nat. Hist.* (8), p. 469
Wroughton, 1917. *J. Bombay Nat. Hist. Soc.*, p. 45
idem, 1918. *J. Bombay Nat. Hist. Soc.*, p. 563

This is the largest of the Slender Lorises; and, until Wroughton described his *malabaricus* in 1917, was supposed to be the only form inhabiting South India.

*Type* of Lydekker's *L. gracilis typicus* is in the British Museum.

*Type-locality:* Madras.

*Material examined:* One living adult female; five skins (with skulls) from Bombay Natural History Society's collection; two mounted skins from Madras Museum.

*Characters: Adult male*

Size larger than any Ceylon Loris; usually over 220 mm. total length, and with an average body weight of about 10 ounces (283 gms.). General colour of upper parts cinereous grey, fading on the lower back to lighter grey or fawn. Heavily frosted on mid-dorsal region, and with a prominent dark stripe in the median line. Dorsal hairs grey at the base, then ringed alternately with whitish, brownish and finally with white again. Extensor aspects of limbs similar, but slightly paler. Flanks lighter, gradually changing to pure white on the under parts. Hairs on ventral surface white throughout both on throat, trunk, and flexor surfaces of limbs. Distal parts of limbs well clothed as in *grandis*. Cheeks well clothed with long white hairs, ascending to meet the bifurcated interocular stripe as in *nordicus*. Circumocular patches very dark brown or almost black with a reddish wash in certain lights. Sides of muzzle better haired than in other forms, the hairs being white.

Skin-pigmentation much as in *nordicus*. Muzzle dusky on top and at the sides; ears black; eyelid region as in *nordicus;* hands and feet flesh-coloured; genitalia as in *nordicus*.

*Skull*

Larger than in *grandis*, and in excess of most specimens of *nordicus;* total length 55 mm. Similar in general shape to the skull of *nordicus*, but not compressed dorso-ventrally, being arched at the vertex (see

Plate XI Fig. 2*d*); nasals relatively short and wide; ethmo-maxillary fissure large, but shaped differently from that of *nordicus*,—tending to be semi-lunar in outline due to deficiency of its lateral margin and to the smoothing down of the antero-medial angle between the sagittal and transverse limbs (see Plate X Fig. 1*d*); temporal lines, as in *nordicus* running almost parallel to one another, and not diverging rapidly behind as in *grandis;* temporal fossae roomy, more ovoid and less triangular in outline than in the preceding forms; palate as in *nordicus*.

*Adult female*

Scarcely different from the male; no tendency to erythrism; heavily frosted, especially on the shorter hairs of the lower back; not appreciably larger than the male in any of the specimens examined.

*Young*

Neonatus silvery-grey in general colour of upper parts, verging to white below. The hairs on the back are long and silky, dark grey at the base, light grey peripherally. A patch behind the crown and a stripe down the mid-dorsal region slightly rusty. Silky hairs interspersed with a few longer wiry hairs of dark colour. White hairs of ventral side scanty and short. Circumocular patches chestnut; interocular stripe wide, and almost met by the white hairs of the cheek region. Muzzle well haired with short white hairs. Limbs scantily clothed with pale grey, almost white hairs on the extensor aspect, darker on the thigh; almost hairless on the flexor side. A good description of the new-born is given by Kinnear (1919).

A half grown animal in the Bombay collection is well covered with long woolly fur, shorter on the lumbar region. Colour of upper parts greyish buff, with the constituent hairs grey at the base followed by a pale neutral zone, and then by a russet one. Some of the longer hairs are slightly frosted in addition. Under parts white throughout, grading into the dorsal colour on the flanks Circumocular patches chestnut; interobital stripe wide, especially above; cheeks white and meeting the bifurcated interorbital stripe superiorly; upper arm as dorsum; forearm and hands white; thigh and leg grey on extensor surface, white on the flexor side; feet white.

*Measurements*

(*a*) Body weight

| | |
|---|---|
| **Living adult female** .. .. | **10½ ozs. (297.1 gm)** |
| **Bangalore ♀** | **8 ozs. (226.4 gm)** |
| **Malur-Kolar ♀** | **8¾ ozs. (247.4 gm)** |
| **do. ♂** | **12¼ ozs. (346.6 gm)** |
| **Average of 4 adults, approx.** | **10 ozs. (283 gm)** |

(*b*) Linear body measurements

| *Locality* | *Sex* | *Total Length* | *Brachium* | *Antebrach.* | *Hand* | *Thigh* | *Crus* | *Foot* | *Ear* |
|---|---|---|---|---|---|---|---|---|---|
| **Bidigiriramjams** | ♀ | **245** | **69** | **74** | **35** | **74** | **85** | **47** | **26** |
| **Malur-Kolar (Shortridge)** | ♂ | **260** | **63** | **71** | **29** | **72** | **74** | **53** | **31** |
| **do.** | ♀ | **245** | **60** | **63** | **32** | **69** | **79** | **52** | **31** |
| **Bangalore (Col. Wall)** | ♀ | **236** | **55** | **68** | **30** | **61** | **75** | **45** | **29** |
| **do.** | ♂ **nb.** | **83** | — | — | — | — | — | **24** | **14** |
| — | ♂ **juv.** | **131** | — | — | — | — | — | **40** | **22** |

(*c*) Skull measurements

| *Locality* | *Sex* | *Max. cranial l.* | *Max. cranial br.* | *Min. cranial br.* | *Across bullae* | *Palatal l.* | *Across m. 3* | *Upper tooth row (excl. incisors)* | *L. of mandible* | *Lower tooth row (excl. incisors)* |
|---|---|---|---|---|---|---|---|---|---|---|
| **Nandidroog, N W Kolar distr.** | ♀ | **55** | **34** | **20** | **33** | **20** | **17** | **17** | **31** | **16** |
| **Malur-Kolar distr.** | ♂ | **55** | **36** | **18** | **34** | **20** | **17.5** | **18** | — | — |
| **Average of 2** | | **55** | **35** | **19** | **33.5** | **20** | **17.25** | **17.5** | — | — |

*Distribution*

Detailed information concerning the distribution of the Mysore Loris is sadly lacking. The type locality is given as Madras, but no specimen seems to have hailed from there in recent times. Quite possibly the type was an animal purchased in Madras, whither they are taken for sale on the authority of Jerdon (1874). All the material gathered by the Indian Mammal Survey by G. C. Shortridge seems to have come from East Mysore, especially the Kolar District, where, according to Shortridge's notes it is said to be very common. A specimen in the Bombay collection given by Col. Wall is labelled with the locality Bangalore. Blanford (1888) gives the west coast near Ratnagiri as a possible locality, and this statement is borrowed by Elliot (1913) and other later writers. Blanford later (1901) believed that *Loris* ocurred in the Malabar region, but such specimens undoubtedly belong to *L. t. malabaricus*. There seems to be no record relating to the eastern range of the animal, and it is not known whether it reaches the east coast or not. The animal undoubtedly occurs in the Nilgiris. My own living example was taken in the Bidigiriramjams in the Nilgiris. With regard to altitude, there is abundant evidence of *L. t. lydekkerianus* living at heights unrecorded for any other form. Shortridge's specimens are labelled as 2,000 ft. and 3,000 ft. The highest record seems to be that given by Kinloch (1898) of 4,700 ft. at Kotagiri in the Nilgiris.

It should be noted in conclusion that Anderson (1881) mentions a specimen of Slender Loris in the Calcutta Museum said to have come from Burmah. Anderson himself seemed to query this, though the animal was obtained from a Burman, and said to have come from the Shan States. No later record of the occurrence of a Slender Loris so far away has been made, though Elliot (1913) confuses matters by stating the distribution of *lydekkerianus* as ' Southern India, near states east of British Burmah in forests of the lowlands (Jerdon)'. No doubt this has its origin in Anderson's statement.

## 5. **Loris tardigradus malabaricus** Wroughton

### The Malabar Slender Loris

*Loris tardigradus* Ryley, 1913. *J. Bombay Nat. Hist. Soc.*, XXII, p. 284
idem., 1913. *loc. cit*, p. 494
*Loris malabaricus* Wroughton, 1917. *J. Bombay Nat. Hist. Soc.*, XXV, p. 45
idem, 1918. *op. cit., tom. cit.*, p. 563

This is the least satisfactory form of the five. As indicated above this form was described by Wroughton as distinct from *lydekkerianus* and from the then-known Ceylonese forms because it differed considerably from the animals collected in Ceylon by E. W. Mayor. These were the only specimens available from Ceylon, and as already shown they were specimens of *nordicus*, and not of the typical Ceylonese animal. Had Wroughton secured some typical *tardigradus* for comparison, I venture to think that he would have hesitated to separate it. This attitude had already been adopted by Miss Ryley (1913 A and B) before the Mammal Surevy had procured any specimens from Ceylon, *i.e.*, they were taken as Indian representatives of the form believed to occur in Ceylon and labelled *L.tardigradus* in contradistinction to *L. lydekkerianus*. This is really all the Malabar specimens are,—representatives in the wet coastal tract of India of the form occupying the corresponding climatic zone in Ceylon. Whether they differ sufficiently to separate subspecifically or not can only be stated on the examination of much more material. For the present, however, I think it best to allow Wroughton's form to stand, though its characterization is by no means as definite as that of the four forms previously discussed.

*L. t. malabaricus* appears to be a small reddish *Loris* similar to the typical *tardigradus*. If any difference exists between these two it would seem to be chiefly in size.

*Type:* Young adult female, Brit. Mus. No. 13,8,22, 3., collected by G. C. Shortridge, 2-xi-13

*Type-locality:* Kutta, South Coorg.

*Material examined:* Three skins, with skulls, in the Bombay collection. This is the only form of which I have not had the opportunity of examining living specimens.

*Characters: Adult male*

Larger than *tardigradus*, but smaller than any other form; total length 220 mm. General colour of upper parts russet or wood-brown (Wroughton),—not so red as in the male of *L. t. tardigradus;* lower parts buff or dirty white, with the bases of the hairs dark grey, except on the throat where they are buff throughout; According to Wroughton there is no median dorsal stripe, but an indication of this exists on one specimen from the Bombay collection. Wroughton also states that frosting occurs,—but in the specimens examined this is not so evident as in the darker races. Circumocular hairs dark chestnut. The proximal parts of the limbs on the extensor surfaces are greyer than the body. Distally the limbs are covered with short dirty white hairs, almost grey on the feet.

No definite statements can be given regarding skin pigmentation, as no fresh material is to hand, and Wroughton omitted to mention this in his original description. According to Wroughton the ears are relatively smaller in this race than in the others.

The skull is small, but larger than that of the typical race,—total length 48 mm. in the type. In general form it is much the same as the skull of *tardigradus*. Nasals short and broad; frontals small; temporal lines as in *grandis* and *tardigradus*, but more heavily marked than in the latter; temporal fossae slightly larger than in *tardigradus;* and shaped as in *grandis;* orbital ring larger than in *tardigradus;* ethmo-maxillary fissure very narrow in its sagittal portion, wider in its transverse limb; and the two limbs at a sharp angle with one another: palate and posterior nares narrow.

### *Adult female*

Sexual differences are probably the same as in *tardigradus*. The adult female in the Bombay collection is browner than another specimen which is undoubtedly a male, though not labelled. The female is also larger and more heavily built.

### *Young*

Unknown to me; said by Miss Ryley (1913, B) to be more rufous.

### *Measurements*

(*a*) Body weight—said by Miss Ryley (1913, B) to be ' about 6 ozs '.

(*b*) Linear body measurements

| *Locality* | *Sex* | *Total l.* | *Hind-foot* | *Ear* |
|---|---|---|---|---|
| Kutta (Wroughton's type) | ♀ | 216 | 45 | 25 |
| Virajpat (Shortridge) | ♀ | 219 | 45 | 24.5 |
| Virajpat (Shortridge) | ♂ | 220 | 44 | — |
| Wynaad (J. Rogers) | ? | 180 | 44 | — |
| Average of 4 | | 209 | 44.5 | 24.75 |

(*c*) Skull measurements

| *Locality* | *Sex* | *Max. cranial l.* | *Max. cranial br.* | *Min cranial br.* | *Across bullae* | *Palatal l.* | *Br across m. 3.* | *Upper tooth row (excl. incisors)* | *L. of mandible* | *Lower tooth row (excl. incisors)* |
|---|---|---|---|---|---|---|---|---|---|---|
| Virajpat, S. Coorg | ? | 50 | 32 | 16·5 | 30 | 19 | 16 | 16 | 29 | 15 |
| do. | ♀ | 50 | 32 | 16 | 29 | 18 | 15 | 16 | 29 | 15 |
| Wynaad | ? | 52 | 31 | 18 | 33 | 19 | 16 | 16 | 29 | 14.5 |
| Wynaad | ? | 49 | 32 | 17 | 29 | 18 | 17 | 16 | 28 | 15 |
| Average of 4 | | 50.2 | 31.8 | 16.9 | 32.6 | 18.5 | 16 | 16 | 28.75 | 14.9 |

### *Distribution*

*L. t. malabaricus* appears to be confined to the wet Malabar tract[1] on the west coast of Southern India. This area has a similar climate to the lowlands of the south-western part of Ceylon, so that it is not surprising that the two areas have produced similar small reddish Lorises. The Malabar tract, however, is not entirely lowland, and the Loris of that region has been recorded at considerable altitudes, *e.g.*,

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[1] This tract extends as far north as the Tapti river (Blanford, 1901)

2,000 ft. and 3,000 ft. in South Coorg (Shortridge). Wroughton (1918) also gives Travancore, in addition to the type-locality, as a habitat of *L. t. malabaricus*. Specimens from the Wynaad in the Bombay collection labelled as *L. gracilis* are also referable to this race. The Loris is said to be rare as far north as North Kanara (Ryley, 1913, B, from Shortridge's notes).

In conclusion I have great pleasure in acknowledging my indebtedness to a number of helpers without whose assistance this paper could never have been attempted. I wish especially to mention the kindness of the Bombay Natural History Society for the loan of all the *Loris* material in their collections, and also the Madras Museum for the loan of two specimens of *Loris* through Dr. Pearson of the Colombo Museum. To the following gentlemen I also wish to tender my thanks:—Mr. D. R. R. Burt for the loan of skulls of *Galago* and *Lemur*, and for assistance in photographing the skulls in Plates IX XI; the Rev. P. T. Cash for a preserved specimen of a new-born *L. t. nordicus;* Prof. G. Harrower of Singapore for preserved specimens of *Nycticebus* and *Tarsius;* Mr. R. C. Morris of Honametti Estate, Mysore, for much trouble in procuring me a live specimen of *L. t. lydekkerianus;* Dr. L. Nicholls, for providing me with certain literature; Dr. J. Pearson of the Colombo Museum for facilities with literature at the Museum; Mr. W. W. A Phillips for continued help and assistance in procuring specimens in Ceylon and especially for his great knowledge of distribution and for his notes on measurements of Ceylon Lorises; and to Mr. A. N. Weinman of the Colombo Museum for providing me with several specimens of the local race of *L. tardigradus*.

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## EXPLANATION OF PLATES

PLATE VII

1. Photograph of living adult female *Loris t. grandis* with infant
2. Photograph of a living adult female *L. t. lydekkerianus*, from Bidigiriramjams, Mysore

PLATE VIII

1. Photograph of a living adult male *L. t. nordicus* from Sigiriya, C. P.
2. Photograph of a living adult male *L. t. grandis*, from Gammaduwa, C. P.

PLATE IX

1. Skulls of *a*, *Lemur*, *b*, *Galago*; *c*, *Nycticebus* and *d*, *Loris* in norma frontalis
2. Same skulls in norma verticalis

PLATE X

1. Skulls of five races of *Loris tardigradus* in norma frontalis
    *a*. Skull of *L. t. tardigradus*, adult female
    *b*. Skull of *L. t. grandis*, adult male
    *c*. *Skull of L. t. nordicus*, adult male
    *d*. Skull of *L. t. lydekkerianus*, adult female
    *e*. Skull of *L. t. malabaricus*, adult
2. Same skulls in norma verticalis

PLATE XI

1. Same skulls in norma basalis
2. Same skulls in norma lateralis

Fig. 1
*Loris tardigradus grandis* ( and young)

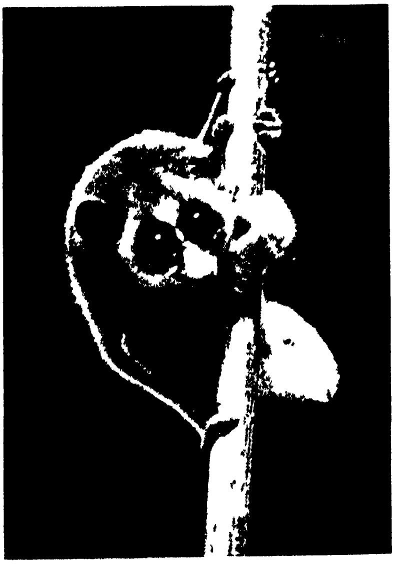


Fig. 2.
*Loris tardigradus lydekkerianus* ♀

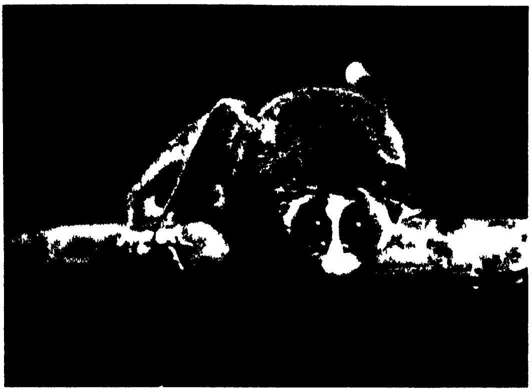


Fig. 1
*Loris tardigradus nordicus* ♂

Fig. 2
*Loris tardigradus grandis* ♂

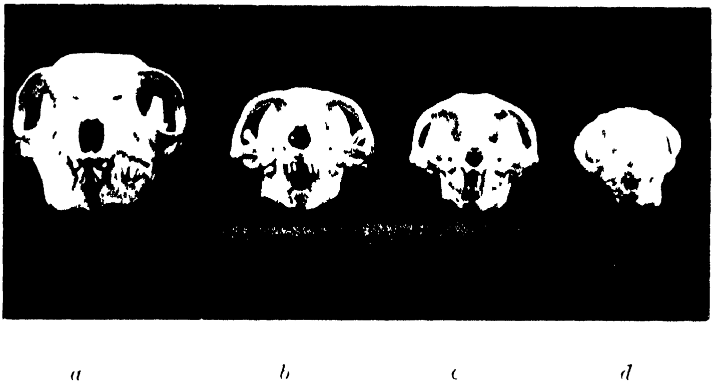


Fig. 1
Skulls of Lorisoids, norma frontalis

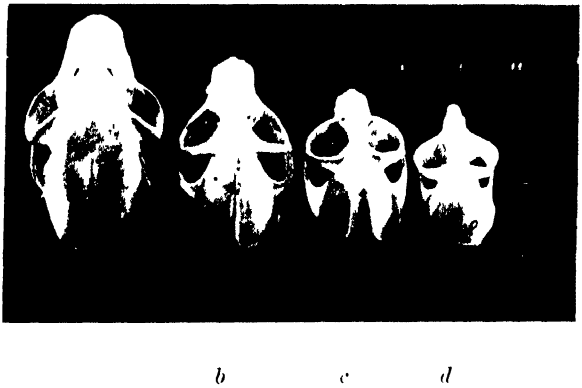


Fig. 2
Skulls of Lorisoids, norma verticalis

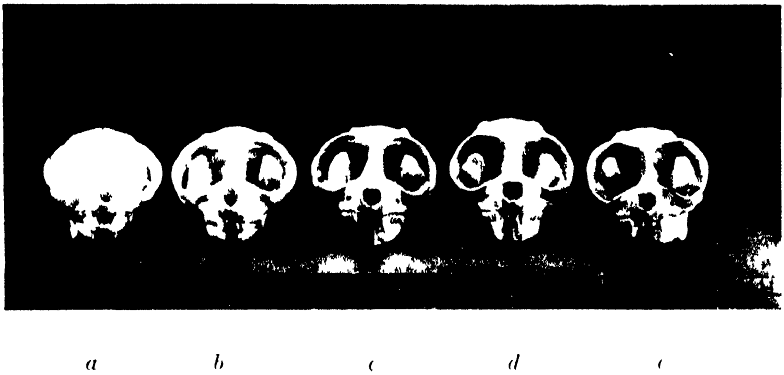


FIG. 1
Skulls of Slender Lorises, norma frontalis

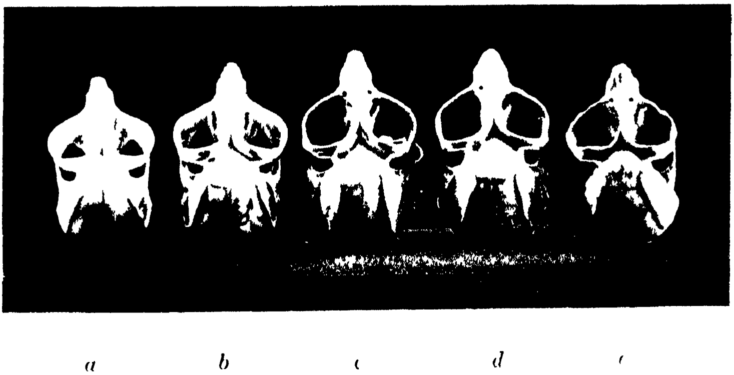
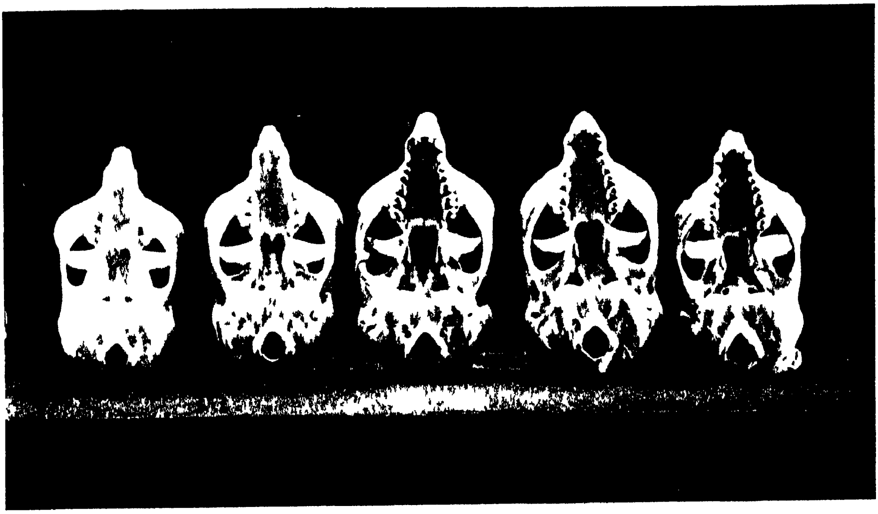


FIG. 2
Skulls of Slender Lorises, norma verticalis



*a* *b* *c* *d* *e*

Fig. 1.

Skulls of Slender Lorises, norma basalis.

*a* *b* *c* *d* *e*

Fig. 2.

Skulls of Slender Lorises, norma lateralis.

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# Survey of the Distribution of Mammals in Ceylon

BY

## W. W. A. PHILLIPS, F.Z.S., M.B.O.U.

## REPORT No. 10.

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| Collection ... | ... No. 11 |
| Locality ... | ... Madola and Hallinna, Opanake district, Sabaragamuwa Province |
| Altitude ... | ... 500 ft. to 2,000 ft. (approx.) |
| Date ... | .. February 16-23, 1933 |
| Collected by | ... G. M. Henry, Esqr. |

This small collection was made by Mr. G. M. Henry, of the Colombo Museum, assisted by the Assistant Taxidermist and a Collector. Mr. Henry was primarily concerned in collecting specimens of insects and birds; mammals were a secondary consideration.

The most interesting specimens collected are those of the Field Mouse (*Leggada booduga fulvidiventris*) which are larger and darker than typical specimens from the dry zone. Possibly a distinct race exists in the jungles of this district but further specimens are required before this point can be cleared up.

This district and the Ratnapura and Galle Districts as a whole are likely to hold some very interesting small mammals in their vast jungles and it is greatly to be hoped that further collections will be made in this part of the Island, in the near future.

Mr. Henry thus describes the country in which his collections were made:—' Madola is a small village about 77 miles from Colombo and 3 from Opanake on the Balangoda road and is at an elevation of about 600 feet. A small river, the Wegan-oya, runs east and west just below the road. On the north side the country rises boldly, in a space of 2 to 3 miles, to a high range culminating in the two Pettiagala peaks (4.944 and 4,612 feet respectively). The higher portions of the range are heavily forested but the lower slopes are varied with chenas, old and new, village gardens and small paddy fields.

' On the south side of the Wegan-oya there is a long strip of new chena ' about 100 yards wide, above which the country bears tall forest with comparatively little undergrowth. The ground slopes fairly steeply up to a ridge which attains, at Welihinda, the height of 2,816 feet.

' Trapping of mammals took place mainly along the river, in the chenas and villages up to about 700 feet and along the edge of the jungle on the south side of the Oya.

' Hallinna is a tea estate about equidistant between Pelmadulla and Opanake. The only collecting done was on the top of a very steep, almost precipitous, ridge called Idirimini, at an elevation of about 2,000 feet, in very high forest with little undergrowth '.

The rainfall of this district averages about 132 inches in the year, the greater quantity of which falls during the south-west monsoon period—May to November.

### (No. 22) **Hesperoptenus tickelli** (Blyth)

*Tickell's Bat*

♂ 1. Typical. **Madola.**

A very common species, found all over the low-country.

(*See also Reports Nos. 2, 3, 5, 6, and 7*)

### (No. 27) **Miniopterus fuliginosus** (Hodgson)

*The Long-winged Bat*

♂ 1. Typical. **Madola.**

A considerable extension of the known range of this species; hitherto it had not been recorded from the south-westerly low-country.

(*See also Report No. 2*)

Several other bats were shot but they could not be recovered.

### (No. 68) **Funambulus palmarum favonicus** Thomas and Wroughton

*The Submontane Palm Squirrel*

♂ 1. ♀ 1. Both typical. **Madola.**

Both these are typically marked specimens of the Common Palm Squirrel of the south-westerly low-country wet zone. In the male, the cap is distinctly reddish while in the female there is a very slight reddish tinge only.

### (No. 71) ***Tamiodes layardi signatus** (Thomas)

*The Flame-striped Jungle Squirrel*

*Funambulus layardi signatus* Thomas, 1924. *Ann. Mag. Nat. Hist.* (9) Vol. XIII, p. 239; Phillips, 1929. *Ceylon J. Sci.* (B) Vol. XV, p. 142.

♂ 1. Typical. Idirimini, near Hallinna.

A very interesting specimen, extending considerably the known range of this race of the handsome and little known Layard's Squirrel.

(*See also Report No. 7*)

### (No. 74) **Bandicota malabarica** (Shaw)

*The Malabar Bandicoot*

♀ 1. Typical. **Madola.**

A fine large female of the common Bandicoot rat. The species is probably common through the south-westerly districts.

### (No. 76) **Rattus rattus kandianus** (Kelaart)

*The Common Ceylon House Rat*

♂ 3. One juvenile; all typical. Madola.

In one specimen the belly is light grey, in the other two pure white.

(*See also Reports Nos. 2 and 7*)

### (No. 81) **Leggada booduga fulvidiventris** (Blyth)

*The Ceylon Field Mouse*

♂ 2. ♀ 2. Madola.

These four specimens are considerably larger and more drab in general appearance than typical specimens from the dry zone areas. After a careful examination of all the available material in the Colombo Museum, however, I find that among specimens from the hills and the wet zone, although on the average they are larger and darker than typical dry zone specimens, there is a considerable variation in size, colour and skull length. On the material at present available, the differences do not appear to be constant or distinct enough to justify

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* Dr. Osman Hill informs me that, after examining several of each species, he is satisfied that this squirrel is correctly referable to Pocock's genus *Tamiodes*.

the describing of a new race but, quite probably, when further specimens have been collected it will be found that the present specimens represent a distinct race confined to the south-westerly low-country wet zone.

(*See also Reports Nos. 2 and 4*)

*Note.* In former reports the name *fulvidiventris* was erroneously attributed to Kelaart—the race was described by Blyth, in the first instance, from specimens sent to him from Trincomalee by Dr. Kelaart.

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| Collection ... | ... No. 12 |
| Locality ... | ... Marichchukaddi, N. P., and Marai Villu, N.-W.P. |
| Altitude ... | ... Sea Coast |
| Date ... | ... March 11 to 21, 1933 |
| Collected by | ... G. M. Henry, Esqr., and Mr. E. C. Fernando of the Colombo Museum |

The country, in which this small collection was made, is semi-desert, sandy, coastal plain, with dense thorny scrub and dry zone jungle a little way inland. There is very little undergrowth and the country is dry and parched for many months during each year. The rainfall averages under 35 inches per annum, almost all of which falls during the north-east monsoon period.

With the exception of Gerbils, which were very numerous, mammals were not plentiful.

The two Musk Shrews (*Suncus c. caeruleus*) are the most interesting specimens in the collection; they form a most welcome addition to the Museum collections.

Mr. Henry has, very kindly, furnished some notes on the individual species, both those obtained and those observed; these notes are given over Mr. Henry's initials.—G. M. H.

### (No. 14) **Hipposideros speoris speoris** (Schneider)

*Sykes' Leaf-nosed Bat*

♂ 1. **Typical. Marichchukaddi.**

A very common species throughout the low-country and lower hills.

'A large colony occupied a semi-ruined bungalow at Marichchukaddi and gave the place a characteristic odour. Several specimens were collected. No other bats were collected, and but few were seen, although a good lookout was kept for them'—G. M. H.

(*See also Report No. 2*)

### (No. 32B) **Suncus caeruleus caeruleus** (Kerr)

*The Common Indian Musk Shrew*

♂ 1. ♀ 1. Typical. Marai Villu.

These two good specimens are a very useful addition to the Museum collections. The subspecies is uncommon in Ceylon and is confined, as far as our knowledge goes, to the dry zone.

### (No. 46) **Viverricula malaccensis** (Gmelin)

*The Small Indian Civet Cat*

♂ 1. Flat skin. Typical. Marichchukaddi.

A typical specimen of a very common animal with an Island-wide range. The skin is prepared for mounting.

### (No. 49) **Herpestes lanka** (Wroughton)

*The Common Ceylon Mongoose*

♀ 1. Flat skin. Typical. Marichchukaddi.

A typical small female of the common mongoose of the district. This species is confined to the dry zone. The skin is prepared for mounting.

### (No. 56) **Herpestes smithii zeylanicus** Thomas

*The Ceylon Ruddy Mongoose*

♂ 1. Flat skin. Typical. Marichchukaddi.

A good specimen of the larger Mongoose that is also found in the dry zone. This species however has an Island-wide distribution. The skin is prepared for mounting.

### (No. 66) **Funambulus palmarum brodiei** (Blyth)

*The Northern Ceylon Palm Squirrel*

♀ 2. Typical. Marichchukaddi.

These two specimens are of interest as they come from near the type locality of the race. They are therefore useful for comparison. Both show slightly reddish caps; evidently in this race, also, there is a reddish cap at some seasons, though it does not appear to be so pronounced as in other races.

'Not very common but a few were collected'—G. M. H.

### (No. 78) **Tatera ceylonica** Wroughton

*The Ceylon Gerbil*

♂ 2. Typical. Marichchukaddi.

Two large males of a species that is very common throughout the dry zone and found also in the wet zone and the lower hills. It is reported to be very plentiful around Marichchukaddi and Marai Villu.

(*See also Reports Nos. 3, 4, and 7*)

### (No. 81) **Leggada booduga fulvidiventris** (Blyth)

*The Ceylon Field Mouse*

♂ 3, ♀ 2. Marichchukaddi.

♂ 3, ♀ 1. In alcohol. Typical. Marai Villu.

Nine specimens, trapped in the sandhills and in the surrounding country.

As the type locality of this form is Trincomalee, on the east coast but also in the dry zone, the present specimens may be taken as typical representatives of the race. They are inclined to be smaller and more distinctly fulvescent than many specimens from both the Hills and from the south-westerly low-country wet zone. Further specimens are, however, required before the describing of any new races can be justified.

'Common at Marichchukaddi. Several trapped. Two adult males were caught alive in the old bungalow and kept alive with a view to domestication but one was killed by the other and the survivor escaped. A very small young one (head and body about 1½ inches long) was captured in the bungalow on 26 iii.33, but was later released'. —G. M. H.

(*See also Reports Nos. 2 and 4 and the present Report*)

Mr. Henry adds the following interesting notes upon species seen but not obtained.

### (No. 2) **Pithecus entellus thersites** (Kelaart)

*The Ceylon Langur*

Two troops were seen in the Wilpattu Game Sanctuary in the neighbourhood of the Game Watchers' quarters. These were the only monkeys seen on the trip.

### (No. 7) **Loris tardigradus** (Linné)

*The Ceylon Loris*

None seen but a strange, shrill cry was frequently heard at night near the camp at Marai Villu, which was said by the local people to be produced by the 'Theivangu'. Much time and flash-light were expended in attempts to see the author of the sound among the dense branches and foliage, but without success.

### (No. 9) **Pteropus giganteus giganteus** (*Brünn.*)

*The Common Flying Fox*

A few were seen at night at Marichchukaddi.

### (No. 42) **Panthera pardus fusca** (Meyer)

*The Indian Leopard*

None seen, but tracks on the sandy road and on the muddy shores of villus showed that leopards are not uncommon.

### (No. 58) **Canis lanka** Wrough.

*The Ceylon Jackal*

Fairly common at Marichchukaddi; not many seen or heard at Marai Villu.

### (No. 60) **Melursus ursinus** (Shaw)

*The Indian Sloth Bear*

None seen, but a few tracks observed on the sandy cart-track at Marai Villu. It was said by the game watchers to be not numerous but one of them and the tracker had both been mauled by bears in the past, though not seriously. A game watcher, asked if he were not afraid to go about his patrol duties in the jungle, said that he would not fear a bear if he had even a light stick with which to defend himself, as, apparently, the bear's courage and ferocity depend on the cowardice of the person who meets it, and it is extremely sensitive to blows on the head.

### (No. 65A) **Ratufa macroura sinhala** Phillips

*The Common Ceylon Giant Squirrel*

Only one seen—on a big tree at Periya Naga Villu.

### (No. 84) **Vandeleuria rubida** Thomas

*The Long-tailed Tree Mouse*

One night, while out collecting with a lamp, a light, fawn-coloured mouse with a very long tail, which could have been nothing else than this species, was seen in a Masan tree. It was eating seeds from a dry fruit, not that of the Masan (*Zizyphus*) but of a creeper with spherical berries, apparently of the natural order Cucurbitaceae. It was extraordinarily tame, and if the nature of the ground had permitted, I could easily have captured it by hand but I could not quite reach it.

Having in my hand a small box-form mouse-trap, baited with toasted coconut, it was set and presented to the mouse—practically touching him—in the hope that the appetizing aroma of the coconut would prove more attractive than the seeds he was eating, but unfortunately the mouse's views on matters of taste did not coincide with mine and at length a slight jarring of the branch he was on, frightened him and he ran up into the tree. The trap was placed on the trunk in the hope that he might get caught during the night, but it was still empty next day.

### (No. 87) **Acanthion leucurus leucurus** (Sykes)

*The Indian Porcupine*

None seen but tracks observed at Māil Villu.

### (No. 88) **Lepus nigricollis singhala** Wrough.

*The Ceylon Hare*

Not very common but a few seen at Marichchukaddi. The comparative scarcity is doubtless due, in the main, to the constant shooting by villagers that goes on at night with the aid of electric torches.

### (No. 89) **Bubalis bubalis bubalis** (Linné)

*The Wild Buffalo*

A herd of 6 wild buffalo was observed with glasses on the south side of the Periya Naga Villu. Few tracks observed.

### (No. 91) **Axis axis ceylonensis** Fitz.

*The Ceylon Spotted Deer*

A few seen at Marai Villu and at Māil Villu. Very few tracks seen on the road. I was informed that the scarcity was apparent only, and was due to the fact that there was plenty of water about, but this does not account for the fewness of tracks. None were seen in the Sanctuary itself but it must be remembered that the dense jungle everywhere and absence of open ' parks ' militates against the chance of seeing many deer.

### (No. 93) **Rusa unicolor unicolor** (Kerr)

*The Sambur*

A few individuals were put up at Marai Villu, Periya Naga Villu and one in the Sanctuary.

### (No. 94) **Moschiola meminna** (Erxl.)

*The Mouse Deer*

One shot by a Collector at Marai Villu.

### (No. 95) **Sus cristatus cristatus** Wagner

*The Indian Wild Pig*

Fairly common both at Marichchukaddi and Marai Villu.

### (No. 96) **Elephas maximus zeylanicus** Blain.

*The Ceylon Elephant*

Elephants, though not seen, were numerous judging from tracks and occasional trumpetings in the distance. They have evidently amused themselves with the telegraph posts and wire which follow the cart-track to Puttalam. There were no reports of ' rogues ' among the local inhabitants.

## REMARKS ON THE GAME SITUATION.

Game mammals, as indicated under the individual species, seemed to be very scarce, with the exception of elephants, as not only were few animals seen but their tracks were not at all numerous. No direct evidences of poaching were observed such as gun reports or ' messas '. In the Wilpattu Sanctuary the extraordinary tameness of a jungle-cock, which strutted around, crowing, a few yards away from us, seems to indicate that little disturbance takes place there. It is, however, necessary to point out that this incident took place on the road to the Watchers' huts at Kali Villu and not more than a mile or so from them, where poaching would hardly be likely to take place.

Owing to the heavy cover it was difficult to form any estimate of the probable amount of game about.—G. M. H.

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| Collection ... | ... No. 13 |
| Locality ... | ... **West Haputale, Ohiya** |
| Altitude ... | ... **4,500 feet to 6,000 feet** |
| Date ... | ... **Early 1933** |
| Collected by | ... **A. C. Tutein-Nolthenius, Esqr.** |

(*See also Reports Nos. 1 and 4*)

A few more specimens, worthy of note, have been received from Mr. A. C. Tutein-Nolthenius, since Report No. 4 was written. Some of these specimens were collected at lower altitudes than those at which the former collections were made. For a description of the locality see Reports Nos. 1 and 4.

It is most interesting to find an apparently new species of Pipistrelle, at an altitude of 6,000 feet, and it is greatly to be hoped that Mr. Tutein-Nolthenius will be able to collect one or more good specimens of it so that the species may be described.

### (No. 11). **Rhinolophus rouxi rouxi** Temminck

*The Rufous Horse-shoe Bat*

♂ 1. Typical. 6,000 feet.

One specimen of this common Horse-shoe Bat came into the West Haputale bungalow, one evening, and was caught.

This is the highest altitude from which this bat has yet been recorded. It does not appear to be common at high altitudes.

### (No. 14) **Hipposideros speoris speoris** (Schneider)

*Sykes' Leaf-nosed Bat*

♂ 3, ♀ 2. Typical. 4,600 feet.

All these specimens are from a colony under a rock at an altitude of approximately 4,600 feet. Four are dark grey and one ♀ has a reddish suffusion. Hitherto, this species had not been recorded from above 2,500 feet.

*(See also Report No. 2 and the present Report)*

### (No. 19) **Pipistrellus ceylonicus ceylonicus** (Kelaart)

*Kelaart's Bat*

♂ 1, ♀ 5. 6,000 feet.

All shot, flying over at dusk, near the bungalow. A very useful series, showing the usual variations in colour. Two ♀s are dark brown with a slight reddish suffusion, two are bright chestnut brown and the fifth is between these two colours. The ♂ is dark brown with a very slight reddish suffusion. This species is the common bat of high altitudes in Ceylon.

### **Pipistrellus** sp.

♂ 1 (skin), ♂ 1. (in alcohol). 6,000 feet.

Two specimens of a long-furred, dark Pipistrelle which appears to be new to science. Unfortunately, the skulls of both are damaged. The species will be described when complete specimens have been obtained.

### (No. 57) **Herpestes vitticollis** Bennett

*The Striped-necked Mongoose*

♂ 1. Flat skin. Typical. 5,000 feet.

'Shot in the afternoon, near the Lines, when it was chasing chickens.'

A deep red specimen of this fine Mongoose, which is uncommon in most parts of the Island. The species had been reported, previously, from the Horton Plains (7,000 feet), lying immediately above West Haputale Estate.

Ceylon J. Sci. (B) Vol. XVIII, Pt. 1. (*December 22, 1933*)

# NOTES

## A Tic Polonga (*Vipera russelli*) swallowed by a Cobra (*Naia naia*)

On the 31st December, 1932, at about 10 A.M. one of the labourers of the Pioneer Goat Farm, Ganewatta, informed me that he had discovered a cobra. I fired at the snake, almost severing it in two and thereby exposed the diamond shaped markings of a tic polonga which exhibited slight injuries on the head. Investigation showed that it had been swallowed head first by the cobra. In spite of its wound, the dying cobra seized the head of the polonga when this was presented to it, while the polonga, which had evidently been recently swallowed, wriggled when fire was applied to it.

The cobra and the polonga measured 5½ and 3½ feet, respectively, minus the parts blown off by the shot.

C. Lucian de Zylwa.

## Birds of the Opanake District

The following list comprises the birds seen during a collecting trip to Madola near Opanake, at the 77th mile on the Colombo-Balangoda road, in the Ratnapura District, Province of Sabaragamuwa, Ceylon, from February 16 to 23, 1933. From Madola excursions were made to Hallinna Estate and Idirimini, *circa* 2,000 feet, the crest of a steep acclivity which borders Hallinna on the north-west. I wish to record my thanks to Mr. P. B. Cruickshank, Superintendent of Hallinna Estate, through whose kindness and hospitality the trip up Idirimini was made possible.

Madola lies at an elevation of about 600 feet, on the north bank of a small stream, the Wegan-oya. To the north, the country rises boldly to a precipitous ridge which attains an elevation of 4,900 odd feet. The higher portions of this range are still covered with fine virgin forest but the lower slopes are varied with village gardens, small paddy fields and chenas (shifting cultivation) both abandoned and new. On the south side of the Wegan-oya the land rises fairly steeply to a ridge, of which Welihinda, 2,316 feet, is the highest point. There is a belt of recent chena along the stream but above this is virgin forest of fairly big trees with comparatively little undergrowth.

The district is situated in the wet zone and has an average annual rainfall of 125 to 150 inches. February however is a fairly dry month.

One of the main purposes of the trip was to investigate rumours of the existence, in the neighbourhood, of a large, dark pigeon described as a ' rock-pigeon ' and said to be distinct from *Columba torringtonii*. This pigeon was said to frequent the jungles above Hallinna Estate. Our visit to Idirimini, however, failed to reveal it and from the descriptions given by men on the spot it seemed more than likely that the Torrington pigeon was the bird the rumours were about, and not *Ducula badia cuprea* as was supposed. This latter pigeon has never been discovered in Ceylon since the original record in Stuart Baker's ' Indian Pigeons and Doves ' p. 107, that ' Mr. J. Stewart also obtained this bird, together with its egg, at Ratnapura in Ceylon '; it is therefore a great desideratum.

In the following list, the numbering and scientific nomenclature are those given in Wait's *Manual of the Birds of Ceylon*, 2nd edition:—

1. *Corvus coronoides culminatus*, the Black Crow.—Common.
3. *Cissa ornata*, the Blue Magpie.—One seen on Idirimini 17.ii.33, in heavy jungle.
6. *Turdoides griseus striatus*, the Ceylon Babbler.—Common in cultivation.
7. *Turdoides rufescens*, the Ceylon Rufous Babbler.—Seen, and one shot, but not very common.
8. *Turdoides cinereifrons*, the Ashy-headed Babbler.—A troop seen on Idirimini and others on Welihinda.
9. *Pomatorhinus horsfieldi melanurus*, the Ceylon Scimitar Babbler.—Common on Welihinda.
10. *Dumetia albigularis albigularis*, the Small, White-throated Babbler.—A troop met with in weedy, abandoned tea on Koraketiya, near Madola.
12. *Pellorneum fuscicapillum*, the Brown-capped Babbler.—Common on Welihinda.
13. *Rhopocichla atriceps nigrifrons*, the Black-fronted Babbler.—Common on Welihinda.
14. *Aegithina tiphia zeylonica*, the Ceylon Iora.—Several seen in chenas, &c., and more heard.
15. *Chloropsis aurifrons davidsoni*, the Yellow-fronted Chloropsis.—One shot and several seen at Madola.

17. *Microscelis psaroides ganeesa*, the Southern Black Bulbul.—Common in jungle on Idirimini and Welihinda.

18. *Molpastes haemorrhous haemorrhous*, the Red-vented Bulbul.—Common in chenas and cultivation.

19. *Iole icterica*, the Yellow Bulbul.—Very common in jungle everywhere.

20. *Pycnonotus melanicterus*, the Black-capped Bulbul.—Common in chena and jungle edges, along streams, &c.

26. *Copsychus saularis ceylonensis*, the Ceylon Magpie Robin.—Common in cultivation.

27. *Kittocincla macroura indica*, the Shama.—Seen at very close quarters in jungle at Madola.

33. *Oreocincla dauma imbricata*, the Ceylon Thrush.—Near the top of Welihinda hill, at about 2,300 feet, in deep jungle, a bird flew from the ground to a low tree and I fired and brought it down. Great was my delight to find that I had bagged an Imbricated Thrush, which I have only seen once before—up Hakgala Peak. It has apparently not previously been recorded from so low an elevation.

40. *Alseonax latirostris poonensis*, the Indian Brown Flycatcher.—Seen once or twice.

41. *Alseonax muttui*, Layard's Flycatcher.—An individual of this species (easily distinguished from the last by its dark moustachial patches, and comparatively rich colouring) was watched with glasses for half an hour while it captured flies in a shady recess in the river bank at Madola.

43. *Terpsiphone paradisi paradisi*, the Paradise Flycatcher.—Birds in red plumage (females or young males) were seen in jungle at Madola and on top of Welihinda.

47. *Lanius cristatus cristatus*, the Brown Shrike.—One seen in chena on Welihinda.

51. *Pericrocotus speciosus flammeus*, the Orange Minivet.—Seen at Madola.

58. *Dicrurus coerulescens leucopygialis*, the White-vented Drongo.—Fairly common in open country.

59. *Dissemurulus lophorhinus*, the Ceylon Crested Drongo.—Seen at Idirimini. A pair was met with on top of Welihinda.

60. *Dissemurus paradiseus ceylonensis*, the Ceylon Racket-tailed Drongo.—A pair of Racket-tailed drongos was seen at close quarters on Welihinda on 21.ii.33. I examined them with glasses and satisfied myself that the outer tail-feathers, though shorter than in normal *D. paradiseus ceylonensis* had definite

bare (or perhaps, very strongly emarginated) shafts for an inch or more. I fired at one and thought I dropped him but could not find him.

Whistler (*J. Bombay Nat. Hist. Soc.* XXXVI, p. 350) has raised the question, on an examination of Legge's material of this species and the afore-going, whether the two species, connected by Legge's abnormal specimens, should not be regarded as variable stages of one, namely, *Dissemurus paradiseus ceylonensis.* He suggests that *D. lophorhinus* may be the young of *D. paradiseus ceylonensis.* The main ranges of the two species are, however, very different; *D. lophorhinus* being distinctly a wet zone bird, while *D. paradiseus ceylonensis* is equally characteristic of the dry zone. I have personally no doubt that *D. lophorhinus* normally attains maturity without developing the large crest and long racket-feathers of *D. p. ceylonensis;* it is a common bird in the wet zone jungles and if it were merely a young stage in the development of *D. p. ceylonensis* the latter would surely be commonly seen in the wet zone—which it is not. On the other hand, it seems to me quite unnecessary to erect a genus (*Dissemurulus*) for *D. lophorhinus* merely on the strength of its poorly-developed crest and lack of bare shafts to the outer tail feathers; it is unquestionably very closely related to *D. p. ceylonensis* and might very well be no more than a subspecies of the latter.

65. *Orthotomus sutorius sutorius*, the Tailor-bird.—Seen but not very common.

76. *Prinia sylvatica valida*, the Ceylon Jungle Wren-warbler.—Heard in chena.

80. *Oriolus xanthornus ceylonensis*, the Ceylon Black-headed Oriole.—Common in village gardens.

81. *Eulabes religiosa*, the Southern Grackle.—Common at Madola.

82. *Eulabes ptilogenys*, the Ceylon Grackle.—Common on Idirimini. A pair was watched bullying some Layard's Woodpeckers in the vicinity of a tree, with a hole in it, which they were seen to visit repeatedly and which doubtless contained their nest. In company with other birds they were congregated at a huge, fruiting Banyan tree in very tall forest, and their loud whistlings, craking notes and flight-noise contributed considerably to the babel of bird-sounds descending from the banquet overhead. The whistling noise made by the wings of the above two species of *Eulabes* is very characteristic and can be heard for a long distance.

85. *Sturnornis senex*, the White-headed Starling.—One seen and shot in high forest on Idirimini.

86. *Acridotheres tristis melanosternus*, the Common Ceylon Mynah.—Common in village gardens, paddy fields, &c.

95. *Passer domesticus confucius*, the House Sparrow.—Common in villages.

99. *Hirundo daurica hyperythra*, the Ceylon Swallow.—Several seen hawking over Koraketiya tea estate.

102. *Motacilla cinerea caspica*, the Grey and Yellow Wagtail.—One seen on the river at Madola.

111. *Zosterops palpebrosa egregia*, the Small Ceylon White-eye.—Seen on Hallinna Estate and at Madola.

113. *Leptocoma lotenia*, Loten's Sunbird.—Seen at Madola.

116. *Leptocoma zeylonica*, the Purple-rumped Sunbird.—Common at Madola. A nest containing two young was found.

117. *Dicaeum erythrorhynchus ceylonense*, Tickell's Flowerpecker.—Common at Madola. One was shot (in mistake for *Acmonorhyncus*) while feeding a young one on top of a breadfruit tree.

120. *Pitta brachyura*, the Indian Pitta.—Heard at Hallinna.

122. *Picus chlorolophus wellsi*, the Ceylon Yellow-naped Woodpecker.—Fairly common; it likes the company of other birds.

127. *Brachypternus benghalensis erithronotus*, the Common Red-backed Woodpecker.—Several seen.

129. *Chrysocolaptes guttacristatus stricklandi*, Layard's Woodpecker.—Several seen on Idirimini. Common in jungle and village gardens at Madola.

130. *Thereiceryx zeylanicus zeylanicus*, the Brown-headed Barbet.—Common in village gardens.

131. *Cyanops flavifrons*, the Yellow-fronted Barbet.—Very common in jungle at Idirimini, Madola, Welihinda. More of a forest bird than the last.

133. *Xantholaema rubricapilla*, the Small Ceylon Barbet.—Common at Madola in village gardens.

137. *Merops superciliosus javanicus*, the Blue-tailed Bee-eater.—Common at Madola in chenas, &c.

142. *Ceyx tridactylus tridactylus*, the Three-toed Kingfisher.—On 17.ii.33 I caught sight of one of these lovely little birds on the river at Madola, and watched it with glasses for some time. Its attitudes and actions appeared very similar to those of *Alcedo a. taprobana* and it had the same habit of jerking its head and tail. Presently it darted into a small pool and captured a crab, with carapace about an inch in width, which

it battered on its perch in the usual way and finally swallowed with some difficulty; then it flew down and retrieved a claw or leg of the crab which had been knocked off. On 28.ii.33, while I was watching an *Alseonax muttui* hawking flies in a gloomy recess in the river bank, one of these kingfishers suddenly appeared, darting down to seize a large, dark-coloured frog, with a body length of probably 1½ inch, which it carried back to its perch and attempted to hammer to death. The frog, however, managed to get its hind legs astride the bird's throat, and eventually forced itself free, to the disgust of the kingfisher which seemed very loath to lose it and spent quite a time looking for it before giving up hope and resuming its quiet waiting for prey. It was noted that both the *Ceyx* observed preferred to take their station in well shaded recesses along the riverside, where their brilliant colouring did not make them conspicuous.

144. *Halcyon smyrnensis generosa*, the Ceylon White-breasted Kingfisher.—Common in open country, paddy fields, &c.

147. *Lophoceros griseus gingalensis*, the Ceylonese Small Hornbill.—Very common and not confined to jungle. It is a fine sight to see one of these birds flying across a forested valley, which it does in a series of bounding curves, as it alternately spreads and closes its broad wings and tail.

150. *Micropus affinis nipalensis*, the House Swift.—A pair seen on the hill above Koraketiya Estate, Madola.

153. *Collocalia unicolor unicolor*, the Edible-nest Swiftlet.—Common.

154. *Hemiprocne coronata*, the Crested Swift.—Seen at Madola.

156. *Caprimulgus macrourus atripennis*, Jerdon's Long-tailed Nightjar.—Heard, but not seen, at Hallinna Estate.

159. *Pyrotrogon fasciatus fasciatus*, the Ceylon Trogon.—Common in jungles at Madola, on Idirimini and Welihinda. Probably breeding, as males greatly predominated amongst those seen, which seems to indicate that the females were incubating; but no nests were found. Both sexes have a similar call-note, a whistled ' h'yoch, h'yoch, h'yoch, h'yoch, h'yoch ' which is easily imitated and almost infallibly brings up any trogons that may be about. This note, which is not accompanied by any conspicuous tail-movement, is uttered while the bird sits bolt upright on a branch. There is another note however, also uttered by both sexes,—a sort of chuckling churr—in the production of which, the birds raise and expand their beautiful broad tails. The trogon is soft and fluffy, a

fact which contributes not a little to its fascinating beauty. On one occasion a female was heard calling, not far from the circuit bungalow where I was staying, and responded to my imitation of its note, with the result that, for at least ten minutes, I was privileged to watch it with glasses at a few yards distance from the verandah. The flight, owing to the short wings, is of a fluttering character, and never for long distances, though fairly quick and dexterous.

165. *Penthoceryx sonneratii waiti*, the Ceylon Banded Bay Cuckoo. Not seen by me but a note was heard at Hallinna and Madola which I think must have been made by this bird.

171. *Phoenicophaus pyrrhocephalus*, the Red-faced Malkoha.—Several were seen together in tall forest on Welihinda ridge. They appeared playful and may have been courting. Note, a low ' kraa '. In life, the face of this bird resembles crimson plush and gives it a most distinctive appearance.

173. *Centropus sinensis parroti*, the Southern Coucal.—Common at Madola.

174. *Centropus chlororhyncus*, the Green-billed Coucal.—Heard in thickets everywhere at Madola, and evidently common, but a good view was obtained of only one. It is most noisy in the early morning.

178. *Psittacula cyanocephala cyanocephala*, the Blossom-headed Paroquet.—One or two pairs were seen in flight in chenas and village gardens above Madola.

179. *Psittacula calthropae*, Layard's Paroquet.—Common at Madola; at least three pairs were observed to be congregated, with much screeching and excitement, about a tall tree, with one or more desirable nesting holes, which they evidently all coveted.

180. *Coryllis beryllinus*, the Ceylon Loriquet.—Common at Madola.

184. *Strix indranee indranee*, the Brown Wood Owl.—Not seen, but its ordinary hoot was heard in jungle opposite Madola on 21.ii.33. The night before, the cry of the ' Ulama ' was heard in the same direction—a two-note, loud, wailing scream, with a gurgle at the end, repeated every few seconds, and distinctly weird, but not especially blood-curdling. At first I thought it was the noise made by villagers protecting their chenas from pig, but on my assistants' drawing my attention to it as the cry of the ' Ulama ' I recognized it as a bird-cry.

185. *Ketupa zeylonensis zeylonensis*, the Fish Owl.—A fine specimen was seen at dusk, in a tree beside the river below the road, and watched for some seconds with glasses.

197\. *Ictinaetus malayensis perniger*, the Black Eagle.—One was seen sailing slowly, close above the tree tops, over the jungle hill opposite the circuit bungalow at Madola. One male, in somewhat heavy moult, was shot by Mr. Martenstyn, of Hallinna, and sent to me. Its crop contained a large rat. Its testicles were small, indicating that the breeding season of this eagle is probably later in the year.

198\. *Limnaetops cirrhatus ceylanensis*, the Low-country Hawk Eagle.—One was seen flying over the jungle hill opposite the circuit bungalow at Madola. My attention was attracted by its loud scream and I watched it with glasses. It perched on tall trees and eventually soared up a short distance and then stooped up the valley.

200\. *Haematornis cheela spilogaster*, the Ceylon Serpent-Eagle.—A few seen and heard, but not very common.

205\. *Elanus coeruleus vociferus*, the Black-winged Kite.—Two young birds, evidently recent nestlings, were seen sitting at the top of a tall, slender tree on a hill chena above Madola, and adults were seen flying over the river several times.

221\. *Cerchneis tinnunculus tinnunculus*, the Kestrel.—Seen at the top of Hallinna Estate and above Madola.

223\. *Dendrophassa pompadora pompadora*, the Pompadour Green Pigeon.—Common at Madola. It is astonishing how these birds can conceal themselves in a tree; on firing at the only one visible in a small fruiting fig tree, a dozen or more flew out!

227\. *Chalcophaps indica robinsoni*, the Bronze-wing Pigeon.—Several were seen in jungle chena villages.

232\. *Streptopelia chinensis ceylonensis*, the Ash Dove.—Common in chena, along roadsides, &c.

236\. *Gallus lafayettii*, the Ceylon Jungle Fowl.—Not common but a few cocks were heard crowing at Madola. A villager brought in a live jungle hen which he had snared. Later, two well-built traps for snaring jungle fowls were found beside a path through abandoned chena. There can be little doubt that snaring of jungle- and spur-fowl, although illegal, goes on extensively all the year round; this doubtless accounts for the comparative scarcity of this species in the district.

237\. *Galloperdix bicalcarata*, the Ceylon Spur-Fowl.—None seen, but its unmistakable whistling cackle was often heard at Madola and Welihinda.

*Remarks.*—With the exception of the Black Eagle, all the birds shot proved to be in perfect plumage and it is evident that February is a good month in which to collect specimens. Only one nest—of *Leptocoma zeylanica*—was discovered and the breeding season appeared to be just commencing. The list is not, of course, exhaustive and it is probable that several species have been overlooked. A Harrier, a small owl, and one or two warblers were seen but not definitely identified. It may be worth mentioning that the following birds, amongst others, which might have been expected in that locality, were not seen. *Sitta f. frontalis* the Velvet-fronted Nuthatch, *Oreocincla spiloptera* the Spotted-winged Thrush, *Lalage sykesii* the Black-headed Cuckoo-shrike, *Acmonorhynchus vincens* Legge's Flowerpecker, *Yungipicus hardwickii gymnophthalmus* the Pygmy Woodpecker, *Alcedo atthis taprobana* the Ceylon Kingfisher, *Astur badius* the Ceylon Shikra, *Turnix suscitator leggei* the Ceylon Bustard Quail. Of these, the absence of *Acmonorhynchus* was the greatest disappointment, but, although always on the lookout for it, I failed to see a single individual. In 1926, however, I shot a specimen on the slopes of Pettiagalla on the other side of the ridge from Madola, so it is probable that this interesting little bird is occasionally found in the latter locality. The only place where I have found it at all numerous is Kitulgala, where, at Christmas, 1929, many specimens were seen feeding on the nectar of *Bombax malabaricum*.

G. M. Henry.

## Birds of the North Puttalam and South Mannar Districts of Ceylon.

The following observations were made during a Circuit for collecting animals for the Colombo Museum between the 8th and 29th of March, 1933. From the 9th to the 17th and from the 26th to the 29th the base was at Marichchukaddi on the Modregam Ar—the site of the Pearl Fishery Camps; the intervening period was spent at Marai Villu in the North Puttalam District, about 8½ miles south of Marichchukaddi. From this place visits were paid to Periya Naga Villu, Māil Villu, and, within the Wilpattu Game Sanctuary, to Kali Villu and Kanjuran Villu.

*General topography and vegetation*

The country at Marichchukaddi consists of open grassy plains interspersed with low jungle and scrub, with a few small tanks, flanked along the coast by low sand-dunes and old deposits of Pearl Oyster shells. The Modregam Ar forms a small lagoon at its mouth, partly separated from the sea by a sand spit which supports a small fishing village set in a coconut tope. A large part of this lagoon is uncovered at low tide, forming mud-flats which afford congenial feeding grounds to numerous small waders. On the north side the lagoon is bounded by a cliff about 30 feet high, of clayey material.

The vegetation north of the Modregam Ar consists of such bushes and trees as the Masan (*Zizyphus jujuba*), Acacias of several species, *Calotropis gigantea*, Wood Apple and other dry-zone plants. The main feature of the flora that impresses a non-botanist is the enormous variety and viciousness of the thorns that arm nearly every tree, bush, and herb in the place. The Collectors suffered a good deal of inconvenience from these thorns and particularly from a seed called 'nerinchi' shaped somewhat like the 'Calthrops' of medieval history, and armed with a very sharp spine, which lay on the ground everywhere and got into bare feet.

South of the Modregam Ar the country is covered with low, but dense jungle broken only by the 'Villus'—shallow, natural lakes, mostly dry in the dry season, but in March full of water with but a narrow grassy margin. In some of these villus the water is almost concealed by long grass which grows thickly and affords ideal conditions for such birds as the Purple Coot and the Water-cock. The Kali Villu, in the Sanctuary, is deep and free from grass but has small dead trees standing in the water.

The numbering and scientific nomenclature follow those given by Wait, *Manual of the Birds of Ceylon*, 2nd edition.

1. *Corvus coronoides culminatus*, the Black Crow.—Very common everywhere.

2. *Corvus splendens protegatus*, the Ceylon House Crow.—Believed seen at Marichchukaddi, but not identified with complete certainty.

6. *Turdoides griseus striatus*, the Ceylon Babbler.—Common at Marichchukaddi and Marai Villu.

12. *Pellorneum fuscicapillum*, the Brown-capped Babbler.—Common at Marichchukaddi and Marai Villu. Often heard but seldom seen.

13. *Rhopocichla atriceps nigrifrons*, the Black-fronted Babbler.—Seen at both camps but not as common as it is in the wet zone.

14. *Aegithina tiphia zeylonica*, the Ceylon Iora.—Very common, especially at Marai Villu, where its sweet, but rather monotonous and drowsy whistlings were constantly to be heard. In addition to the usual call 'chee-e-e-too' I detected a whistle suggesting the words "whip-wibirdie' which was uttered every morning from a tree above my tent.

16. *Chloropsis jerdoni*, Jerdon's Chloropsis.—Seen at Marichchukaddi at close quarters.

18. *Molpastes haemorrhous haemorrhous*, the Red-vented Bulbul.—Common everywhere.

21. *Pycnonotus luteolus*, the White-browed Bulbul.—Common everywhere. Two nests, each containing two eggs, were found at Marai Villu in jungle beside game-tracks. One was in the still-green foliage of a tree that had recently been broken down by an elephant and was only about 2 feet from the ground; the other was in a branch which projected half way across the track. Both were very conspicuous and it is a marvel that the 'Galuguluwa' survives at all, seeing that it places its nest in such foolish situations. Had the bird only sense enough to sit still it might hope to escape observation, but it invariably flutters off in a manner that absolutely invites investigation. Probably, however, many nests are well hidden and only the foolish ones get discovered.

25. *Saxicoloides fulicata fulicata*, the Black-backed Robin.—Seen at Marichchukaddi.

26. *Copsychus saularis ceylonensis*, the Ceylon Magpie Robin.—Common everywhere.

27. *Kittocincla macroura indica*, the Shama.—Common in jungle everywhere.

40. *Alseonax latirostris poonensis*, the Indian Brown Fly-catcher.—Seen at Marichchukaddi.

43. *Terpsiphone paradisi paradisi*, the Paradise Flycatcher.—Common, especially at Marai Villu and neighbourhood. Most males seen were in the chestnut phase but a few magnificent, full-plumaged white males were seen and one bird in the particoloured red and white stage.

44. *Hypothymis azurea ceylonensis*, the Ceylon Azure Flycatcher.—Not common, but one seen at Marai Villu.

46. *Lanius schach caniceps*, the Southern Rufous-backed Shrike.—Very common at Marichchukaddi. Not seen at Marai Villu, where the dense jungle does not suit its habits.

47. *Lanius cristatus cristatus*, the Brown Shrike.—Seen both at Marichchukaddi and Marai Villu.

50. *Tephrodornis pondiceriana affinis*, the Ceylon Wood-shrike.—Common at Marichchukaddi where the species was breeding. A nest was found in a gnarled tree and, as usual, it was very difficult to distinguish from the bark of the forked branch which supported it. It contained two eggs which hatched

during our stay. If the parent would only quell her fears, and sit tight on the approach of a human, her nest would be very difficult to discover as the bird itself is well camouflaged when incubating; as it is, she often betrays the nest by hurriedly leaving it.

52. *Pericrocotus peregrinus malabaricus*, the Small Minivet.—A few seen at Marichchukaddi.

53. *Lalage sykesii*, the Black-headed Cuckoo-shrike.—Seen at Marichchukaddi.

55. *Artamus fuscus*, the Ashy Swallow-shrike.—Common at Marichchukaddi, where two nests, each containing young were found. They were in hollows at the broken ends of dead branches at about 7 to 9 feet from the ground. The parents were most vigilant in mobbing crows, kites or other marauders within a considerable radius of their treasures, and their great powers of flight gave them an advantage which the larger birds recognized. When approaching one in flight this bird's wings appear very thin and they are carried at a slight upward tilt. The tail is used much for steering, and when perched, the bird frequently rotates its tail through a few degrees as if to keep the mechanism limbered out.

56. *Dicrurus macrocercus minor*, the Ceylon Black Drongo.—Common at Marichchukaddi.

63. *Acrocephalus dumetorum*, Blyth's Reed-warbler.—Seen at Marichchukaddi.

65. *Orthotomus sutorius sutorius*, the Tailor-bird.—Common at Marichchukaddi. One night, while out collecting insects with a powerful lantern I came upon a pair of tailor-birds asleep on a twig, beside, but not covered by, a fairly big leaf. I could not resist the temptation to stroke the fluffy little creatures but they were too sleepy to resent my familiarities and it was only after I had teased them quite a lot that the little hen hopped to another twig and began to show that she thought things had gone far enough. Wild birds must be very resistant to rain, for my observations at night show that many kinds choose very exposed situations for roosting.

77. *Prinia inornata jerdoni*, the Ceylon Wren-warbler.—A nest containing four eggs was found in a low thorn-bush near Dixon's tower, Marichchukaddi.

80. *Oriolus xanthornus ceylonensis*, the Ceylon Black-headed Oriole.—Fairly common everywhere.

83. *Pastor roseus*, the Rose-coloured starling.—Believed seen among the squabbling, chattering throng of mynahs, paroquets, swallow-shrikes, &c., settling down to roost in the coconut tope on the sand-spit at Marichchukaddi. Definite identification was not made, however.

84. *Temenuchus pagodarum*, the Brahminy Mynah.—Fairly common at Marichchukaddi.

86. *Acridotheres tristis melanosternus*, the common Ceylon Mynah.—Common everywhere.

87. *Ploceus philippinus*, the Baya.—None seen by me but several fresh-looking nests were noticed in a tree at Periya Naga Villu.

93. *Uroloncha punctulata punctulata*, the Spotted Munia.—Common at Marichchukaddi.

96. *Hirundo rustica gutturalis*, the Eastern Swallow.—Very common everywhere. The majority were young birds heavily in moult but a few adults with long tail streamers were noticed.

103. *Motacilla flava thunbergi*, the Grey-headed Wagtail.—Common at Marichchukaddi and on the grassy shores of villus.

107. *Anthus richardi rufulus*, the Indian Pipit.—Common everywhere on open grass-land. Several were put up from their roosts among the grass while I was collecting insects at night.

109. *Mirafra assamica affinis*, the Bush-lark.—Common everywhere in scrub or bush land.

110. *Pyrrhulauda grisea*, the Ashy-crowned Finch-lark.—Common at Marichchukaddi.

113. *Leptocoma lotenia*, Loten's Sunbird.—Common everywhere.

114. *Leptocoma asiatica asiatica*, the Purple Sunbird.—A nest of this species was found at Marai Villu in a mass of the cobweb formed by a gregarious spider. The previous species is usually the one that utilizes these cobwebs but as I had a good look at the mother at night and examined her at very close quarters, with the aid of my collecting lamp, I could not be mistaken—the comparatively short beak distinguished her from *L. lotenia*.

116. *Leptocoma zeylonica*, the Purple-rumped Sunbird.—Common everywhere.

117. *Dicaeum erythrorhynchus ceylonense*, Tickell's Flowerpecker.—Common everywhere.

120. *Pitta brachyura*, the Indian Pitta.—Common everywhere. It is worthy of remark that remains of two individuals of this species were found in the jungle. In one case they consisted of a mass of feathers on the ground, in the other the carcass

of the bird was found lying on a branch about 7 feet above the ground. It seems probable that its brilliant colours make it a tempting mark to birds or beasts of prey.

126. *Brachypternus benghalensis ceylonus*, the Ceylon Golden-backed Woodpecker.—Several specimens of the golden-backed woodpecker were collected, both at Marichchukaddi and Marai Villu. At the latter place, one, which was shot while digging a nest-hole in a tree, proved to be a male.

128. *Chrysocolaptes festivus*, the Black-backed Woodpecker.—A large woodpecker which was believed to be this species was observed digging a nest-hole in a tree in the Sanctuary, but unfortunately it took fright and flew away before I could get a satisfactory view of it.

130. *Thereiceryx zeylanicus zeylanicus*.—The Brown-headed Barbet was the only Barbet seen and was not very common, either at Marichchukaddi or Marai Villu.

134. *Coracias benghalensis indica*, the Southern Indian Roller.—One or two pairs seen at Marichchukaddi (where they were breeding in dead coconut palms) and one pair seen at Marai Villu.

136. *Merops orientalis orientalis*, the Common Indian Bee-eater.—Very common everywhere. While out collecting with the lamp one night at Marichchukaddi I found a large number of these lovely little birds roosting in pairs among the leaves of a densely foliaged tree. A sweep with my net captured one, which, after stroking and admiring for a few minutes, I released. It took its ordeal very patiently, hardly fluttering at all.

137. *Merops superciliosus javanicus*, the Blue-tailed Bee-eater.—Very common everywhere, especially at Marai Villu, where there were large flocks. In the heat of the day individuals were frequently seen to fly down and plunge into the water of the villu. I watched them carefully with glasses to see if they were catching any prey, but feel convinced that their purpose was bathing, not fishing. I have several times seen this species capture the large dragon-fly *Anax guttatus*.

138. *Melittophagus erythrocephalus erythrocephalus*, the Chestnut-headed Bee-eater.—Several pairs seen both at Marichchukaddi and Marai Villu.

139. *Ceryle rudis leucomelanura*, the Indian Pied Kingfisher.—A pair at Marichchukaddi frequented the lagoon below the bungalow.

140. *Alcedo atthis taprobana*, the Ceylon Kingfisher.—A nest of this kingfisher was betrayed by the embarrassment of the parent

on catching sight of me while she was bringing a fish to her young—which led to investigation up the banks of a small dry water-course. The nest-hole was about 2 feet in depth, and by using the glass bottom of one of my pill-boxes as a mirror to reflect a beam of sunlight down the hole, I was able to see that there were $n$ unfledged young in the chamber at the end. On examining the nest a week later I observed with dismay two dead fledgings cast out below it. Subdued sounds emanating from the hole indicated that something was in occupation but my mirror device would not function owing to the sun being behind me—and clouded over, to boot. However, ten days later, on my return from Marai Villu, I again examined the nest by reflected light and found three fledgings, almost ready to fly, inside. The unaccustomed glare caused them to blink and shuffle out of the way of the beam. The floor of the tunnel was swarming with fly maggots. Loveliness nurtured in squalor!

144. *Halcyon smyrnensis generosa*, the Ceylon White-breasted Kingfisher.—Seen at Marichchukaddi.

146. *Anthracoceros coronatus*, the Large Pied Hornbill.—A large flock of these ungainly birds was seen at Periya Naga Villu—hopping about on the branches of trees as if they were gigantic canaries.

147. *Lophoceros griseus gingalensis*, the Ceylonese Small Hornbill.—Not very numerous, but a few seen—and more heard—at Marai Villu and in the Sanctuary.

148. *Upupa epops ceylonensis*, the Ceylon Hoopoe.—Only a few hoopoes were seen at Marichchukaddi.

150. *Micropus affinis nipalensis*, the House Swift.—A flock of these swifts was seen at dusk at the small tank, south of the Modregam Ar at Marichchukaddi, which they visited for their evening drink.

154. *Hemiprocne coronata*, the Crested Swift.—Seen at Marai Villu.

155. *Caprimulgus asiaticus*, the Common Nightjar.—Common at both Marichchukaddi and Marai Villu. At the latter place one was found incubating a single egg on the bare, sandy soil of the open area between the villu and the jungle. The site was quite unshaded and the bird's camouflage was perfect as she was not seen until she sprang up almost at my feet—revealing the egg. When disturbed she flew excitedly about but seized the opportunity to settle on a sandy patch and

dust herself—not throwing the sand over her like a hen but rather seeming to ' scrabble ' herself into it. She flew back to the egg very soon after I left it. On two occasions she permitted me to sit on a camp stool within three or four yards and sketch her with the aid of glasses. At first she crouched, with her head in line with her back, and eyes closed except for a narrow slit, and became absolutely indistinguishable from the sticks, stones and pieces of bark strewn around. Later however, she developed more boldness—raised her head, half opened her eyes, and puffed out her feathers—only to ' freeze ' again on the slightest unusual action on my part. On the second occasion I spent an hour or more sketching her in bright sunlight, and noticed her throat quivering as she panted with the heat. My sketch finished, I crept up to see how near she would allow me to approach, but, when about 2 feet away, her nerves would stand the strain no longer and she sprang into the air with an anxious chuckle, to fly about in an agitated manner. While she did so, her mate in the near-by jungle could be heard ' chuck, chuck, chuck '-ing away as if beseeching her to return to her duties; so he was evidently on the watch and interested in the proceedings. I had no sooner left the nest for a few yards than she was back on her precious egg, which evidently represented the full clutch in this instance as several days elapsed between my first and final views of it.

156. *Caprimulgus macrourus atripennis*, Jerdon's Long-tailed Nightjar.—Common at Marai Villu. On the 15th of March, a Game Watcher pointed out to me one of these birds incubating two eggs on the side of the path through the jungle—another marvellous case of camouflage, the bolder markings on this species harmonizing with the stronger light and shade contrasts of its jungle environment, even as the paler coloration of *C. asiatica* assimilates it to its surroundings in the open.

164. *Cacomantis merulinus passerinus*, the Indian Plaintive Cuckoo. —Fairly common at both localities.

167. *Clamator jacobinus taprobanus*, the Pied Crested Cuckoo.— Common at Marichchukaddi.

169. *Eudynamis scolopaceus scolopaceus*, the Koel.—Seen and heard at Marai Villu.

170. *Rhopodytes viridirostris*, the Small Green-billed Malkoha.— Fairly common at both localities but very shy.

178. *Centropus sinensis parroti*, the Southern Coucal.—Common everywhere.

177. *Psittacula krameri manillensis*, the Rose-ringed Paroquet.—Common at Marichchukaddi. Seen feeding on the green-and-crimson fruits of a cucurbitaceous creeper. Numbers roosted at night in the palms of the coconut tope.

185. *Ketupa zeylonensis zeylonensis*, the Brown Fish-owl.—The deep moan of the Fish Owl was heard at the ford of the Modregam Ar.

188. *Otus bakkamoena bakkamoena*, the Collared Scops Owl.—Heard, but not seen, both at Marichchukaddi and Marai Villu. Its note however is quite distinctive.

192. *Pandion haliaetus haliaetus*.—An Osprey daily visited the Marichchukaddi lagoon and was on one occasion seen to capture a fish, with which it flew to the jungle on the south side of the lagoon. It was not in very good plumage.

198. *Limnaetops cirrhatus ceylanensis*, the Low-country Hawk Eagle.—One seen at Marai Villu.

200. *Haematornis cheela spilogaster*, the Ceylon Serpent-Eagle.—One, in immature plumage, shot at Periya Naga Villu. It was noted that, on the underside, its wings did not show the broad banding so characteristic of the adult but were checkered with small bars like the wings of *Limnaetops*.

201. *Haliaetus leucogaster*, the White-bellied Sea-Eagle.—Several seen at Marichchukaddi and Marai Villu.

203. *Haliastur indus indus*, the Brahminy Kite.—Very common everywhere. A young bird was taken from a nest in one of the palms of the coconut tope.

204. *Milvus migrans govinda*, the Pariah Kite.—Common at Marichchukaddi.

206. *Circus macrourus*, the Pale Harrier.—Fairly common.

209. *Circus aeruginosus aeruginosus*, the Marsh Harrier.—Fairly common.

211. *Astur badius badius*, the Ceylon Shikra.—One young male shot at Marichchukaddi.

221. *Cerchneis tinnunculus tinnunculus*, the Kestrel.—Common at Marichchukaddi. Several resorted each evening to the coconut tope on the beach for roosting.

223. *Dendrophassa pompadora pompadora*, the Pompadour Green Pigeon.—Common at both localities.

*Muscadivora aenea pusilla*, the Ceylon Green Imperial Pigeon.—Several seen and one shot at Marai Villu.

282. *Streptopelia chinensis ceylonensis*, the Ash Dove.—Common everywhere. Breeding.

283. *Streptopelia decaoto decaoto*, the Ring Dove.—Contrary to expectations, this dove was not found to be common at Marichchukaddi, very few being seen and none collected.

285. *Pavo cristatus*, the Peafowl.—One, an adult male in full plumage, seen—appropriately—at Māil Villu (=Peacock Swamp).

286. *Gallus lafayettii*, the Ceylon Jungle Fowl.—Common, both at Marichchukaddi and Marai Villu. Those of the latter locality were among the largest and finest jungle-fowls that I have seen. The cocks were in full feather and had very large combs and long tails. Several broods of young chicks with their mothers were seen. In the Sanctuary an extraordinarily tame cock was met with.

242. *Francolinus pondicerianus pondicerianus*, the Southern Grey Partridge.—Common at Marichchukaddi among the sand-dunes and scrub along the coast. Evidently not breeding, as the specimens collected were in somewhat worn plumage.

243. *Turnix suscitator leggei*, the Ceylon Bustard Quail.—Common at Marai Villu around the swamp and a few seen at Marichchukaddi. While out collecting at night with a lamp several pairs were put up and one pair was captured by clapping a butterfly-net over them before they took to flight. The male and female roost in pairs on the ground among grass, &c., scraping a little hollow for themselves.

249. *Amaurornis phoenicurus phoenicurus*, the White-breasted Water-hen.—Common wherever suitable conditions exist.

251. *Gallicrex cinerea*, the Water-Cock.—A pair seen at Māil Villu.

252. *Porphyrio poliocephalus poliocephalus*, the Purple Coot.—Seen at Māil Villu and Kanjuran Villu.

253. *Burhinus oedicnemus indicus*, the Stone-Curlew.—A pair or two frequented the sand-dunes at Marichchukaddi.

254. *Esacus recurvirostris*, the Great Stone-Plover.—Seen at Marichchukaddi on the beach and mud-flats, and at Kanjuran Villu and Periya Naga Villu, on the grassy borders of the swamps.

261. *Lobivanellus indicus indicus*, the Red-wattled Lapwing.—Common on shores of tanks and villus, &c. Not breeding and therefore not unduly noisy.

262. *Lobipluvia malabarica*, the Yellow-wattled Lapwing.—Common at Marichchukaddi.

265. *Pluvialis dominicus fulvus*, the Eastern Golden Plover.—Very common at Marichchukaddi and Marai Villu. Some birds showed a few black feathers on the breast.

267. *Cirrepedesmus mongolus atrifrons*, the Lesser Sand Plover.—Common at Marichchukaddi along the beach and on the mud-flats.

268. *Charadrius dubius jerdoni*, Jerdon's Little Ringed Plover.

269. *Charadrius dubius curonicus*, the European Little Ringed Plover.—Ringed Plovers were common at Marichchukaddi but it is very difficult to discriminate between the two subspecies unless the birds are in hand. Probably both were present.

270. *Leucopolius alexandrinus alexandrinus*, the Kentish Plover.

271. *Leucopolius alexandrinus seebohmi*, the Indian Kentish Plover.—Kentish Plovers were very numerous on the shore and mud-flats at Marichchukaddi, but the same remarks apply to these two subspecies as to the last two.

273. *Himantopus himantopus himantopus*, the Black-winged Stilt.—Common at Marai Villu and other villus.

275. *Numenius arquata orientalis*, the Eastern Curlew.—Several Curlews were seen at Marichchukaddi, but they defied every effort to make closer acquaintance with them..

276. *Numenius phaeopus phaeopus*, the Whimbrel.—Common at Marichchukaddi but very wary.

278. *Terekia cinerea cinerea*, the Western Terek Sandpiper.—The swarms of little snippets on the mud-flats at Marichchukaddi included a good many of these birds, but strenuous efforts to collect some resulted in only two specimens being procured, as they were very wide-awake. It may be of interest to record that I watched a small flock of Terek Sandpipers on the shores of the Jaffna lagoon at the end of December, 1932, so there has evidently been a considerable influx of these, usually rare, visitors this season. The only other occasion on which I have met with this bird, was on the 9th March, 1913, when I shot a solitary specimen at Marichchukaddi. On skinning it, its crop was found to contain small crabs.

279. *Tringa hypoleucos*, the Common Sandpiper.—Common at Marichchukaddi.

280. *Tringa glareola*, the Wood Sandpiper.—Common at Marichchukaddi and especially at Marai Villu, where, on the grassy margin of the swamp, it showed strong territorial instinct, each bird resenting any intruder of its own species on its chosen beat.

282. *Tringa stagnatilis, the Marsh Sandpiper.*—Fairly common at both localities. Specimens shot proved to be excessively fat and were in beautiful plumage.

284. *Tringa totanus totanus*, the Redshank.—Very common at Marichchukaddi; wary and noisy as usual.

285. *Glottis nebularia*, the Greenshank.—Common at Marichchukaddi.

288. *Erolia minuta minuta*, the Little Stint.—Common at Marichchukaddi.

291. *Erolia testacea*, the Curlew Stint.—Common at Marichchukaddi.

297. *Capella stenura*, the Pintail Snipe.—Common at Marichchukaddi and especially at Marai Villu.

301. *Larus brunnicephalus*, the Brown-headed Gull.—One or two small flocks seen at Marichchukaddi, containing birds in both Summer and Winter plumage.

303. *Chlidonias leucopareia javanica*, the Javan Whiskered Tern.—A few of these terns frequented the swamp at Marai Villu.

306. *Gelochelidon nilotica nilotica*, the Gull-billed Tern.—Birds of this species, both in Winter and Summer plumage, swarmed at Marichchukaddi.

307. *Thalasseus bengalensis bengalensis*, the Smaller Crested Tern.—Common at Marichchukaddi.

323. *?Phalacrocorax carbo sinensis*, the Indian Large Cormorant.—A flock of cormorants, probably of this species, was seen from the ss. 'Nautilus' flying towards land from the Shoal-buoy position.

325. *Phalacrocorax niger*, the Little Cormorant.—Common on the swamp at Marai Villu and at Kali Villu, &c.

326. *Anhinga melanogaster*, the Snake-bird.—Seen at Marichchukaddi tank, south of the Modregam Ar.

329. *?Phaethon lepturus lepturus*, the White Tropic Bird.—A pair of Tropic birds visited the ss. 'Nautilus' on the morning of 9.iii.33 and were observed with glasses as they flew round the ship in the neighbourhood of the Shoal Buoy position. They were most likely of this species but identification was complicated by the fact that their long tail feathers appeared to have been recently moulted and the new ones were quite short—in one specimen hardly longer than the rest of the tail, in the other, projecting a few inches. Unfortunately it was not possible to procure one of them by shooting.

335. *Threskiornis melanocephalus*, the White Ibis.—One or two seen at the small tank, south of the Modregam Ar, at Marichchukaddi.

339. *Dissoura episcopa episcopa*, the White-necked Stork.—Seen at Periya Naga Villu.

341. *Leptoptilos javanicus*, the Smaller Adjutant.—A pair was seen at Periya Naga Villu and watched with glasses.

343. *Anastomus oscitans*, the Open-bill.—Flocks seen at Marichchukaddi and Periya Naga Villu.

344. *Ardea purpurea manillensis*, the Eastern Purple Heron.—Seen at Māil Villu.

347. *Egretta alba modesta*, the Eastern Large Egret.—Seen at several of the villus. Other Egrets were seen but not definitely identified.

352. *Ardeola grayii*, the Pond Heron.—Common at every pool or swamp.

353. *Butorides striatus javanicus*, the Little Green Bittern.—One seen amongst mangroves on the Modregam Ar.

354. *Nycticorax nycticorax nycticorax*, the Night-Heron.—Seen at Marichchukaddi.

363. *Dendrocygna javanica*, the Whistling Teal.—Flocks seen at Māil Villu, Periya Naga Villu, and Kanjuran Villu.

372. *Podiceps ruficollis capensis*.—Dabchicks were numerous on Marai Villu and other swamps. They spent a lot of time chasing each other and scuttering along the surface, and appeared to be courting and nest-building. As there were apparently no fish in the villu (a professional fisherman was taken from Marichchukaddi for the purpose of collecting villu fish, but his efforts with a visi-del (throwing-net) proved quite abortive), their food is a mystery unless they contented themselves with insect larvae.

G. M. Henry.

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# Nature's Workshop in Ceylon. *

This world's no blot for us,
Nor blank; it means intensely and means good;
To find its meaning is my meat and drink.

*R. Browning. Fra Lippo Lippi.*

My subject is really too comprehensive to be compressed into the limits of a single lecture. Any adequate treatment of the theme in its entirety would require a large volume and demand more knowledge than an amateur such as myself can possess. All that I can do is to give a fragmentary sketch of a few aspects; but my object is to present some idea of the significance of what an older generation would have called the ' manifold gifts of nature ' spread before our eyes.

Visitors to Ceylon are never weary of praising the splendours of our scenery, the luxuriance of our vegetation and the gorgeousness and variety of our birds and butterflies. Too few of us, I fear, who live here reflect that the same forces of nature which have carved our hills and valleys are responsible for the variety and the distribution of our fauna and flora; and, further, that these forces are at work to-day, as they have worked in the past. Every living thing is acted on by, and reacts to its environment : and by environment is meant the sum total, not only of its relations to inanimate surroundings, but of all contacts direct or indirect with its living neighbours. Unless they have some acquaintance with the biological sciences, few people consider the intricacies of this web of life, or the far-reaching manner in which one living organism may be affected by others.

Occasional, outstanding instances are familiar to the man in the street. Everyone nowadays is aware of the connexion between plague and rats, or beween malaria and anopheline mosquitoes, and there is the famous instance, quoted by Darwin in his ' Origin of Species ', of the indirect influence of cats on the red-clover crop in some parts of England.

The complex web of life and its equally complex inanimate environment do not stand still, but, acting and reacting on each other, change slowly from age to age. Since the publication of Darwin's ' Origin of Species ' gave a new direction to the outlook of modern biology, biologists all over the world have been studying this marvellous web of life, as it exists to-day, in the endeavour to gain understanding of the causes and processes which have brought it into being and which are still shaping its evolution. I hope to show in the course of my lecture that in all branches of Natural History Ceylon affords rich and most significant material for such studies, and that there are wonderful opportunities open to any research worker in Ceylon who has the ability to master his subject, and to utilize his knowledge with insight and understanding.

A recent writer[1] has well said that the pageant of evolution of living things is the accompaniment of the evolution of the earth's surface, and in order to gain some idea of how our present fauna and flora came into Ceylon, and to explain the local distribution of the various types and forms, we must first glance at the geological history of this Island of ours.

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* (Paper read before the Royal Asiatic Society, Ceylon Branch, 20th October, 1932.)

At first sight our geological record appears decidedly meagre. Most of the strata in Ceylon belong to the Archaean period—the oldest rocks in the world. Wherever they occur these rocks always underlie the younger fossiliferous strata. Nowhere in the world are they found stretched out smooth and flat as they must have lain when they were first deposited. It is probable that most of them were originally sedimentary rocks, but everywhere they have been twisted and contorted by movements of the earth's crust. Heat and pressure have metamorphosed their internal mineralogical composition into a crystalline structure.

If they could be spread out once more into their original horizontal position they would form a pile many, many thousands of feet in depth. They must have accumulated throughout untold ages, but as they contain no fossils one cannot date their relative position in the Archaean era with any certainty. Some of the oldest series may have been deposited before there was any life on earth, but in the period covered by the later series lowly organisms must have existed, though not in forms containing hard parts which could be preserved as fossils.

From the time when these very ancient strata were formed, our rock record, with one fragmentary exception, is an absolute blank, until we reach strata, which are, geologically speaking. comparatively recent. We have practically no sedimentary, fossil-bearing strata, such as are found in England, to record the evolution of life from the early invertebrates of the Cambrian series; the fishes, amphibians and insects which flourished in carboniferous times; the great development of dinosaurian reptiles and the primitive mammals and birds of the geological middle ages, down to the rise of more specialized mammals and birds in the tertiary period.

Geological time can be measured only vaguely, but a rough idea may be given by the following illustration. If we represent the tremendous age of the earth by a period of 100 units—each unit covering anything from one million to three million years or more of real time—then the Archaean era would occupy about 50 units, or half of the total; the Palaeozoic era would represent about 30 units; the Mesozoic about 15; and the Tertiary ages about 5. The period covered by civilization, which may be said to have started about 5000 B.C., would occupy considerably less than one hundredth part of a unit, and the first appearance of palaeolithic man would date back to about one-twelfth, or at most one-sixth of a unit ago.

Still keeping to this imaginary scale we may say that the Archaean rocks of Ceylon range over a period between 50 and 100 units ago. Our record is then blank until we find a small patch of sandstone and limestone rocks at Tabbowa in the Puttalam District, laid down at the bottom of a fresh water lake during the Jurassic period, about 12 to 15 units ago. Then there is another great blank until we come to a broad belt of limestone rocks of the Miocene age covering the north of the Island, down to a line which runs south-west from a point a little south of Mullaittivu to a point a little north of Puttalam. These strata were laid down at the bottom of a shallow, calm sea about one unit ago on our imaginary scale, or somewhere about two million years ago in real time. The Miocene period was the golden age of mammals and it was probably at this time that the primitive humanoid stock began to diverge from the ancestors of the anthropoid apes. The Miocene strata of the north of Ceylon, however, are marine sandstones and limestones and as yet have not yielded any terrestrial fossils.

So far, this does not give us much evidence on which to reconstruct our geological history. If, however, you look at a map of the Indian Ocean which shows the depth contours, it is quite evident that Ceylon must be considered as part of the same continental shelf as the Indian Peninsula. A belt of very shallow sea, about 120 miles from end to end, stretches between the north-west of the Island and the coast of South India. All round the rest of the Island the 100-fathom line lies at an average distance of only 12 miles from the coast. From this line the sea-bed descends rapidly to oceanic depths, and the 1,000-fathom line lies very little further out. If the sea suddenly sank 6,000 feet the Gulf of Mannar would still extend to a point a little north of Colombo. The 2,000 fathom line would exclude the whole of the gulf, but off the coast from Galle round to Trincomalee it lies only about 100 miles from the shore. On the other hand, very small alternations in the sea-level along the shallow belt in the north-west would transform Ceylon, now into part of the mainland, or again into an Island.

As I shall show later, in the more recent geological periods we can trace, and date with some certainty, several such movements; but the nature of our rocks and of our fauna and flora confirms the view that, geologically speaking, Ceylon is an adjunct of the neighbouring mainland. The Archaean rocks which occur here are of the same age and composition as the great block which forms the bulk of the Indian Peninsula. This block is one of the oldest land surfaces in the world. Until Tertiary times it was bounded on the north by a wide, though comparatively shallow sea, which probably extended eastwards from the Mediterranean right across Asia and which lay over the area now occupied by the Himalayas and their subsidiary ranges.

From the fossil remains found in South and Central India, Madagascar, South and East Africa and West Australia, it is evident that all these regions were once connected by land, and that in earlier ages the present Indian Peninsula, including Ceylon, formed part of a great Southern Continent, known to geologists as Gondwanaland. There are several theories to account for the disappearance of this continent. One school holds that the greater part of it foundered bodily at several intervals between the Jurassic period and the close of the Cretaceous. Another, newer theory, which fits in extraordinarily well with the known facts of Indian geology, but which raises considerable difficulties in other ways, holds that there was no foundering, but that the component parts of Gondwanaland were ruptured by great rifts in the earth's crust, and have slowly drifted apart from each other to occupy their present positions. A drift of a yard a year would be amply sufficient.

To return to Ceylon : The absence of all sedimentary rocks over the main surface shows that, since the Archaean age, for the greater part of the time our Island has been a land-surface. The amount of contortion and folding to which our ancient metamorphic rocks have been subjected, and the occurrence among them of rocks of igneous origin, can only mean that in early geological times there were great and violent earth movements, possibly of a world-wide nature; but these cataclysmic movements all died down aeons ago. Since then there have been great alterations in the sea-level; but the movements have been more gradual and mostly in an upward direction. The whole land surface has slowly risen, and as it rose has been subjected to the forces of denudation. Our mountains have not been elevated into ranges by violent upheavals and contortions of the earth's surface; they are the remnants of ancient plateaux, of which the greater part has been carved away by rain, wind and sun acting through untold ages. The process of elevation has probably been infinitely gradual; at times interrupted by long halts, or even downward movements; but on the whole elevation has predominated.

The most ancient plateau of Ceylon stands at a horizon which is now about 6,000 feet above sea-level. A small fragment of it still remains round about Nuwara Eliya and Pattipola, while broken-down remnants cover the area from Namunakuli and the Uva basin to the hills around Kandy, and in East Matale and Dumbara.

It was a plain of denudation on a level approximating to the sea-level of that far-off time. One may picture it as a plain,—such as now extends over the northern half of the Island,—where the main surface had been worn down by ages of weathering, while harder fragments still stood out as isolated hills. Although little above sea-level, this plain may have existed as a land surface right across to the present hills of South India.

After long ages elevation again set in and continued, probably infinitely slowly, until after more long ages there was another great halt at a sea-level, now about 1,500 feet above the sea. The remains of this plain are more extensive. They are most clearly traced in the level stretches round Kandy and Gampola, and in the shelf below Haputale and Haldummulla, which can be viewed very plainly from Haputale Pass. The lesser hills scattered over the low-country are evidence that this plain must have extended, at any rate, on the west and south of the Island, to a line not far short of the present coast. Equally clear evidence of this extension is revealed by the formation of the valleys of the larger rivers, such as the Kelani and Kalu-ganga. River courses are frequently of great geological age, and it is clear that in the days of the '1,500-foot' plain these rivers flowed to the sea across that plain, in beds which were many hundred feet above their present level. When elevation set in once more the greater part of this '1,500-foot' plain was gradually worn down to nearly the level of the present coastal plain. Ridges of the more resistant rocks have withstood aerial denudation and now stand out as long, low ranges; but where these ridges cross the main river valleys the rocks were not able to withstand the erosion of running water in the bed of the river, and consequently the rivers now cut through the ridges instead of having to flow round them. This is exemplified by the gorge of the Kalu-ganga near Nambapane and of the Kelani above Hadduwa. The same phenomenon is not unfrequent in many other parts of the world.

You can follow very clearly the description which I have just given if you study the large scale relief map of Ceylon shown in the Colombo Museum, or the Surveyor-General's Office.

Unfortunately, we have as yet discovered no material, in Ceylon itself, enabling us to date the periods at which these two plateaux were formed, or to determine whether, when they were formed, Ceylon existed as an island or as part of the Indian Peninsula. The small remains of Jurassic rocks at Tabbowa,[2] which were mentioned earlier in my paper, do not lie undisturbed *in situ*. They are faulted into the surrounding Archaean strata. That is, there has been a slip in the earth's crust at this spot and this small fragment of Jurassic age has slipped downwards into a position between much older rocks, so that we cannot tell whether it was deposited before or after the time when the coastal plain stood at the 6,000-foot, or even at the 1,500-foot level.

A comparative study of South Indian geology may reveal the existence of these two levels on the flanks of the South Indian hills, in areas where it will be possible to date their occurrence. All we can say at present is, that the '6,000-foot' plain is of very great age, and the '1,500-foot' plain, though much younger, is of respectable antiquity. Even the present coastal plain is of considerable age, as it must have come into existence before the Miocene limestone strata in the north of the Island were deposited.

Early in Miocene times, or at the close of the Oligocene, the existing coastal plain sagged below sea-level and these limestones were laid down on top of it on the floor of a still, though probably shallow sea. There are small patches of similar Miocene rocks near the coast in the Hambantota District, showing that the depression must have been general all round the Island. Ceylon must then have been cut off from India for a considerable time, as these limestones in places appear to reach a thickness of several hundred feet.

This is the first stage in our geological history at which we can definitely say that Ceylon was an island. If it had remained as an island ever since we should have possessed a fauna and flora as distinct as those of Madagascar, representing in the main older types of Miocene or Pre-Miocene ages, which might have thrown more light on the earlier vicissitudes of our geological history. As it is, only isolated relics of this older fauna and flora exist, chiefly among the lowlier and less highly developed forms, to give us scattered hints of our past record.

For the Pliocene age, which succeeded the Miocene, we have no very definite evidence, but during this period subsidence appears to have been checked and the level of the land gradually rose; as when we come to Pleistocene times we have very clear indications that there was a land bridge between South India and Ceylon. There are two main features of the Pleistocene period which are of great significance. It was a period of pronounced cold, at any rate in the Northern Hemisphere. The climate was far more severe than in the Pliocene which preceded, or the present age which succeeded it. Great ice-fields, like those in the Polar regions, covered a large part of northern Europe and Asia, while the snow-fields and glaciers of the Himalayas were far more extensive and reached much lower elevations than at the present day. Secondly, it was during the onset of this Great Ice Age that traces of palaeolithic man became generally evident.

Here in the Tropics, of course, we find no traces of glaciation during the Pleistocene age, but Mr. Wayland, who was at one time Assistant Mineral Surveyor in Ceylon, and who was also a keen physical geologist, has clearly proved from a study of the gravels and sand deposits of our northern forest-tract, that these gravels were laid down at a time of intense rainfall and that with them are associated early palaeolithic implements. His paper, entitled 'The Stone Ages of Ceylon' is published in Volume XI. of Spolia Zeylanica, Part 41, page 85.

This evidence shows that the onset of the Great Ice Age made itself felt in Ceylon by a long period of exceedingly heavy rainfall and comparatively low temperature. The general change in climate came on slowly, but was very marked in its effect on the fauna and flora of the world. A very large proportion of Pliocene types gradually faded out. It was only the hardier and more vigorous types which survived and in their turn gave rise to modern species.

The onset of the Ice Age would also have set on foot a general migration southwards, wherever possible, of more northerly forms. Ceylon lying on the south of the great Indian Peninsula was in a position to receive this invasion from the north, and the presence of early palaeolithic man among the invading forms undoubtedly means that Ceylon was then joined to South India by a land-bridge; as it was scarcely possible that the human race of the time had attained any knowledge of navigation, or was able to construct even the rudest boat.

The results of the invasion can easily be imagined. The older, insular fauna and flora of Ceylon, which had been isolated in Miocene and earlier Pliocene times, would be adversely affected by the great change in climate. For them there was no possible retreat. They had to stay where they were and compete, in the struggle for existence, on unfavourable terms with the more vigorous invaders from the north.

Consequently, among the higher vertebrates, certainly among the birds, the older forms have been almost entirely swept away. Among the lowlier vertebrates, such as the snakes and fresh-water fishes, and among the invertebrates there are more evidences of survivals from earlier times, and I have no doubt that there are many survivals among our flora; but in the main the fauna and flora, especially in the wet zone, are the descendants of the Pleistocene invaders from India.

By the close of the Ice Age, when the climate had begun to grow drier and warmer, Ceylon appears once more to have become separated from South India, so that re-migration northwards was impossible. Among such of our birds as possess no great powers of flight, there are several endemic species—that is species peculiar to the Island—whose nearest relatives are not found at the present day southwards of the Himalayas.[3]

When the climate grew warmer their South Indian brethren were able to migrate northwards once more, but the Ceylon forms were trapped, and have retreated to the wetter parts of the hill districts.

Quite recently, perhaps about 10,000 to 15,000 years ago, when the climate had approximated to modern conditions the land once more rose. For a short time Ceylon was again united to South India, and a second invasion took place, of forms which had peopled the dry plains of South-East India, into the dry zone of Ceylon.

The endemic species in Ceylon are nearly all inhabitants of the wet zone. The more recent invaders of the dry zone have not yet had time to differentiate to any appreciable extent from their representatives in South India.

The last phase in our geological history was a slow sinking of the land surface which has cut us off once again. This subsidence began, probably, almost in historic times and appears to be still continuing.

Our more recent geological history thus furnishes an explanation of how the main part of our fauna and flora came to inhabit the island. The forms found in the wet zone are closely related to the fauna and flora of the wetter, Malabar districts of South India, while among them are a few Himalayan forms. These are all descended from the Pleistocene invaders. The dry zone forms correspond even more closely with the fauna and flora of the drier, Coromandel sub-region of South India and represent a still more recent influx.

A word may be said about the survivals from earlier times. An account of some of these will be found in a paper by Dr. Willey, ' The Constitution of the Fauna of Ceylon ',—the first article in Volume I of Spolia Zeylanica.

There is a distinct Malayan affinity in a few of our species. It is possible that some of these, for instance Bligh's Whistling Thrush,—*Arrenga blighi*—and the Red-faced Malkoha—*Phoenicophaus pyrrhocephalus*—among our birds, are merely relics of the Pleistocene invasion. The ancestral stock may have originated in the north, and at the onset of the Ice Age some of the members may have migrated directly south through the Indian Peninsula into Ceylon, while others moved south-east into Malaya.

On the other hand among our forest trees there is a large family, known as the Dipterocarps, to which belong such well known species as Hora, Mendora, and the various Duns. The family is also well represented in Northern and Central India, Burma, and Malaya; but scarcely any species are common to any two of these countries. The very high percentage of endemic species in all these sub-regions points to considerable age and to differentiation which probably goes back to a period earlier than the Pleistocene.

Again, there are a few vertebrate forms, such as the Slender Loris and the Chameleon, which show affinity with African, and especially Madagascan types. The Loris is the sole representative in Ceylon and South India of the Lemurs. At the present day Madagascar is the headquarters of the *Lemuridae*—over 30 species occurring there—while few are found elsewhere, and only in India, South-East Asia and parts of Africa. We know, however, from fossils, that in earlier Tertiary times ancestral types of Lemurs occurred in Europe and North America, and it is barely possible that our Loris is a survival from northern and not from African ancestors. On the other hand the Chameleon appears to have sprung from an origin distinctively African.

The Australian elements in our fauna are confined to lowlier forms, such as certain earth-worms and snails, and take us right back to the lost continent of Gondwana-land, which was broken up in the Mesozoic era.

A comparative study of our flora with that of neighbouring regions may possibly throw more light on the significance of these earlier survivals.

To sum up: Age-long denudation has carved our hills and valleys and levelled our plains, while in recent geological times comparatively minor oscillations of the sea-level, combined with sweeping climatic changes, have peopled the island with a fauna and flora derived, on two distinct occasions, from the neighbouring continent. Survivals from earlier periods exists, chiefly among the lower vertebrates, the invertebrates, and, perhaps to a greater degree, among some orders of our flora.

Again, the land surface of the island ranges from sea-level to an elevation of 8,000 feet, while the rainfall varies from under 40 inches a year in parts of the dry zone to over 200 inches in the wettest areas. Owing to this diversity of conditions, we possess in every branch of natural history a great variety of forms. From their ancestry, their profusion, and above all from their present isolated, insular position our fauna and flora are full of significance, and offer a rich field to any research-worker who is endeavouring to throw light on the processes by which evolution is effected.

But before I can explain their significance I shall first have to attempt the extremely difficult task of giving a short and simple resumé of the theories which hold the field to-day in the study of evolution.

As all know, it was the publication of the ideas held by Darwin and Wallace which caused the theory of evolution to be accepted by the scientific world; but, as Sir Arthur Thomson[4] has remarked, 'it would be a terrible contradiction in terms if a theory of evoluation did not itself evolve'. It says much for the genius and insight with which Darwin interpreted the vast array of facts collected by him that so much of his original theory still stands four-square. The grand fact of evolution and all that it implies has been demonstrated beyond cavil, but there are still great differences of opinion regarding the processes which bring into being the variations, which in their turn form the basis of evolutionary progress. To quote again from Sir Arthur Thomson,[5] 'the question before us is this; what, as regards the factors in evolution, have been the changes since Darwin's day?'

Darwin's own theory may very roughly be expressed as follows:—Variability is a fact of life, and individuals that have varied in a profitable way will succeed better than those which have not varied, or have varied in the opposite direction. If these profitable variations can be handed on by heredity their type will come to be the type of the race, whereas unprofitable variations will be weeded out by natural selection. There will be a survival of the fittest in the struggle for existence.

This struggle for existence must be interpreted in the widest sense. It is not merely an internecine competition. The struggle includes every reaction by which the organism seeks to overcome the difficulties of its environment. Success may be achieved by mutual aid and interdependence, as well as by direct competition; or it may be effected by an adaptive response to changing conditions. 'The process of evolution is a long drawn out process of testing all things and holding fast that which is good. The variations are the qualities which are to be tested, the struggle for existence, which includes the organism's endeavours, is the sieve which tests; heredity secures the holding fast of that which is good '[6].

Darwin himself said that our ignorance of the laws of variation is profound. He rejected to a very great extent the idea, held a generation before his time by Lamarck, that characteristics acquired during the life-time of the individual could be passed on by inheritance; and though he was much interested in ' sports ', or sudden mutations, he thought that these would be swamped by inter-crossing. His own general idea was that the offspring of every parent organism varied slightly and fortuitously in different directions. Certain of these variants would be slightly more suitable to their environment than others. ' Natural selection ' would favour these, and by directly or indirectly eliminating all variations except those which continued in the most favourable direction, it would in the course of time produce changes which would be large enough to be considered specific. In other words he looked upon ' natural selection ' as a directing factor of change and not only as a standardizing sieve which would eliminate obviously unfavourable variations.

Weismann, the great exponent of Neo-Darwinism further undermined any facile acceptance of the idea that acquired characteristics could be directly inherited. In his researches on the germ-plasm he demonstrated that the germ-cells which give rise to the next generation are set apart within the body at an early stage in the development of the individual. The individual is merely the host which passes on from generation to generation the hereditary characteristics bound up within the germ.

The next great contribution came from the Mutationists, whose work was heralded by the publication in 1901 of ' The Mutation Theory ' by de Vries. They showed that many large variations, or ' sports ',—for instance, certain forms of albinos—were heritable. Their theories were further confirmed by the rediscovery of the paper published by Mendel nearly half a century earlier. Mendel by his experiments had conclusively proved that distinctive characters were often inherited in their entirety and need not be swamped by intercrossing. His discoveries have revolutionized the breeding of domestic plants and animals. The earlier work of de Vries and Bateson has been followed up and confirmed by an immense amount of experiments on the breeding of various plants, animals, and insects, and by detailed microscopical research on the structure of germ-cells and of the fertilized ovum, or zygote.

The mutations which crop up in the course of new breeding experiments appear to be fortuitous. They just happen. One cannot predict them, but when they occur they frequently come to stay and are transmissible.

On the other hand, for some years field naturalists and palaeontologists have been imbued with the idea of what is termed orthogenesis. The results of their studies appear to point to an increasing purpose which often seems to run in one definite direction through successive generations, and a great deal of evolution has probably been brought about by some process of accumulation of variations which are not necessarily adaptations to their environment.

Pycraft in his book on ' Camouflage in Nature ' shows that in certain families of birds, such as Kingfishers and Swallows, there seems to be an innate tendency to an intensification of colour. The ancestral form, still represented by existing species, was a comparatively dull bird. From this ancestral form various groups of species have developed more and more vivid hues. As Pycraft points out the change does not seem due to environment. The conditions of the environment of all species of swallow are singularly uniform. Nor can it be said that the more vivid hues are favourable variations, in the Darwinian sense. Yet we get in the same area different species in which the colour schemes are vividly contrasted. The tendency to change, however, is not chaotic, but rhythmical, and pursues an orderly sequence.

On the other hand, in many instances environment does seem to be a potent factor in causing change, often by degrees which are too imperceptible to be classed as mutations. Take, for instance, a specimen of the Ceylon race of the Red-vented Bulbul—the kondé kurulla, *Molpastes haemorrhous*—and compare it with a specimen of the same species from the foothills of the Himalayas. There are obvious differences in size and plumage, and thirty years ago the two races were considered to be different species. Yet if you trace this bulbul down through the wide tract which separates the Himalayas from Ceylon you will find that one geographical race grades insensibly into the next; there are no sudden mutations. The same is true of scores of Indian species which are found over a wide geographical range.

Here again there seems to be an orderly, rhythmical sequence of change. Physiological research on the properties of the 'hormones' or secretions of the ductless glands, in human beings and certain mammals and birds appears to throw some light on the problem. These hormones affect the circulation and so influence the whole body. Those of the thyroid and pituitary glands in human beings stimulate or retard growth and development. In birds the action of the hormones of the sexual glands makes itself manifest in the development of the nuptial plumage at the approach of the breeding season. A gradual change of environment may in some way affect the ductless glands and their hormones. The hormones in turn acting throughout the body may exercise a deep saturating influence, which, if repeated steadily through successive generations, will in course of time affect the germinal cells and so induce slow variation.

To sum up the situation: it will be seen that since Darwin's time further rays of light have been thrown on the processes by which evolution is effected. Variation is not so fortuitous as Darwin imagined, nor does natural selection play such an important part as he thought, as a directive factor in evolution. The work of the mutationists and followers of Mendel has shown that brusque mutations do occur and are transmissible; and further that the inheritance from generation to generation is bound up in the germ. When variation occurs it must originate and be expressed in the germ-cells, which are not lightly affected by characteristics acquired during the life-time of the individual. The blacksmith does not directly transmit to his children the specialized muscles developed by his calling.

It is generally agreed that, as an eliminating sieve, natural selection acts as effectively as Darwin taught; but so long as a variation does not definitely handicap the organism, it will not be eliminated. If the new character is definitely a handicap a mutation will not survive. Albinism is a very wide-spread heritable mutation, but in undomesticated species it seldom persists. An albino jungle-fowl chick, for instance, would seldom have a chance of surviving to maturity and so of being able to pass on its character to the next generation.

Field naturalists fully recognize the work of the mutationists and Mendelists. They admit that some brusque mutations do occur in nature. Great advances in evolution, such as the rise of birds and mammals from ancestral reptilian stocks, were probably due to such mutations.

On the other hand a large amount of variation in nature does seem to be extremely gradual—as mentioned above in the instance of the Red-vented Bulbul—and not by clear-cut stages. Again, while the mutations which occur in the course of breeding experiments appear to be almost as fortuitous as the slight variations which Darwin looked upon as a basis of change, the progress of evolution in wild nature often seems to proceed in a definite continuous direction, not imposed by the environment, but innate.

In the laboratory, the nursery-garden, or the breeding-pen, the experimenter cannot reproduce the intricate background of nature; the slow influence of changes in the natural environment, the constant jostle with neighbours, friendly or hostile, and the struggle to overcome the difficulties of its surroundings, by which every organism in a state of nature is tested, and which it must successfully face if it is to survive and pass on its inheritance. In many cases the subjects of breeding experiments have to be isolated as carefully as possible. It is probably for this reason that hard-shell mutationists are apt to attach too much weight to brusque mutations as the main directive factor in evolution.

To quote once more from the recent writer mentioned in the earlier part of my lecture: 'We may claim a growing recognition, not indeed for the bare Lamarckian idea that effects of use and disuse are directly passed on to descendants as such, but for the subtler idea that the organism, especially during growth, is very sensitive to change, and that the adjustments made in it somehow affect not only their possessor but also his descendants.'

Now that we have learnt when and whence our fauna and flora came to inhabit Ceylon, and have taken a hasty glance at the problems connected with the study of evolutionary progress, we are in a position to estimate the significance of that fauna and flora to students of evolution.

Ceylon is in fact a most interesting corner of nature's workshop. Within the comparatively small compass of the Island the inorganic background of climate and physical surroundings varies to an extraordinary degree, from the parched, coastal plains of Mannar and Hambantota, to the dripping hill-jungles round the higher reaches of the Kelani and Kalu-ganga, or the cool heights of Nuwara Eliya and the Horton Plains. Yet, with all this internal diversity, owing to our position near the equator the broad seasonal aspects of our climate are distinct from those in temperate regions where the difference between summer and winter is so strongly contrasted.

The wide range of temperature and rainfall in various parts of the Island has afforded room for a web of life sufficiently rich and varied in all its branches as to present, within handy limits, an adequately wide field for investigation. There are for instance about 375 species or subspecies of birds, and nearly 90 species of snakes on the Ceylon list.

In India, the only large land-surface which adjoins us, the fauna and flora have been catalogued and described, with fair completeness, in publications which are generally easy of access; so that a comparative study with Indian forms is not difficult. Our fauna and flora are sufficiently closely connected to make such comparative study of great value. At the same time the differences are sufficiently marked for us to perceive and estimate the influence of an isolated, insular environment in the differentiation of species.

Looking at the question all round, I do not think that there is any region of the world better situated for the examination of theories elaborated as the result of experiments in the laboratory, or of investigations in temperate climates. The intricate background of nature and the web of life are focussed within the confines of the Island. They are not the same as elsewhere, so that we are able to view problems and theories from a different angle, a fact which may prove of the greatest value.

May I give one or two illustrations in ornithology, the only branch of Natural History in which I can lay any claim to intimate knowledge? My instances are connected with the seasonal rhythm which manifests itself in breeding and migration.

In birds, the gonads—the sexual organs—become more fully developed at the approach of the breeding season. In temperate regions breeding activity reaches a maximum, and with migrants migration takes place with great regularity in the springtime. The migrating impulse seems to be closely connected with the breeding impulse. What timing agent is responsible for this regularity, this seasonal impulse in the life of the bird?

Some extremely interesting work has been done on this subject by a Canadian Professor—W. Rowan[8]. He experimented in winter on captive individuals of certain species of junco and crow which breed in Canada and winter several hundred miles southward, but still within the temperate zone. By subjecting his captives to increasing periods of artificial light, or even by keeping them awake for progressively longer periods each day without artificial light, he found that their gonads were stimulated, and drew the following conclusions: that the gonads are annually reactivated with the lengthening daylight in spring; that in migrants the state of the gonads is intimately connected with the impulse to migrate; so that the date of migration is ultimately determined by the variation in the duration of daylight.

Another Ornithologist, in East Africa—R. E. Moreau[9]—points out that though these inferences carry conviction for birds whose lives are passed in northern temperate regions, conditions in the tropics are so different that here the periodicity cannot be accounted for by the stimulus of increasing daylight. Want of time prevents me from discussing his paper at any length, but he observes that, in the tropics, periodicity in breeding is influenced by those conditions of climate and food supply which suit best each particular species.

This is a conclusion which I myself reached many years ago when considering the diversity of breeding seasons in the dry zone of Ceylon[10]. There, most of the birds which nest in trees or bushes breed during the rainy north-east monsoon, when the jungle is fresh and green. On the other hand, birds which nest on the ground would have their nests drowned out, at that season, by the torrential rains; so they breed during the dry period of the south-west monsoon. Further, the north-east rains do not arrive with quite the same regularity as do the lengthening days in higher latitudes, and if the rains are late the north-east breeding season is correspondingly deferred. Again, I have found that, in the dry zone, if an unwonted spell of rain occurs during the south-west monsoon to freshen up the jungle, some individuals of certain species which usually breed in the wet season, will start nesting once more. In the wet zone, some or other individuals of these species may be found breeding throughout a great part of the year.

This change in the seasonal rhythm of the bird does seem, in some species, to be causing slow differentiation. There are certain small Warblers—among them our Tailor-bird—*Orthotomus sutorius*—which range from North India to Ceylon. In Northern India, where there is a distinct winter and spring, these warblers breed mainly during May, June, and July. Their summer plumage is marked by a longer tail, and in some species by a less fulvous tone than the winter dress.

In Ceylon, a more extended breeding season, in other words a less-sharply defined seasonal breeding impulse, appears to have weakened the difference between the winter and breeding plumage in birds of the Ceylon races.

Again, in the tropics we find. under present conditions distinct traces of a slow breaking down of the migratory habit. Certain individuals of a good many migrant species may be found loitering in Ceylon during the south-west monsoon, instead of departing northwards[11]. Most of these loiterers appear to be yearling birds, which for some reason have not attained full maturity, nor acquired the full breeding plumage: a fact which strengthens the view that the migratory and breeding impulses are closely connected.

In certain cases the migratory habit has broken down still further, and in such species as the Peregrine Falcon and the little Kentish Plover, alongside of a migrant subspecies which breeds in the far north and visits India and Ceylon only in the winter, we find a darker, smaller subspecies, which breeds in this Island and is resident all the year round.

Once more the change in the seasonal rhythm has induced a slow change in form.

An immense amount of work on the problems of migration has been carried out, but mainly in temperate regions; and so far as I can find, comparatively little attention has been paid to this habit of loitering; for the simple reason that few migrants loiter during the winter in their breeding haunts. They would be killed off by the cold if they attempted to do so.

I have no doubt that any one who is familiar with other branches of Natural History in Ceylon, and who has given any intensive study to local problems connected therewith, would be able to adduce other illustrations which would emphasize the advantage of being able to look at things from a different angle. It does afford an opportunity for catching glimpses, here and there, of the processes of evolution actually at work. One can at times

Watch
The Master work, and catch
Hints of the proper craft, tricks of the tool's true play.

There is one more aspect of my subject upon which I wish to touch. Unless any collection in a Museum has been accurately catalogued and described, its value, to students who may wish to consult it, is greatly diminished. This is equally true of the fauna and flora of any country. In Ceylon I am afraid that the work of cataloguing and description is far from complete and until it is more complete, the value to science of our fauna and flora is considerably less than it would be if the full extent of their treasures were available for reference. As I shall show, something has been done, something is being done at the present time, but there is still much to do, and more workers are required to take up this important task.

To glance first at geology: Government Mineralogists have been occupied mainly with the mineralogy and petrology of the Island and only incidentally with our physical geology. The first attempt at a connected account of our geological history is given in a pamphlet entitled 'The Geology of Ceylon', published in 1929 by Dr. Adams of the McGill University, Canada. This treatise is by no means exhaustive. It is based partly on two visits paid by the author to Ceylon and partly on various papers in scientific journals, notably the Administration Reports of Dr. Coomaraswamy and several very interesting articles in Spolia Zeylanica by Mr. Wayland. I have already made special reference to one of Mr. Wayland's papers, and the rest of my remarks on our earlier geological history owe much to Dr. Adams' treatise. A copy of it is on record in the Museum Library and should be consulted by those who wish to pursue the subject further. There is no doubt that the geological history of Ceylon holds out a most fascinating, though enigmatical prospect for further research.

The study of botany received attention even in earlier Dutch days, and the first works on the subject were published by Hermann in 1717 and Burmann in 1737. Hermann's collection of plants was taken to Europe, and, to the lasting benefit of botanical science, fell into the hands of Linnaeus, the father of botanical and zoological classification. Linnaeus' 'Flora Zeylanica', one of his earlier works, was published in 1747. Hermann's collection, after many vicissitudes, now rests in the British Museum. In English times the previous work of Moon and Thwaites was incorporated in the five volumes of Trimen's Flora, which appeared between 1893 and 1899. A supplementary sixth volume was brought out by Mr. Alston last year, so that the descriptive catalogue of our flora is fairly complete and up-to date.

Turning to our fauna, the great series of volumes published by the Government of India on 'The Fauna of British India' includes Ceylon in its field of survey. As I have already mentioned, these volumes are of great value for purposes of reference and comparative study, but the references to Ceylon in many cases are by no means complete, and frequently do not give the distribution within the Island, a point which is often of considerable importance. For purposes of accurate local information they require to be supplemented by Manuals which give a more comprehensive survey of our Ceylon forms.

Pioneer work on our mammals, as on other classes of vertebrates, falls to the credit of a Ceylonese, Dr. Kelaart, who published his 'Prodromus Faunae Zeylanicae' in 1852, after discovering many new species. Little original work was done locally between his time and the present century. Many of our most interesting mammals are found among the bats, the insectivores and the rodents. The proportion of endemic forms in these orders is comparatively high, but being, in the main nocturnal animals they have to be sought for in their haunts by trained observers and collectors. Since the war Mr. W. W. A. Phillips has taken up this work with enthusiasm. With the aid of other collectors and observers he has gathered much new material and is engaged in describing our Mammalia in a volume planned on the same lines as my 'Manual of the Birds of Ceylon'. It is hoped that before long it will be ready for publication.

As in most countries, birds have received more attention than any other vertebrates. Kelaart's 'Prodromus' includes a mere sketch of our ornithology, but early workers such as Templeton, Layard, Holdsworth, Bligh, and Kelaart himself were in close touch with the earlier authors in India, Blyth and Jerdon. Legge's 'Birds of Ceylon', published in 1880, gave a most complete account of our ornithology and all work done since his time is in the nature of a supplement to his magnificent volume.

For Reptiles, Kelaart in his 'Prodromus' again claims credit for pioneer local research, though not of a very extensive nature. Since his time little local work was published or recorded, until, in 1921, Colonel Wall of the Indian Medical Service brought out a volume on the 'Snakes of Ceylon'. This is based on expert knowledge of the subject, gained in India, and on material furnished by the Colombo Museum and local collectors such as E. E. Green, Abercromby and, above all, Drummond Hay. Mr. Deraniyagala has published articles in Spolia Zeylanica on some of our lizards and turtles, and it is hoped that he will eventually give us a volume on the Reptiles of Ceylon, other than Snakes.

We look to the same writer or to Mr. Malpas for a monograph on our fresh-water fishes.

In the remaining class of vertebrates, the Amphibia—our frogs, toads and coecilians—Kelaart's published work includes a certain amount of information on Ceylon species; but, here again, since his time little local work has been recorded. Mr. Burt, of the Ceylon University College, and his assistants are interesting themselves in the subject, and it is hoped that they will in time bring out a full descriptive catalogue of our Amphibia.

As regards the vast assemblage of Invertebrates, in most classes there is an almost untrodden field. In the great class of Insecta our butterflies have been pretty fully worked out. In the early eighties Moore published a finely illustrated work on the ' Lepidoptera of Ceylon ', but much new material has been discovered since, and incorporated in Ormiston's ' Butterflies of Ceylon ', which came out in 1924. Research work of great interest could be undertaken in the investigation of female varieties, seasonal forms, mimicry and other biological problems presented by this order. E. E. Green, formerly on the staff at Peradeniya as Entomologist, has published a beautifully executed monograph on ' Ceylon Coccidae '—the scaly-bugs —a family which includes the cochineal and lac-insects. Mr. Henry of the Colombo Museum is preparing a volume on our Orthoptera—grasshoppers, stick-insects, mantises, cockroaches and their allies. Lastly Mr. H. F. Carter, Medical Entomologist, is working out the mosquitoes found in Ceylon.

In other classes of the Invertebrates even less ground has been covered. Specialists from Kelaart downwards have written at length on the Pearl Oyster, while Kelaart, again, investigated the Nudibranch Molluscs found in the sea near Trincomalee. His researches on this suborder take rank, in extent and value, with his researches on our mammals, as a pioneer contribution to the study of our fauna. The investigation of the nudibranchs found in other parts of the world has received considerable attention in recent years, and Mr. Burt, with his assistants Dr. Fernando and Mr. Kirthisinghe, is now engaged in revising and bringing up-to-date Dr. Kelaart's earlier work, which was left unfinished at his death.

Mention should also be made of two other authors, though neither of them undertook a complete survey of any special order, or class. Professor Herdman's published works include much material of high, authoritative value on our marine fauna. Dropping to a more amateur level, Mr. H. Nevill, C.C.S., in the seventies and eighties of last century interested himself in various branches of Natural History, Archaeology, Folk-lore, &c., and eventually brought out a magazine called ' The Taprobanian ', mainly written by himself, which ran from October, 1885, to June 1888, and which contains a considerable amount of useful information.

In the remainder of this enormous field there is little beyond various scattered papers in Spolia Zeylanica, though many of these are by acknowledged experts and are of great value within their necessarily limited scope. The field awaits systematic local investigation, and I hope that in good time workers will be forthcoming. There is a growing interest among the rising generation in Nature Study and Natural History. One need not be a professional scientist, to undertake the survey of any particular order. The work can be taken up as a hobby, a most fascinating hobby. I would specially bring to notice such classes as our land molluscs and earthworms. They are forms of great antiquity, and owing to their limited powers of locomotion they do not migrate—I use the term in its general, not its ornithological sense—with such ease as many insects, or the vertebrates. Consequently it is more than probable that an intensive study of our local forms would bring to light many interesting survivals from the time when Ceylon formed part of the great lost continent of which I spoke earlier in my lecture.

I would however remind would-be authors—and I speak from experience—that it is not a task which can be undertaken rashly, or completed in a hurry. You must first be sure that you possess an adequate working knowledge of the subject, and sufficient enthusiasm to carry you through. You must be prepared to make a patient and careful examination of all available material, to spare no pains in seeking out new material, and to hunt up existing references to local forms. Above all, your work must be accurate, methodical and as complete as possible. Lastly, I would advise would-be authors to be sparing in the use of technical jargon. Much of it which one meets with nowadays is quite unnecessary and can be avoided, with advantage.

And now to conclude. I hope that I have brought before you sufficient evidence to further the dawning interest taken in the study of our Natural History; to give you some idea of the significance of such study, and of the advantages which our Island affords to students who are willing to undertake research work. I am speaking to a Society which, in recent years at all events, has been mainly interested with historical and archaeological subjects. You are justly proud of our archaeological treasures. I hope the time will come when you will be, as justly, prouder still of our fauna and flora.

W. E. Wait.

October 20, 1932.

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# On the Amphipod Genus Talitrus, with a Description of a New Species from Ceylon, Talitrus (Talitropsis) topitotum, sub-gen. et sp. nov.

BY

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(With Two Plates and One Text Figure)

An amphipod of terrestrial habit found in Ceylon at Hatton, is described in this paper and given the name *Talitrus* (*Talitropsis*) *topitotum*, sub-gen. et sp. nov.

In the course of determining this amphipod, it was found that, although it fulfills all the conditions of the family Talitridae (Leach), there is no existing genus which will accommodate it. As the affinities to the genus *Talitrus* Latreille are sufficiently close not to warrant the creation of a new genus, it was thought advisable to redefine the genus *Talitrus* Latreille to include it, at the same time placing it in a new sub-genus *Talitrus* (*Talitropsis*) to indicate the differences between it and the other species of the genus. The discussion of the evidence necessitating this step is given at the beginning of this paper; it is followed by a fresh definition of *Talitrus* and of the new sub-genus, while the detailed account of the new species concludes the paper.

## DISCUSSION

The new species fulfills all the conditions required for inclusion in the Talitridae (Leach) (Orchestiidae Leach), as defined by Boeck (1872), Della Valle (1893), and Stebbing (1906). The different genera of this family, as of other families of the Amphipoda, are distinguished by comparatively small differences or trivial characters (Calman, 1909), but the characters accepted as of principal generic significance are the shapes and sizes of the first and second gnathopods in the male and female. These in themselves are diagnostic, but are taken in conjunction with the relative sizes of the antennules and antennae, the various characters of the epimera, maxillulae, maxillipeds, pleopods, uropods and telson. The most nearly related genera are those belonging to the *Talitrus-Orchestia* group, and the distinctions which separate the genera of this group may be summarized as follows:—

| | Gn. 1 ♂ | Gn. 2 ♂ | Gn. 1 ♀ | Gn. 2 ♀ |
|---|---|---|---|---|
| ***Talitrus*** **Latreille** | Simple | Feebly chelate | Simple | Feebly chelate |
| ***Orchestoidea*** **Nicolet** | ,, | Strongly subchelate | ,, | ,, |
| ***Talorchestia*** **Dana** | Subchelate | ,, | ,, | ,, |
| ***Orchestia*** **Leach** | ,, | ,, | Subchelate | ,, |
| ***Parorchestia*** **Stebbing** | ,, | ,, | ,, | Subchelate |

From the fact that *Talitrus*, *Orchestia*, and *Talorchestia* are found, not only on the shore, but inland, it can be deduced that the condition of the first and second gnathopods is not dependent on habitat. On the other hand an examination of the pleopods, among other characters, in the littoral and terrestrial forms of one genus, shows variations according to habitat, and this is what one would expect to find in a natural scheme of classification. It remains to distinguish between the characters which are modified and those which are constant under different conditions, otherwise converging species of different genera may be grouped together. As the different describers of species vary in the extent of their descriptions, and as it is not possible to have access to types, an analysis of all the characters of each species cannot be made. The descriptions available, however, show that the maxillulary palp, the terminal segment of the palp of the maxilliped, the pleopods, and the uropods vary, the most obvious difference being the reduction of the pleopods in terrestrial forms.

The new species, described below, agrees, with two exceptions, with the definition of *Talitrus* Latreille, given by Della Valle (1893). The following is Della Valle's definition, in which I have italicized the characters in which the new species differs, but it is to be noted that the number of joints in the palp of the maxilliped has been emended in later definitions.

> ‘Antenne anteriori più brevi del peduncolo delle posteriori. Mascelle anteriori con *palpo affatto rudimentale*.—Piedi mascellari col *palpo composto di soli tre articoli*. In ambedue i sessi i gnatopodi anteriori hanno la mano assottigliata all' estremo distale, e quindi non subchelata; i gnatopodi posteriori sono deboli, con la mano quasi foliacea.
>
> ‘Telson quasi intero (appena smarginato all' apice). Nella pelle esiste un apparecchio glutinifero diffuso, ma molto ricco di cellule glandolari.’

Stebbing (1906) redefined the genus, and in so doing restricted it, the characters which he added exclude the new species still farther;

he emended 'palpo affatto rudimentale' to 'palp minute, 2-jointed', and added the characters:—'Gnathopod 1 stronger than Gnathopod 2; Gnathopod 2 fifth joint expanded proximally. Peraeopod 2 with short notched finger; and marsupial plates lanceolate.' These characters, singly or in combination, exclude our species. Furthermore, Stebbing in recognizing *Talitroides* Bonnier 1898 as a distinct genus, accepted as valid generic characters, such differences in structure as one would expect in terrestrial forms as opposed to littoral forms. Calman (1912) pointed out that there was nothing wholly inconsistent in the identity of *Talitroides bonnieri* with *Talitrus aluaudi*, so that as a genus *Talitroides* ceased to exist. Another genus *Talitrator*, also possessing the characters of the gnathopods found in *Talitrus* was defined by Methuen (1913) to include *Talitrator eastwoodae*, which species was afterwards shown by Stebbing (1917) to be *Talorchestia africana* Bate, and which became *Talitrator africanus*. Later, Hunt (1925) proposed that *Talitrator* be abandoned, and redefined *Talitrus* to include all the forms of both genera which were then known. The creation of new genera, which are later shown to be unnecessary, appears to be due in part to the too-prescribed definitions of *Talitrus* by later writers, and in part to the incomplete accounts of earlier workers. The most recent diagnosis (Hunt 1925) removes some of the difficulties for the inclusion of our species. In this definition 'Maxilla 1, palp minute, 2-jointed' (Stebbing 1906) becomes 'Maxilla 1, palp minute, 1 or 2-jointed'; also, Hunt emends the 3-jointed condition of the palp of the maxilliped from 'palp, fourth joint wanting' (Stebbing) to 'palp, 3-jointed, or with rudimentary fourth joint', but he retains the character of the brood-plates as 'small, lanceolate.' 'Lanceolate' connotes lance-like, or flat, tapering to the outer extremity, which is not the shape in our species, nor in *Talitrus africanus*, which can be seen in Methuen's figure (1913, Plate X, Fig. 7).

I do not consider it justifiable to create a new genus for the reception of our species, on the slender difference between a minute and a non-existent palp, and the questionable character of the lanceolate shape of the oostegites, but, as the genus stands at present, it cannot include this form. The presence of a palp, however minute, is insisted on in previous definitions, so that I consider the best purpose would be served by placing this new species in a sub-genus of *Talitrus*, with *Talitrus* (*Talitrus*) as the typical sub-genus, and by modifying the definition of *Talitrus* to include both sub-genera.' In accordance with this view a fresh diagnosis is given of *Talitrus* based on that of Della Valle (1893).

### Genus **Talitrus** Latreille

Antennule shorter than peduncle of antenna. Maxillula with palp minute, rudimentary or absent. Maxilliped with palp of three joints, or with rudiment of fourth joint.

First gnathopod simple and second gnathopod feebly chelate in both sexes. Second gnathopod with meropodite produced postero-distally and propodite produced beyond minute dactylopodite. Telson entire, or emarginate.

The definition of the genus *Talitrus* by Hunt (1925) may then be accepted as that of the typical sub-genus *Talitrus* (*Talitrus*) in which definition I would take exception only to the description of the brood-plates as ' lanceolate ' if *Talitrus* (*Talitrus*) *africanus* is to be retained.

I propose the name *Talitrus* (*Talitropsis*) for the new sub-genus, which is distinguished by the following characters:—

### **Talitrus (Talitropsis)**, sub-gen. nov.

With the characters of the genus, and the following:—Maxillulary palp absent. Second gnathopod stronger than first gnathopod. Oostegites small, flat, distally rounded, borne on coxopodites of second gnathopod to third peraeopod inclusive. Branchiae borne on coxopodites of second gnathopod to fourth peraeopod inclusive.

The new species I name *Talitrus* (*Talitropsis*) *topitotum* after the Tamil name for Hatton—the type locality.

### **Talitrus (Talitropsis) topitotum,** sub-gen. et sp. nov.

This species was taken in Ceylon at Hatton, which is situated about 50 miles from the coast at an elevation of 4,300 ft. The specimens were obtained one night under a packing-case in a garage. The case had only been there for a few days, but as a lamp was in use in the garage at the time, I was at first in doubt as to whether the animals had been attracted to the light, or had selected the dark space under the case as approximating their natural habitat, but in using the lamp to collect specimens, I discovered that they were photophobic, and therefore assumed that they normally live in shaded parts, probably under stones. I collected about twenty specimens. A few specimens of the same species were given to me by Mr. G. M. Henry of the Colombo Museum; these were obtained a few years ago from Talawakele which is about 10 miles from Hatton, so that the occurrence is not an isolated one.

This account is based on the specimens obtained from Hatton, although they are apparently identical with those from Talawakele.

The length of mature individuals varied from 8.5 to 10 mm., the largest specimens being females carrying developing eggs although smaller mature females were also observed. They were slatey-green in colour and were extremely active.

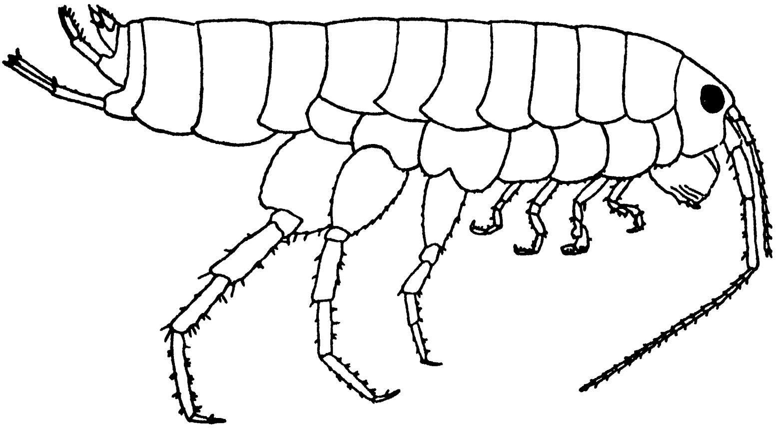

Fig. 1. *Talitrus (Talitropsis) topitotum*, sub-gen. et sp. nov. × 12

*Body* compressed, widest part being in the region of the third peraeopods.

*Head:* rostrum absent, length of visible part of cephalothorax equal to that of the first segment of the pleon. Eye oval, but almost round, black, in diameter greater than one third the length of the cephalothorax. Space between eyes equal to smaller diameter of eye.

*Antennule* (Plate XII, Fig. 1) short, almost as long as peduncle of antenna, flagellum of same length as peduncle. Peduncle of three segments of which the third is longest, followed by a flagellum of five to eight segments. Armature of two spines at antero-distal angle of each segment of flagellum, and group of four terminal spines on ultimate segment.

*Antenna* (Plate XII, Fig. 2) shorter than the peraeon, geniculate, consisting of peduncle of four apparent segments of which the first is fused with the head, and a flagellum of 16 to 22 segments. The segments of the peduncle increase progressively in length, the ultimate being one quarter as long again as the penultimate. Armature of spines on ventral surface of segments of peduncle, conspicuous spines distally close to each articulation; each segment of flagellum with circle of four spines distally.

*Labrum* (Plate XII, Fig. 3) large, distally rounded, and along this margin a row of minute setae, the setae inclining towards the centre of the margin.

*Mandibles* (Plate XII, Fig. 4): incisor process of each mandible ends in a double tooth, below which are, on the right mandible two bluntly serrated teeth, and on the left a single tooth. Lacinia mobilis present on left mandible, absent from right. Just proximal to incisor teeth are four plumose setae on left mandible and six on right. Each mandible with a strong molar process provided with rows of minute denticles, and at the corner of each molar process proximal to the plumose setae is a tuft of small plumose setae.

*Paragnatha* (Plate XII, Fig. 5) well developed; inner lobes wanting, outer lobes large and produced at postero-lateral angles into so-called mandibular processes. Outer lobes beset with fine fur-like setae along distal and inner margins, tufts of setae proximally at inner angles of lobes.

*Maxillula* (Plate XII, Fig. 6) larger than maxilla; inner endite narrow, with mesial and lateral edges nearly straight, distal margin tipped with two plumose setae; outer plate beset distally with nine dentate teeth. No vestige of a palp present.

*Maxilla* (Plate XII, Fig. 7): inner plate shorter and slightly broader than outer plate, both obliquely truncate and beset distally with slender curved spines, of which those on the inner plate are bounded internally by a conspicuous plumose spine, and those on the outer plate are fewer in number and twice as long. A few simple setae proximal to the plumose spine and on the lateral margin of the outer plate.

*Maxillipeds* (Plate XII, Fig. 8) fully developed with inner and outer plates, and a four-jointed palp in which the fourth joint is rudimentary. First joints of the appendages fused in the mid-line forming a plate broad proximally and narrow distally where margin is deeply concave. Second joints fused proximally but free distally; each bears an inner plate which extends to the distal limit of the first joint of the palp. Inner plate with straight inner margin and smooth, slightly convex, outer margin, beset distally with plumose setae and two conspicuous, short, club-shaped sense organs; on the ventral surface of the inner plates, at a distance of one quarter the length of the plate from the distal end there is a group of three simple setae. The third joint of the appendage with a prominent spine at its latero-distal margin, close to the origin of the palp, and on its inner margin bearing the outer plate which extends as far as the distal limit of the second joint of the palp. Outer plate with straight inner margin and convex outer margin, bordered with simple setae distally; two simple spines present on ventral surface of the lobe. Palp with four joints, fourth joint unguiculate but rudimentary; the proximal three joints of the palp of the same length but narrowing progressively, each with two prominent spines at latero-distal angle; third joint tipped with spines which surround and obscure the rudimentary fourth joint.

*First gnathopod* (Plate XII, Fig. 9): epimeron narrow and rounded distally, partially concealed by second epimeron, with six spines along margin. Coxopodite fused with epimeron; basipodite strong, broadening slightly distally, with a spine in the middle of the posterior surface and with a few spines distally; ischiopodite and meropodite small, mero-carpopodite articulation oblique; carpopodite with postero-distal expansion bearing prominent spines, which, in conjunction with spines on the posterior face of meropodite and propodite and with the dactylopodite form a grasping organ; propodite not expanded distally; dactylopodite small, it cannot be folded on propodite in true sub-chelate manner, *i.e.*, appendage simple.

*Second gnathopod* (Plate XII, Fig. 10): epimeron almost twice as broad as first epimeron, and almost as broad as deep, distal margin smoothly rounded, bearing nine spines, posterior margin concave. Oostegite, a narrow lamina, rounded distal margin bearing 4-6 setae. Branchia partially bilobed, of same length as coxopodite. Basipodite more robust than corresponding segment of first gnathopod; meropodite with a prominent rounded swelling postero-distally facing propodite; carpopodite with a postero-distal lobe extending laterally over base of propodite; propodite swollen and extending beyond vestigial dactylopodite; dactylopodite so small as to be functionless as a chela-forming finger. Spines present at postero-distal angles of basipodite and ischiopodite, and on antero-distal angles of carpopodite, and a double row on either side of propodite, a single spine on postero-distal swelling of meropodite.

*First peraeopod* (Plate XIII, Fig. 1): epimeron of same size as second epimeron, ventral margin beset with seven spines. Oostegite longer than basipodite, narrow flat and distal rounded margin beset with 6-18 simple setae. Branchia twisted. Peraeopod longer than second gnathopod. Basipodite a little shorter than the three succeeding segments, with four spines on anterior margin and one spine on postero-distal angle; ischiopodite small with two spines on postero-distal angle; meropodite with antero-distal swelling and provided with prominent spines on posterior face; carpopodite and propodite each armed with three groups of three spines spaced along posterior face; dactylopodite small and straight with one spine at the base of the terminal claw.

*Second peraeopod* (Plate XIII, Fig. 2) similar to first peraeopod but smaller and less robust. Epimeron of same shape and size as second epimeron. Oostegite tipped with 6-12 simple setae. Mero-, carpo-, and pro-podites smaller than those of first peraeopod, and spines less numerous; dactylopodite small and tapering, with straight margins.

*Third peraeopod* (Plate XIII, Fig. 3): epimeron divided into two subequal lobes, anterior moiety larger with convex anterior margin, fringed with a few minute setae, posterior moiety with straight posterior margin and three setae. Branchial sac swollen, twisted and pear-shaped, attached by narrow end and extending beyond epimeron. Oostegite with 4-6 simple setae. Basipodite flattened and expanded, bearing five spines situated in notches on anterior face, and six less-robust spines in notches on posterior margin; ischiopodite small; meropodite with postero-distal swelling surmounted with a single spine; carpopodite with three groups of spines spaced along anterior face, propodite also with three groups of spines spaced along anterior face; dactylopodite with antero-distal spine in addition to terminal claw.

*Fourth peraeopod* (Plate XIII, Fig. 4): epimeron divided, anterior moiety smaller than posterior moiety, posterior margin of which is convex. Branchia trifoliate and projecting posteriorly to lie close to basipodite of fifth peraeopod. Basipodite flattened and expanded, with greater expansion than in the third peraeopod, with eight spines in notches spaced along anterior edge; meropodite with postero-distal swelling surmounted with a single spine; carpopodite with four groups of spines spaced along anterior margin; propodite as long as basipodite and characterized by five groups of spines spaced along anterior face, and four along posterior face; dactylopodite small, smooth, tapering, with sub-terminal anterior spine in addition to terminal claw.

*Fifth peraeopod* (Plate XIII, Fig. 5): epimeron entire, slightly deeper behind than in front. Basipodite larger and more symmetrically expanded than in third and fourth peraeopods, anterior and posterior margins broadly serrate, anterior margin with seven spines, distal margin emarginate; ischiopodite short, articulating with anterior part of distal emargination of basipodite; meropodite robust, with postero-distal process bearing a single spine, armed with four groups of spines spaced along anterior face; carpopodite longer than corresponding segment in fourth peraeopod, armed with four groups of spines spaced along anterior face, and a few spines on posterior face; propodite broadly serrate with five groups of spines spaced along anterior face, and four on posterior face; dactylopodite small, narrow, tapering, with two sub-terminal spines, in addition to terminal claw.

*Pleopods* (Plate XIII, Figs. 6, 7, and 8): first and second pleopods fully developed with unequal, segmented rami, each segment of which bears two finely plumose setae; first pleopod with fourteen segments on exite and seven on endite; second pleopod with ten segments on exite and four on endite; protopodites of first and second pleopods united distally by two pairs of coupling hooks; third pleopod reduced, not reaching beyond free margin of pleura, exite represented by a small conical tubercle surmounted by a single slender seta, endite rudimentary but recognizable; a small seta present just proximal to internal distal angle of protopodite.

*Uropods* (Plate XIII, Figs. 9, 10, and 11): the three uropods, like the three pleopods, reduced progressively. Peduncle of first uropod, with a conspicuous spine distally, slightly longer than the two equal rami; a group of spines at the tip of each ramus with one spine of predominant size. Second pleopod with peduncle half the length of that of the first and twice as broad, beset distally with one large and several small spines, three spines on postero-lateral edge of peduncle; rami equal in size and of the same length as peduncle, beset with conspicuous distal spines and three spines on broadly serrate postero-lateral margins. Third uropod uniramous, protopodite small and conical, of a length equal to diameter of base; armed distally with three spines of which one is longer than the single ramus; ramus is a small conical tubercle with two distal spines.

*Telson* (Plate XIII, Fig. 12) thick and short, emarginate distally not amounting to divided condition; lateral margins broadly serrate, armed with four or five spines.

*Armature:* spines mostly with rounded tips and narrow, pointed, sub-terminal branch which extends beyond rounded end.

In conclusion I wish to record my thanks to Dr. J. Pearson, Director of the Colombo Museum, for the interest which he has taken in this paper and for the facilities he so willingly gives for the use of the Colombo Museum Library.

## SUMMARY

The following is a synopsis of the diagnostic characters of *Talitrus* (*Talitropsis*) *topitotum*, sub-gen. et sp. nov:—

Type locality: Hatton, Ceylon, alt. 4,300 ft.

Colour: greenish-slate.

Size: 8.5 to 10 mm.

Antennule only slightly shorter than peduncle of antenna, flagellum 5-7-jointed. Antenna shorter than peraeon, geniculate, ultimate joint of peduncle one quarter as long again as penultimate joint, flagellum 17-22-jointed Mandible: lacinia mobilis on left mandible. Maxillula without palp. Maxilliped: inner lobe tipped with plumose setae, and two short club-shaped sense organs. Fourth joint of palp rudimentary but distinct, tipped with spine. First gnathopod simple in both sexes, slightly smaller than second gnathopod. Second gnathopod feebly chelate in both sexes, meropodite with postero-distal swelling, carpopodite with postero-lateral swelling produced over base of propodite; propodite extending beyond minute functionless dactylopodite. Peraeopods: first larger than second; third, fourth, and fifth with basipodites progressively expanded Pleopods progressively reduced; third with peduncle not projecting beyond pleura, exite small conical process, endite rudimentary. Uropods progressively reduced; third small, peduncle conical, with single ramus. Telson deep, longer than broad, distally emarginate. Branchiae borne on coxopodites of second gnathopod to fourth peraeopod; last branchiae trifoliate. Oostegites small, flat, distally rounded, borne on coxopodites of second gnathopod to third peraeopod. Epimera· first narrow, fifth and sixth divided. Sexes alike except for presence of oostegites in female

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## DESCRIPTION OF PLATES

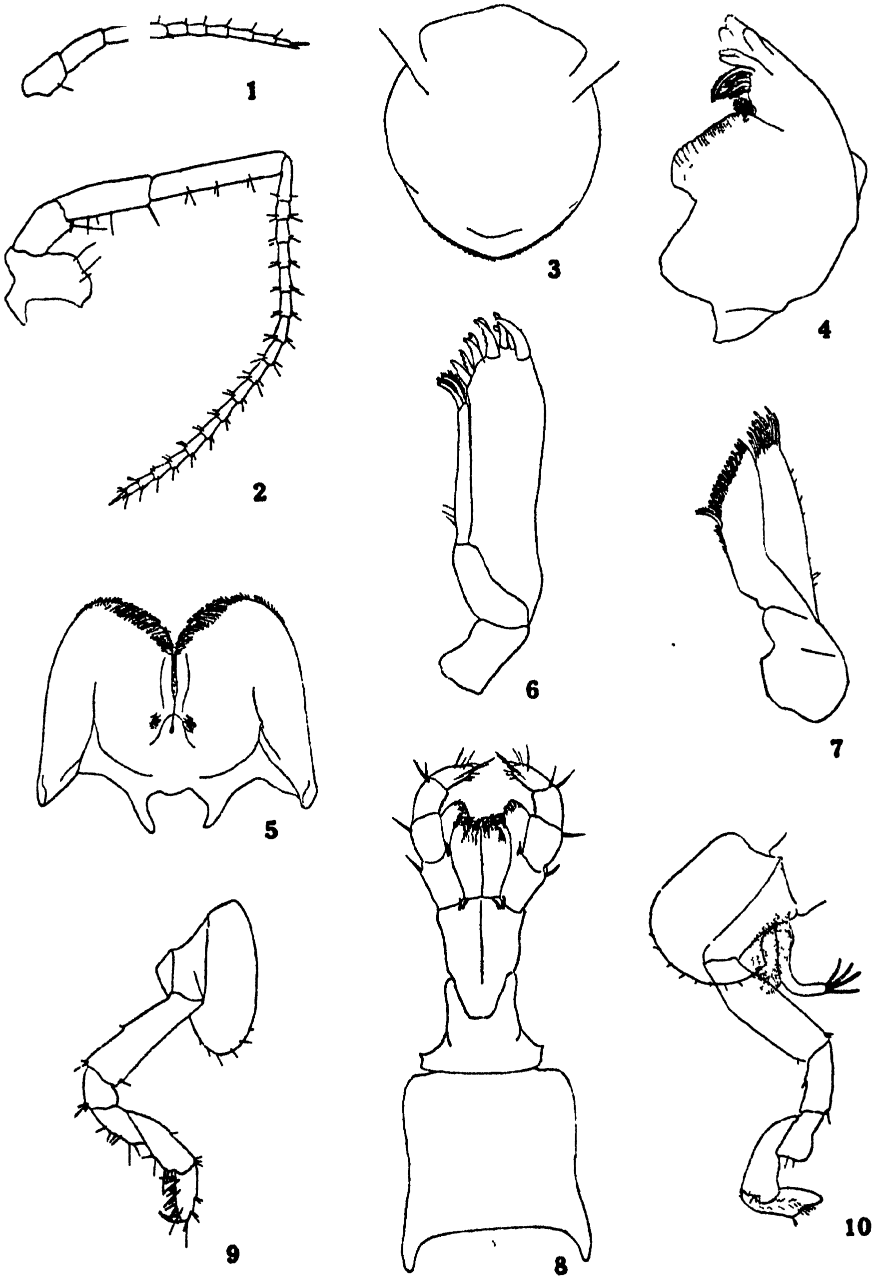
The line drawings are made from microphotograms of the appendages, by the method of outlining the prints in waterproof indian ink and dissolving away the photogram with iodine in potassium iodide, and subsequently washing in hypo and water.

PLATE XII. *Talitrus (Talitropsis) topitotum*, sub gen. et sp. nov.

*Fig.* *1.*—Antennule × 25
*Fig.* *2.*—Antenna × 25
*Fig.* *3.*—Labrum × 80
*Fig.* *4.*—Left mandible × 80
*Fig.* *5.*—Paragnatha × 80
*Fig.* *6.*—Maxillula × 80
*Fig.* *7.*—Maxilla × 80
*Fig.* *8.*—Maxillipeds × 50
*Fig.* *9.*—First gnathopod × 25
*Fig.* *10.*—Second gnathopod × 25

PLATE XIII. *Talitrus (Talitropsis) topitotum*, sub gen. et sp. nov.

*Fig.* *1.*—First peraeopod × 25
*Fig.* *2.*—Second peraeopod × 25
*Fig.* *3.*—Third peraeopod × 20
*Fig.* *4.*—Fourth peraeopod × 20
*Fig.* *5.*—Fifth peraeopod × 20
*Fig.* *6.*—First pleopod × 30
*Fig.* *7.*—Second pleopod × 40
*Fig.* *8.*—Third pleopod × 80
*Fig.* *9.*—First uropod × 25
*Fig.* *10.*—Second uropod × 25
*Fig.* *11.*—Third uropod × 80
*Fig.* *12.*—Telson × 80



D. R. R. Burt del.

*Talitrus* (*Talitropsis*) *topitotum*, sub-gen. et sp. nov.

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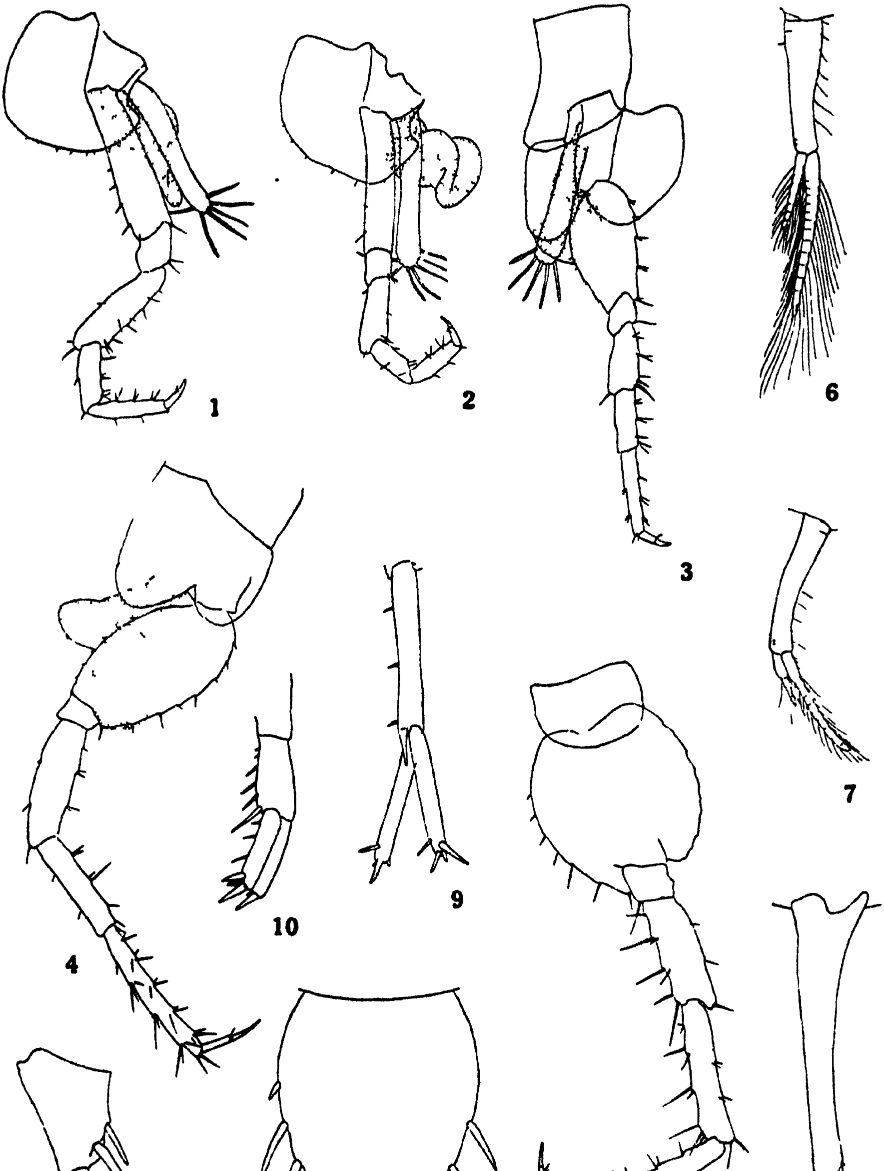

D. R. R. Burt del

*Talitrus (Talitropsis) topitotum*, sub gen. et sp. nov.

Ceylon J. Sci. (B) Vol. XVIII, Pt. 2 (*May 22, 1934*)

# Observations on the Genus Genimen Bolivar (Insecta, Acrididae), with Description of a New Genus and Species

BY

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(With One Plate)

The genus *Genimen* was erected by I. Bolivar (1918) to include a single species from Mysore and the South Canara District of S. India, *G. prasinum*. Uvarov (1927) described two species from Ceylon, *G. ceylonicum* and *G. subapterum*. The former was described from a unique ♂ and the latter from a unique ♀, and, in his description of *G. subapterum*, Uvarov indicated that the discovery of the male of this species might necessitate the erection of a new genus. The Colombo Museum now possesses good series of males and females of both these species, and comparison of the male genitalia (see Plate XIV, Figs. 1 and 2) shows that a new genus is clearly desirable for the accommodation of *G. subapterum* and a new species closely related to it. Before describing the new genus and species, however, I wish to offer some remarks on the remaining members of Bolivar's genus.

## **Genimen prasinum** Bol.

Through the kindness of the Entomologist of the Agricultural Department, Coimbatore, S. India, I have a ♀ specimen of this species captured at Gudalur, Nilgiris on 7-vii 20. The measurements of this specimen are given below, with those of the following species.

## **Genimen ceylonicum** Uvar.

Plate XIV, Fig. 1

The female of this species resembles the male in all ambisexual characters, but is larger and has less prominent eyes and proportionally shorter antennae. In life, the pale longitudinal bands on head and body in both sexes are white, with a beautiful nacreous lustre, which degenerates to dirty yellowish in dried specimens. Most specimens show faint traces of black hind-femoral bands on the dorsum of the femur, in the position of the bands of *G. prasinum*.

This species feeds on the leaves of the prickly, wild shoe-flower, *Hibiscus furcatus*, a common plant at low and medium elevations in Ceylon, particularly in the wet zone; and the grasshopper may be looked for wherever this plant grows. It is not easy to catch however, the use of a net being almost impossible owing to the prickles of the plant, and the jumping of the insect is both smart and powerful. Many specimens have been in various stages of immaturity when captured but they have been reared in the laboratory without difficulty.

*Measurements.* For comparison, the measurements of the above-mentioned specimen of *G. prasinum* are also given.

| | *G. ceylonicum* | | *G. prasinum* |
|---|---|---|---|
| | ♂ | ♀ | ♀ |
| | mm. | mm. | mm. |
| Length | 11.7 to 13.0 | 15.0 to 15.5 | 17.0 |
| Length of antenna, about | 10.0 to 11.5 | 9.1 to 11.0 | ? (broken) |
| Width of head, including eyes | 2.9 to 3.0 | 3.1 to 3.4 | 2.95 |
| Length of pronotum | 2.2 to 2.4 | 2.7 to 3.0 | 2.6 |
| Width of body at mesepisternum | 3.0 to 3.2 | 3.8 to 4.0 | 3.8 |
| Length of hind femur | 7.0 to 8.0 | 8.2 to 9.6 | 8.75 |
| Breadth of hind femur | 1.8 to 2.0 | 2.2 to 2.4 | 2.1 |

*Material examined.* 10 males and 11 females from Kandy, November and December, 1930, January, 1931, May, 1933; 1 male, 1 female from Kitulgala, April, 1927; 1 female from Labugama, August, 1932; 2 females from Madola, near Opanake, February, 1933.

### **Genimenoides,** gen. nov.

Resembling *Genimen* Bolivar in size and general characteristics but somewhat more stoutly built, with small but distinct tegmina and a small tympanum.

Eyes large and prominent, very narrowly separated dorsally. Antennae filiform. Pronotum as in *Genimen*. Prosternal tubercle short, conical. Tegmina small, lateral. A small but distinct tympanum. Fore and mid legs fairly stout, normal. Hind femora stout, very convex on their outer aspect, their genicular lobes obtusely angular, not spinous; their carinae not very strongly developed. Hind tibiae lacking an outer apical spine. Hind tarsi fairly long with their distal joint longest, middle one shortest.

Anal tergite of ♂ minutely excised in the middle, broadly emarginate, with a small projection on each side. Supra-anal plate roughly triangular, with very broadly rounded apex; ♂ cerci conical, somewhat compressed, with a small tooth on the inner side near the apex (see Plate XIV, Fig. 2); ♀ supra-anal plate triangular, compressed; ♀ cerci small and conical. Valves of ovipositor stout, dorsal and ventral pairs nearly equal in length, margin of the latter coarsely dentate.

Genotype: *Genimen subapterum* Uvarov (1927)

## **Genimenoides subapterum** (Uvarov)

Plate XIV, Fig. 2

*Genimen subapterum* Uvarov, 1927. Some Orthoptera of the Families Mantidae, Tettigoniidae and Acrididae from Ceylon. *Ceylon J. Sci.* (B) Vol. XIV, p. 111, Plate XII, Fig. 9.

The male of this species has never been described. It is similar to the female in all ambisexual characters and in colour, but is smaller, with more prominent eyes and a small abdomen (reaching not more than two-thirds of the length of the hind femora).

*Coloration.* The following notes, drawn up from fresh specimens, supplement the description given by Uvarov. General colour, yellowish green. Antennae dark olivaceous green. A broad, longitudinal, ill-defined crimson band (included in the olivaceous band mentioned by Uvarov) on the upper part of the sides of pronotum behind the anterior sulcus. The following, dirty-white callous spots are present, but their degree of distinctness varies greatly in different individuals: a row of 5 around the ventral two-thirds of the orbit; one on the mandible near its articulation; a sub-dorsal row, slightly converging anteriorly, between the sulci on pronotum, and another, larger row across the middle of the lateral lobes; 2 spots on mes-episternum and 3 on met-episternum. The tegmina are bluish-grey, darker discally, with two whitish longitudinal stripes. All the tibiae and tarsi are bottle-green, as are also the hind femoral knee-lobes.

*Measurements*

|  | ♂ mm. | ♀ mm. |
|---|---|---|
| Length | 11.3 to 11.5 | 15.0 to 18.0 |
| Length of antenna, about | 7.5 to 9.0 | 7.5 to 9.0 |
| Width of head, including eyes | 3.1 to 3.3 | 3.5 to 4.0 |
| Length of pronotum | 2.4 to 2.7 | 3.1 to 3.7 |
| Width of body at mes-episternum | 3.0 to 3.1 | 3.9 to 4.3 |
| Length of tegmen | 1.0 to 1.7 | 2.0 to 2.4 |
| Length of hind femur | 7.2 to 7.5 | 9.0 to 10.0 |
| Breadth of hind femur | 2.1 to 2.25 | 2.7 to 3.0 |
| Length of hind tibia | 6.2 to 6.7 | 8.0 to 9.0 |
| Length of hind tarsus | 3.1 to 3.2 | 3.8 to 4.2 |

*Material examined.* 1 male, 5 females from Balangoda, April, 1926; 7 males, 7 females from Battaramulla (W. Prov.), November 1926, March, May, June, July, August, September, 1931; 1 male, Kanniyai (E. Prov.), April, 1931; 1 female, Labugama (W. Prov.), August, 1932; 3 males, 1 female, Rakwana (Sab. Prov.), May, 1929; 2 females, Wellawaya, December, 1927.

*Remarks.* One of the Balangoda specimens was identified by Dr. Uvarov. As Battaramulla, a village about four miles from Colombo, is only a mile or so from the type locality, Kotte, the series from there may be regarded as topotypical. The specimen from Kanniyai was taken at the Hot Springs about nine miles from Trincomalee; it is the largest and most distinctly-marked specimen in the series but is clearly conspecific with the others.

The food plant of this species has not been definitely noted but it appears to feed on a variety of jungle shrubs. Most of the specimens have been taken by sweeping amongst low secondary growth.

## **Genimenoides coloratum**, sp. nov.

Plate XIV, Figs. 3-6

*Male and female.* In size, structure and sculpture almost indistinguishable from *G. ceylonicum;* the antennae appear to be somewhat longer and the tegmina shorter than in that species. In coloration however it is so distinct that I feel the erection of a new species to be necessary.

*Coloration.* Head olivaceous, pale greenish on frontal rostrum. Antennae greenish black, lighter green at base. Eyes, in life, buff with a purple sheen, shading to greyish posteriorly; in dried specimens light or dark brown. All palpi green with extreme apices dark brown. A small white callous spot on each side of face midway between the base of antenna and the clypeal suture; a similar white spot at the proximal end of mandible; one on disk and one at ventral angle of gena; one at postero-ventral and one at postero-dorsal margin of orbit. Pronotum black with a white, median stripe, more or less interrupted between the first and second sulci and broken into spots by the remaining sulci. A row of three white spots on each side of the dorsum of prozona in the intersulcar spaces; the first pair of these are somewhat elongated and point obliquely outwards from the white spot on the front, median margin. A small white spot on the fore-margin opposite to the middle of the eye; a broad white band longitudinally crossing the middle of the lateral lobes. The sides of the dorsum of the metazona are occupied by a pair of large, ill-defined, deep-crimson blotches.

The dorsum of meso- and meta-thoraces and abdomen is black with a white median stripe; the sides of meso- and meta-thoraces and abdomen are yellowish green. The mes episternum is blackish. The meso-meta-sternal plate is dark olive brown with whitish fore-margins and a discal patch about the metasternal foveolae.

The tegmina are black in the inner half, green in the outer, with a trace of a whitish median stripe.

The fore and mid legs are bright yellowish green, somewhat darker on the tibiae; the hind femora are bright yellowish green with brick-red knees; the hind tibiae are greenish blue, darker distally and brown at the knees. Hind tarsi greenish.

This account of the coloration was taken from a living specimen and allowance must be made for discoloration in preserved examples. In particular, the white spots tend to become dirty yellowish or concolorous with the surrounding areas.

The red knees and white, median, dorsal stripe suffice to distinguish this species, at a glance, from *G. subapterum*.

*Measurements*

| | ♂<br>mm. | ♀<br>mm. |
|---|---|---|
| Length | 11.5 | 13.5 |
| Length of antenna, about | 8 + (broken) | 9.0 |
| Width of head, including eyes | 3.1 | 3.5 |
| Length of pronotum | 2.6 | 3.1 |
| Width of body at mes-episternum | 3.0 | 4.0 |
| Length of tegmen | 1.0 | 1.6 |
| Length of hind femur | 7.3 | 9.2 |
| Breadth of hind femur | 2.0 | 2.7 |
| Length of hind tibia | 6.5 | 8.0 |
| Length of hind tarsus | 3.2 | 4.2 |

*Material examined.* 1 female taken at Kandy (Lady Horton's Drive) xii-25; 1 male (type) taken at the same locality, 8 to 13-v-33, as a last-instar larva and reared to maturity in the laboratory, being specimenized on 19-vii-33. Both specimens were captured on *Hibiscus furcatus*, and the type specimen was reared to maturity on the leaves of this plant, which is the food-plant of *Genimen ceylonicum* also.

The species is evidently rare, as search—without success until this year—has been made for it ever since the first specimen was captured in 1925.

The type will be presented to the British Museum (Natural History).

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## EXPLANATION OF PLATE

PLATE XIV.

*Fig. 1.—Genimen ceylonicum* Uvar., ♂ genitalia, dorsal, × 16
*Fig. 2.—Genimenoides subapterum* (Uvar.) ♂ genitalia, dorsal, × 16
*Fig. 3.—Genimenoides coloratum* sp. nov. ♂ dorsal, × 4¾
*Fig. 4.—Genimenoides coloratum* sp. nov. ♀ lateral, × 4¾
*Fig. 5.—Genimenoides coloratum* sp. nov. ♂ face × 7¼
*Fig. 6.—Genimenoides coloratum* sp. nov. ♂ meso- and meta-sterna × 7¼

PLATE XIV.

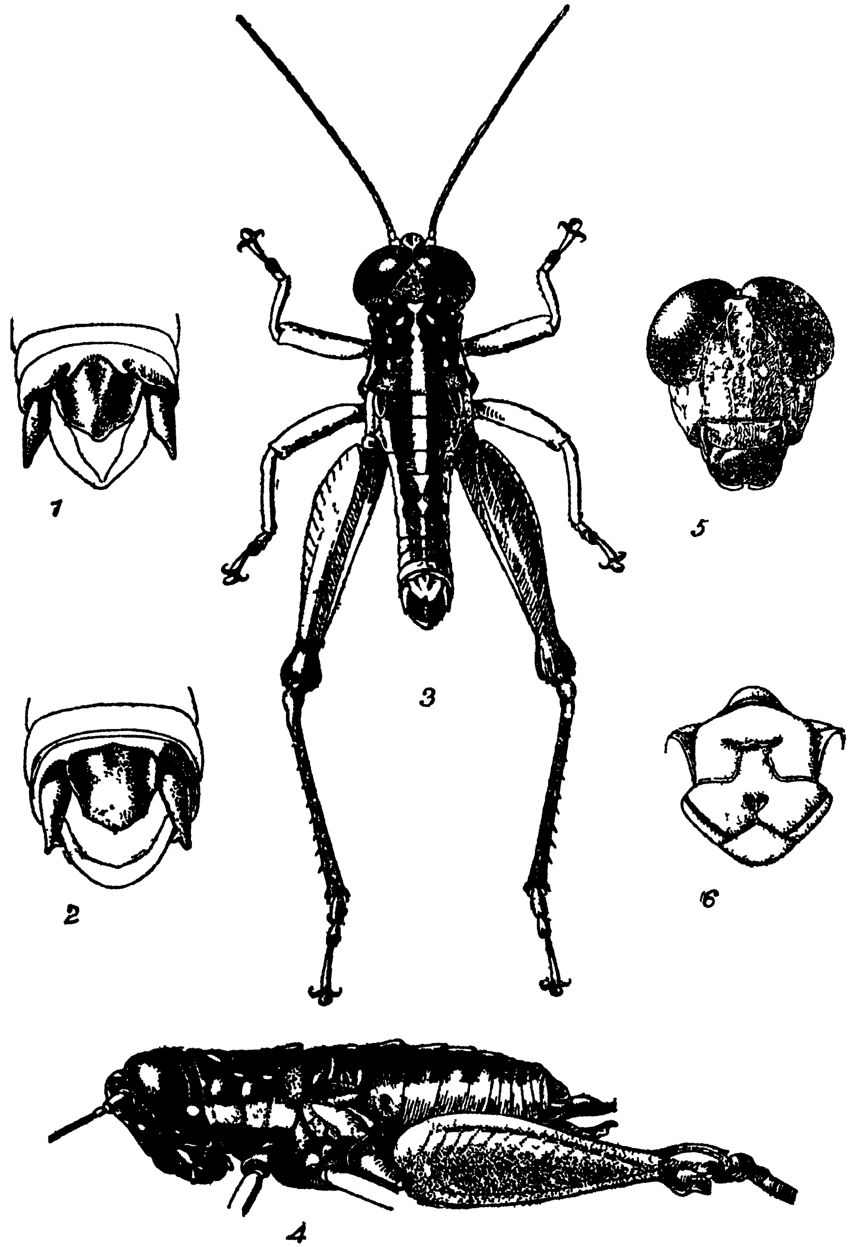

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Fig 1 *Genimen ceylonicum* Uvar
Fig 2 *Genimenoides subapterum* (Uvar), gen nov
Figs 3 5 *Genimenoides coloratum*, sp nov

Ceylon J. Sci. (B) Vol. XVIII, Pt. 2 (*May 22, 1934*)

# Some Phylogenetic Features in the Leathery Turtle Dermochelys coriacea

BY

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(With Three Plates and One Text Figure)

The systematic position of *Dermochelys coriacea* (Linné) baffled zoologists for many years and to such an extent that several authorities reversed their views on its affinities more than once while Thecophoran fossils erroneously interpreted as ancestral Athecans, added greatly to the confusion of ideas (Deraniyagala, 1930 *b*). It was only when an account of the embryonic development of this turtle was obtainable that intricate theories were supplanted by definite evidence which showed that what had been considered to be comparatively recent secondary developments, were of early origin.

The embryonic stage F. (Deraniyagala, 1932) throws most light on the external characters of *Dermochelys*. In this description it was stated that the earliest pigment to appear was white on the corselet ridges. Since then two other specimens of similar development have been obtained without such pigmentation and it is possible that the white noted in (F) was merely light refraction from the ridges of the hyaline animal, for this specimen was obtained away from a laboratory and not carefully examined before preservation. It was studied later after remaining one year in cedar wood oil, consequently certain features escaped notice in the shrunken embryo. The two recently obtained were 42 days old. Turtle eggs when incubated after removal from the nest exhibit a very irregular latent period (Deraniyagala, 1932). Hence other embryos of this batch were far less advanced.

The eggs [1] were obtained at Väligama (S. P.) on December 22, 1932, and embryos extracted on February 1, 1933.

The largest when fresh from the egg (Plate XV) was hyaline with eyes pigmented and strongly protruding. Rudiments of two sclerotic plates occupied the posterior of each and assuming the left eye to be the dial of a clock they were at one and five o'clock respectively. The snout was thick and subconical and the reduced nares had prominent rims. The limbs had begun to alter from the end plate to the paddle-like stage and digits were recognizable on each. The outlines of the carapace were complete, and although the supra-caudal portion was still fused with the tail, it had a well defined margin.

The most important external feature was the remarkable development of the corselet ridges which were almost as complete at an even earlier stage. Each carapace ridge consisted of a row of protuberances as in the adult and each costal ridge originated from an anterior prominence, while a continuation of the neural ridge ran half way down the neck as a smooth longitudinal fold. The plastral ridges were smooth but the median double ridge was unrecognizable.

The elongate, cylindrical tail was also of interest in possessing a well developed dorsal crest as in the adult, while it was rather constricted close to its tip which was compressed. The genital protuberance was nearly as long as the hind limb.

The measurements of the largest embryo (Plate XV) taken 24 hours after fixation in Bouin were as follows :—

Total length (curved) 19 mm.

Vertex to costal ridge 10 mm., width of head including eyes 8.5 mm., eye 3.7 mm., length of carapace 14 mm., width of carapace 7.5 mm., depth of body 8.5 mm., axilla to groin 7 mm., length of inframarginal ridge 6 mm., length of fore limb 4.25 mm., length of hind limb 4 mm., across curve of tail 5 mm.

The earlier stage had a less prominent snout, eyes and lower jaw than the previous stage. Its carapace outlines were also less distinct

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[1] These egg shells were marked with small green flecks.

but the ridges were almost as advanced as in the preceding embryo. The tail was sub-cylindrical with its dorsal crest less distinct. The dimensions of the embryo were as follows: Total curved length 18 mm., head and neck 9 mm., depth of head 6 mm., eye 3.25 mm., length of carapace 11 mm., depth of body 7.5 mm., axilla to groin 7 mm., length of fore limb 3.5 mm., length of hind limb 2.8 mm., across curve of tail 3.6 mm.

Plate XVI depicts a younger stage which is less advanced than embryo E. (1932). In Ringer's saline the specimen continued to lash its tail strongly once every three or four seconds. Under the opercular fold lay the vestiges of two ectodermal branchial grooves.

The tail was long and its tip of exceptional interest because it showed particularly well the peculiar reptilian kink described by me in 1932 (Plate XV, Fig. 2, Plate XX, Fig. 1).

This tip was compressed and had a terminal point bent dorsally [1]. In the living specimen the notochord was plainly visible kinked in accordance with its surroundings. The entire structure bears an extraordinary resemblance to the heterocercal caudal termination in fishes. This feature is very possibly a primitive structural alteration and may prove of value in ascertaining the relationships of this order.

The measurements of the specimen were as follows:—Total length (curved) 11 mm., depth of head 3 mm., eye 1.25 mm., vertex to last branchial groove 4.2 mm., axilla to groin 3 mm., tail (curved) 3 mm., allantois 5.5 by 4 mm.

Examination of embryos of *Dermochelys*, the Carettoidea and *Geoemyda trijuga thermalis* (Lesson) show that after the limbs begin to alter from the end-plate stage into either paddles or digits the embryo is faintly pigmented, corselet scutes appear and all the rudiments of the sclerotic plates are present.

*Dermochelys* possesses seven carapace ridges which appear early in embryonic life prior to the above mentioned changes. The Thecophora on the other hand possess only three carapace ridges which in the species examined appear after the commencement of these changes. In *Dermochelys* the ridges persist throughout life but in the majority of Thecophora they disappear soon after birth while in a few forms such as *Geoemyda trijuga thermalis* (Lesson) and *Eretmochelys*

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[1] A homologous case among reptiles has been noted by me from embryos of *Crocodylus porosus* Schneider (1932, p. 81).

*imbricata* (Linné), they persist until middle age. Thus it is evident that Thecophoran ridges are either vestiges or secondary developments from the Athecan.

In a paper on Testudinate evolution (1930 b, p. 1069) I stated that ' probably the ancestral form had large scales similar to those on the carapace ridges, continued along the white pigment of the neck [1]. Subsequently these scales disappeared when the telescoping neck developed and only the pigment remained '. This is supported by the vestige of a neural nuchal ridge in the embryo and suggests an ancestor with dorsal ridges somewhat similar to the seven seen on embryos of *Sphenodon punctatus* Gray; (see Wettstein 1932, Fig. 165) which further support the view that the Athecan ridges are primitive.

The early appearance of the premaxillo-maxillary cusp may also prove to be a primitive feature as it is displayed in rudimentary form by both *Sphenodon* and *Crocodylus*. The caudal crest of *Dermochelys* is another feature of phylogenetic interest. It is quite noticeable in unpigmented embryos of both this form and in the Carettoidea. In the latter it disappears as the embryo develops [2].

The next feature for consideration is the mosaic of platelets which lie superficially upon the thick dermal corselet. There is reason to believe that after a testudinate becomes aquatic, thé animal which when terrestrial was slow moving and protected itself by the strength of its corselet, now evades danger by rapidity of swimming. In its adaptation for speed it attempts to dispense with the now useless and cumbersome osseous protection and the corselet rendered more plastic by loss of its bony structure improves its stream lining with greater facility.

Familiar instances of such incipient osseous degeneration are the fontanelles of the Cheloniidae while the Trionychoidea show in addition, a disappearance of the marginal bones which are entirely or partially wanting. *Dermochelys* exhibits a proportionally greater loss than any other aquatic testudinate and retains only a feeble vestige of the abdominal osseous mosaic. This implies that it was aquatic prior to the others now living. Moreover it has lost the anterior enlarged marginals in a manner somewhat similar to that displayed by *Lissemys* Smith, a genus of Trionychoidea; while among the

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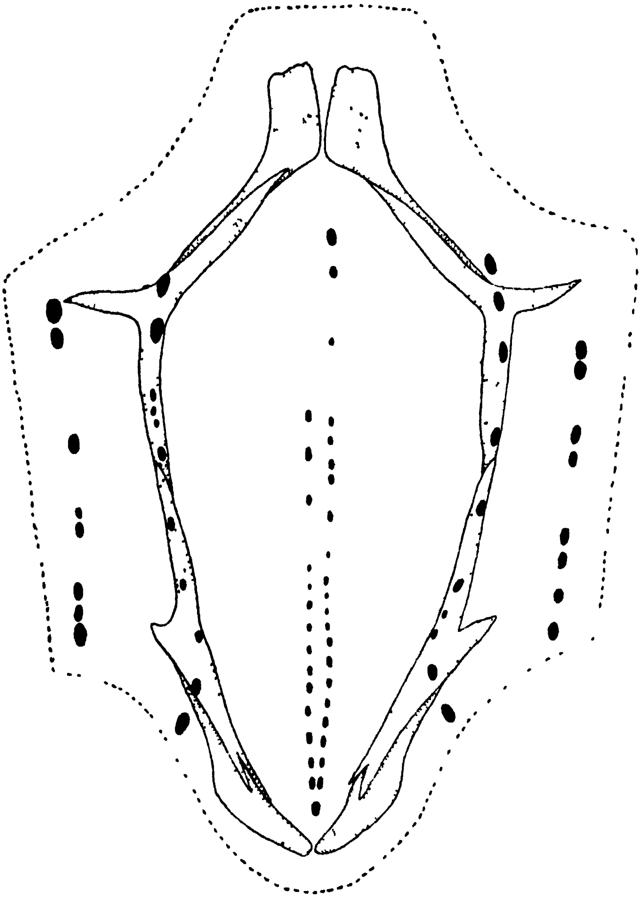
[1] In young *Dermochelys* the ridges are white and these colour bands are continued on to the neck.

[2] The embryo of the Ceylon apodal skink *Acontias (Evesia) smithi*, shows the tail feebly compressed dorsally, although in the adult it is sub-cylindrical while the tail of the Agamid *Lyriocephalus* is strongly compressed.

Cheloniidae, the anterior marginals are narrower than the posterior ones.



P. Deraniyagala del.

Fig. 1. Plastron of *Dermochelys* showing platelets (black) and bones × $\frac{1}{10}$

In addition to these losses, that tenuity of the dorsal platelets in *Dermochelys* which renders them useless as a protection, suggests their impending effacement.

A similar process apparently occurred in the Emydosauria. Fossil forms and the living Cayman possess a dorsal and ventral armature of osseous platelets. The other members of this order have lost the latter. It is therefore reasonable to presume that (*a*) the ventral platelets of the Cayman will disappear in their turn (*b*) the other forms possessed similar ventral platelets at one period of their evolution. The loss of the plastral mosaic in *Dermochelys* except for vestiges in the 5 ventral ridges is significant. Fossil Athecans possess more ventral ossification than their modern representative and support the view suggested by the Emydosauria that *Dermochelys* once possessed a complete dorsiventral osseous mosaic which it is gradually losing.

An example of a fossil Athecan is *Psephophorus polygonus* von Meyer, from the Pliocene. In it the carapace mosaic is continued downward inframarginally to cover the sides of the plastron completely.

In adult *Dermochelys* (Plate XVII) this ventral extension is so reduced that it forms a narrow lateral strip of 4 or 5 longitudinal rows of contiguous platelets. This only extends a short distance down the bridge of the dermal carapace and terminates far above the inframarginal ridge platelets (I.M.).

The following measurements show what extent of the bridge is occupied by these disappearing platelets:—

Length of head 310 mm., straight length of carapace 1,425 mm., bridge of dermal corselet from axilla to groin 635 mm., distance from marginal to inframarginal ridge 145 mm., distance from inframarginal ridge to extension of carapace mosaic upon bridge 85 mm.

The lepidosis of the young provides further evidence that at one period *Dermochelys* had a complete osseous mosaic on both carapace and plastron. It has already been shown (Deraniyagala, 1932, p. 94) that there is a connexion between the scales and platelets which are probably osteoderms. In the scaly young, each of the 7 longitudinal carapace ridges is covered by a uniserial row of enlarged scales and in the smooth skinned adult each ridge consists of a single row of enlarged platelets, Plate XVII M. Yet although the plastral lepidosis is identical with that of the carapace, there are no plastral platelets except for a vestigial row, on each ridge, and at times even these are wanting (Fig. 1). Recently I discovered that in the month old young, ecdysis commences from the centre of the plastron and spreads outwards. In view of the evidence already presented and the known connexion between the scales and platelets there is little doubt but that the plastron was once covered with a mosaic similar to the dorsal. Dissection of the adult reveals the fact that this osseous mosaic is now disappearing from the carapace (Plate XVII). *Dermochelys* young or adult[1] has a distinct anterior margin where the heavy dermal carapace

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[1] See illustrations of young and adult by Deraniyagala, 1930 (a).

(c) rises above the skin of the neck and flippers (N). In the young the carapace scales extend to this line of demarcation and among them are two or three supra-axillary pores (P) more or less constant in position. The infantile lepidosis indicates that the osseous mosaic should extend to this anterior boundary which is in front of the pores, but dissection of the smooth skinned adult shows that the platelets invariably lie behind these pores. The outline of this mosaic between the marginal and costal ridges is generally irregular along its anterior edge and further suggests that the absence of platelets from the carapace margin is due to reduction. Actual measurements from an adult carapace are as follows:—

Head length 275 mm., length of carapace along curve of neural ridge 1,590 mm., distance between marginal and supramarginal ridges 163 mm., distance from anterior margin of carapace to mosaic of platelets between the ridges mentioned, 28 to 52 mm.

As the platelets outnumber the scales of the young it is suggested that they are osteoderms of scales which have fused and enlarged before the animal became aquatic.

Under aquatic conditions the scales disappear and the corselet ossification appears to be following their example. The loss of the anterior carapace platelets in *Dermochelys* is analagous to the loss of the anterior marginals in Trionychoidea while the absence of its ventral and much of its lateral mosaic reminds one of the fontanelles exhibited both by these terrapins and the Cheloniidae. Hence the manner of losing ossification in the Athecan corselet is no different from that of the Thecophoran. Fossils of both aquatic Thecophora and Atheca show that this loss is by no means rapid, hence after comparison of *Dermochelys* with other aquatic forms, Dollo's theory (1901) seems improbable, namely, that *Dermochelys* alone should lose an entire Thecophoran corselet, develop a complete mosaic corselet and finally lose more of this second osseous protection than any other living testudinate has had time to do with its first corselet.

In view of the evidence examined a reasonable interpretation of the Athecan corselet would be as follows:—Among aquatic Testudinates there is a tendency to evolve a boneless corselet [1]. In this direction *Dermochelys* has been more successful than any other. Its extreme specialization for rapid swimming denotes that this loss of its osseous corselet is a result of the turtle taking to water prior to the other

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[1] A unique form, *Testudo tornieri* Siebenrock, shows convergent evolution in a considerable loss of the secondary skeletal expansions from the corselet. The marginals however are unaffected. This loss is to enable it to squeeze itself into crannies in the rock where it defies extraction from its shelter by inflating itself with air. The scutes and scales are unaffected.

natatorial forms. By this early change of environment it retains anatomical features which rank it as the most primitive member of the order. (Deraniyagala, 1930b.)

In contrast to this latter feature there are indications that the Athecan corselet will most probably be the first to reach its goal of aquatic specialization by becoming boneless.

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## EXPLANATION OF PLATES

PLATE XV.—The first 42-day embryo of Dermochelys × 5.8

PLATE XVI.—The third 42-day embryo of Dermochelys showing × 9.5

(*a*) opercular fold covering ectodermal branchial grooves.
(*b*) caudal kink.

PLATE XVII.—Some carapace and inframarginal platelets of adult ♀ *Dermochelys* × $\frac{1}{5}$

B = bridge of dermal corselet
C = anterior margin of carapace
M = marginals, IM = inframarginals, N = skin of neck,
P = supra-axillary pores, PL = plastron.

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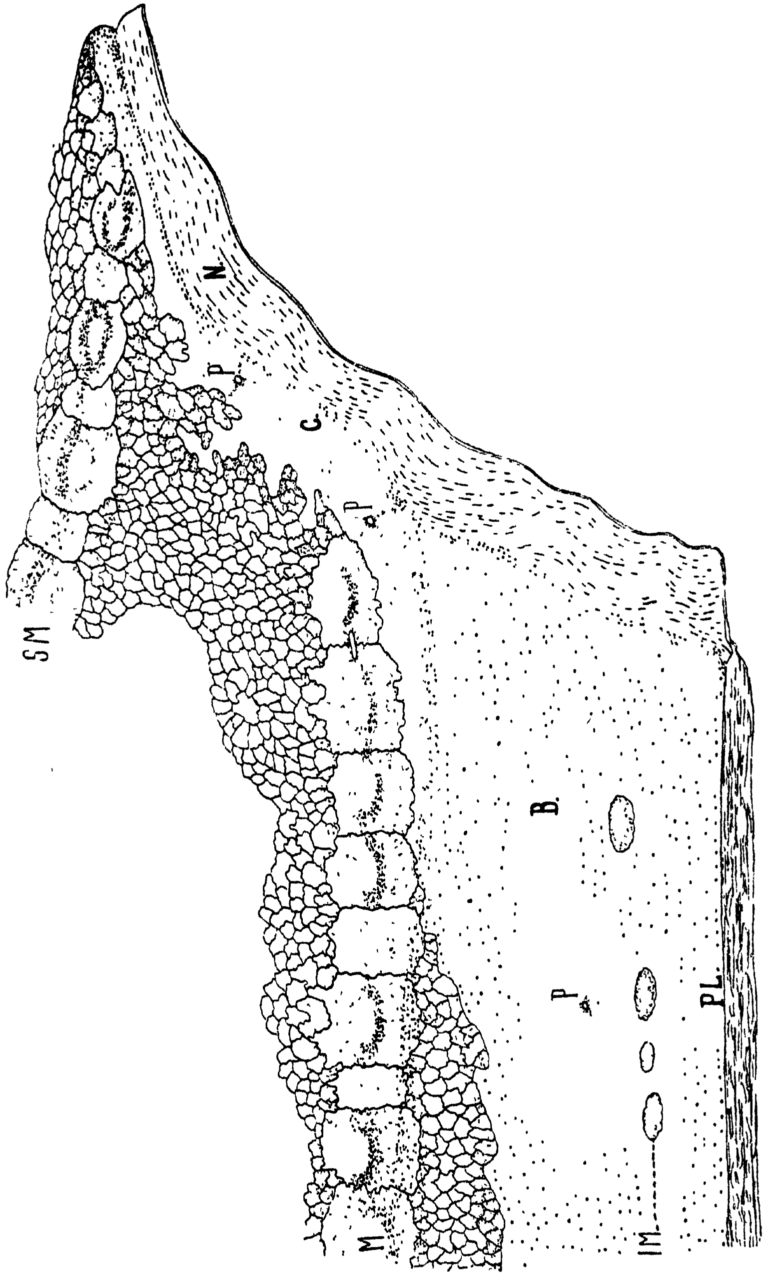
Embryo of *Dermochelys coriacea* × 5.8

P Deraniyagala del

Embryo of *Dermochelys coriacea* × 15



Right antero-lateral corselet ossification of *Dermochelys* × 1/5

B = bridge of dermal corselet, C = anterior margin of carapace
M = marginals, IM = inframarginals, N = skin of neck
P = supra-axillary pores, PL = plastron.

P. Deraniyagala del.

CEYLON J. SCI. (B) VOL. XVIII, PT. 2. *(May 22, 1934)*

# Relationships among Loggerhead turtles (Carettidae)

BY

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(With One Plate)

All living marine Thecophora comprise the superfamily Carettoidea which consists of two families easily separable from each other by the position of the nuchal scute and the number of costals.

One of these families, the Cheloniidae has the nuchal separated from the first costals and possesses 4 pairs of costal scutes. This contains 2 monotypic genera previously regarded as belonging to the single genus *Chelonia* Latreille. One of these is now placed in the genus *Eretmochelys* Fitzinger, although a considerable amount of intergradation exists between the two as pointed out by me (1930), *e.g.*, *Eretmochelys* when old possesses juxtaposed scutes resembling those of *Chelonia*, there is comparatively little difference in the number and arrangement of the skull or corselet bones, and both forms possess an intergular scute and a bony palatal ridge. (Plate XVIII, Fig. 1.)

It is also seen that *Eretmochelys* possesses several features in common with members of the other family such as the black plastron of the young, the number of claws and prefrontal scales, closure of the costoperipheral fontanelles and temporary imbrication of scutes (Plate XVIII). This family is the Carettidae recognizable by the nuchal which is contiguous with the first costals and the possession of more than 4 pairs of costal scutes. There are 4 species of which one is a recent discovery (Deraniyagala, 1933). The original three were once placed in as many genera but latterly they have all been assigned to a single genus and even species after Gadow propounded his theory that the young of *Caretta* possessed supernumerary scutes which gradually reduced to the typical number in the adult (1899).

This view has recently been disproved by the discovery of two distinct species in the Indo-Pacific which do not appear to interbreed (Deraniyagala, 1933). It was probably failure to recognize their identity which induced Gadow to formulate his theory after examination of a brood from New Guinea and collections from different Museums.

In view of the intergradation prevalent among the Carettoidea either a single genus should be recognized for each family or most species should be monotypic of a genus. Modern opinion has adopted the latter course with the Cheloniidae and the Carettidae should be treated likewise for they posses differences quite as salient.

The genera of Carettidae can be divided into two groups. One of these is comprised of two genera with a more or less constant arrangement of the corselet scutes; the other consists of one highly variable genus.

The first group usually has 5 pairs of costal scutes, the second has more than 5. One of these pentecostal scuted genera is the connecting link between the two groups, as it closely resembles the multiscuted, variable form in details of an osteology which is unusual.

The two extremes of the Carettidae are represented by the variable, multiscuted form at one end and a pentecostal form with a pleurodirous arrangement of the carapace bones at the other.

These genera arranged in ascending order are as follows.

### Genus **Lepidochelys** Fitizinger Plate XVIII, Fig. 2

Systema Reptilium 1843 p. 30 type *Chelonia olivacea* Eschscholtz

Dorsally olive green, plastron pale yellow. Flippers with 2 claws. Each bridge with 4 enlarged inframarginal scutes, costals 6-9 on each side, paired or unpaired, very rarely 5 pairs. Skull generally neorbital, maxillaries separate, ' ectopterygoid ' processes usually strong, palate smooth. Neural bones range up to 15; generally 13 or 14 and 2-3 between each pair of costals. (Deraniyagala, 1933 Fig. 3.)

Habitat Indo-Pacific and East Atlantic.

### Genus **Colpochelys** Garman

Bulletin Museum of Comparative Zoology, Harvard VI, 1880 p. 123. type *kempi*

Dorsally dark grey, plastron pale yellow. Flippers usually with 3 claws. Each bridge with 3 or 4 enlarged inframarginal scutes [1], costals usually 5 pairs, occasionally variable. Skull generally neorbital, maxillaries separate, ' ectopterygoid ' processes usually strong, palate with a transverse ridge. Neural bones 11-14 and 2-3 between each pair of costals.

Habitat Gulf of Mexico.

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[1] Hay (p. 186)—states that there are 4, de Sola's figure shows 3.

## Genus **Caretta** Rafinesque

Specchio delle Scienze origionale Enciclopedico di Sicilia 1814, *type C. nasuta*

Dorsally reddish brown, plastron lighter. Flippers with 2 claws, rarely 1. Each bridge with 3 enlarged inframarginal scutes, costals usually 5 pairs occasionally variable. Skull generally palaeorbital, maxillaries contiguous, ' ectopterygoid ' processes vestigial or absent, palate smooth, neural bones usually 7-11 and 1 or 2 between each pair of costals (Hay, p. 186). The last 1-5 pairs of costals contiguous at their neural ends. Pygals 2 or 3. Two species.

One Mediterranean and Atlantic, one Indo-Pacific.

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### EXPLANATION OF PLATE

PLATE XVIII

*Fig 1.*—Old *Eretmochelys imbricata* ♀ with juxtaposed scutes (photograph) × $\frac{1}{11}$

*Fig. 2.*—Adolescent *Lepidochelys olivacea* showing imbricate scutes (photograph) × $\frac{1}{5}$

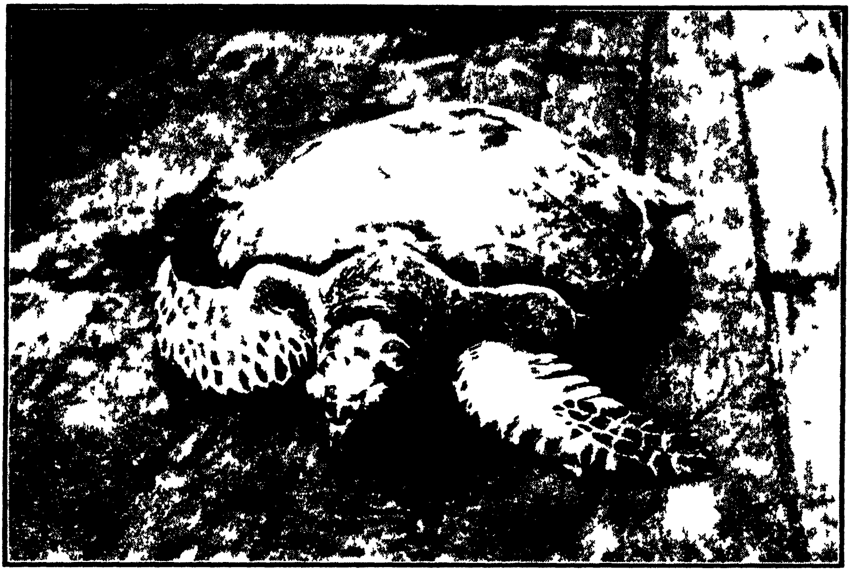

Fig. 1

*Eretmochelys imbricata* with juxtaposed scutes × $\frac{1}{11}$

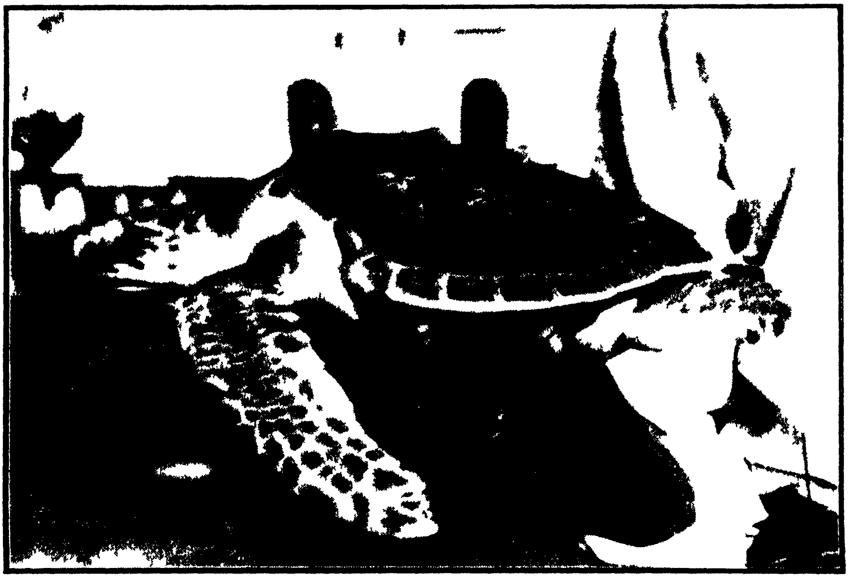

Fig. 2

*Lepidochelys olivacea* with imbricate scutes × $\frac{1}{5}$

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# Corselet Reduction in some Testudinates

BY

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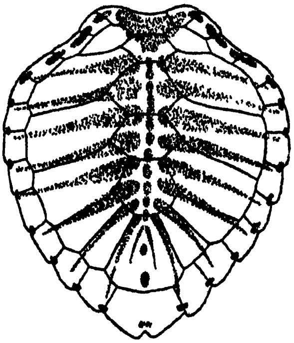
(With Fifteen Text Figures)

Testudinata are unique among vertebrates in the protection afforded to the head, limbs and tail by withdrawal under the ribs which are more or less fully extended. Although this order has reached the limits of osseous hypertrophy it is furnished with fewer ribs than the majority of mammals, a remarkable feature, because reptiles usually possess more ribs than other vertebrates.

The ancestral type has already been discussed (Deraniyagala, 1930 b) and the twisted fore limbs with claws turned inwards and the burrowing habits displayed by living forms during aestivation, hibernation, burrowing into the mud or preparatory to oviposition suggest that they were essentially fossorial at one stage. The temporary presence of imbricate scutes on some denotes that such structures once existed but gradually became juxtaposed probably after the animals developed a stiff corselet and abandoned the fossorial habit.

SCUTES. The juvenile scales in Atheca are comparatively fewer and larger than the osseous platelets of the adult and suggest that during the palustrine period of evolution the scales underwent enlargement and numerical reduction at a faster rate than their osteoderms with which they agree in general arrangement (Deraniyagala, 1932).

In Thecophora a similar process of numerical reduction is noticed and the scutes are generally fewer than the plates they cover. In most forms there are 4 pairs of costal scutes but the Carettidae fail to reach this condition and display a range of from 9 to 5 pairs.



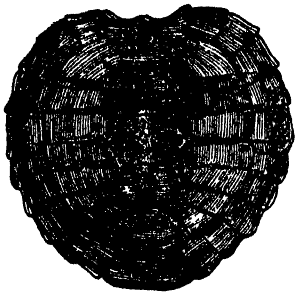


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Fig. 1. Carapace of young *Lepidochelys* stained and cleared × $\frac{2}{3}$

Fig. 2. Carapace of young *Testudo elegans* stained and cleared × $\frac{3}{4}$

Comparison of this family with the quadricostal scuted Cheloniidae is of value in ascertaining the numerical reduction of scutes. In the Carettidae the nuchal is contiguous with the first costals whereas the second costals are contiguous with both the first and second vertebrals. In Cheloniidae as in other Thecophora the nuchal is separated from the costals by the first vertebral, while the first pair of costals which in this family are contiguous with the first and second vertebrals, correspond to the second costals of the Carettidae. It is now evident that the first vertebral has replaced the first costals. Further evidence that such is the case is seen in cleared young specimens. In the Carettidae the first costal scutes are anterior to the second pair of ribs which have the second costals above them (Fig. 1). In other Thecophora the first costals are above the second pair of ribs (Fig. 2). This alteration which should be regarded as important a family characteristic as the presence or absence of infra- or supra-marginals, separates the Carettidae from the others.

In a separate paper in this journal I have shown that 3 genera comprise the Carettidae. One of these, *Lepidochelys* is highly variable, and a study of its various scute arrangements throws important light on the evolution of a testudinate with 4 pairs of costals.

Examination of 378 specimens of *Lepidochelys olivacea* ranging from embryo to adult, shows that the total number of carapace scutes surrounded by the marginals varies from a possible 27 to 15 or even less. The more constant *C.caretta* usually possesses only 15 (Babcock, 1930) as does *Caretta gigas* Deraniyagala (1933). For general purposes it will suffice to ascertain the trend of numerical scute reduction from 27 to 15 which is the lowest figure where the nuchal is contiguous with the first pair of costals. Occasional specimens of the Carettidae show an attempt at further scute reduction numerically and one side possesses 4 costals, the other more (Fig. 3).

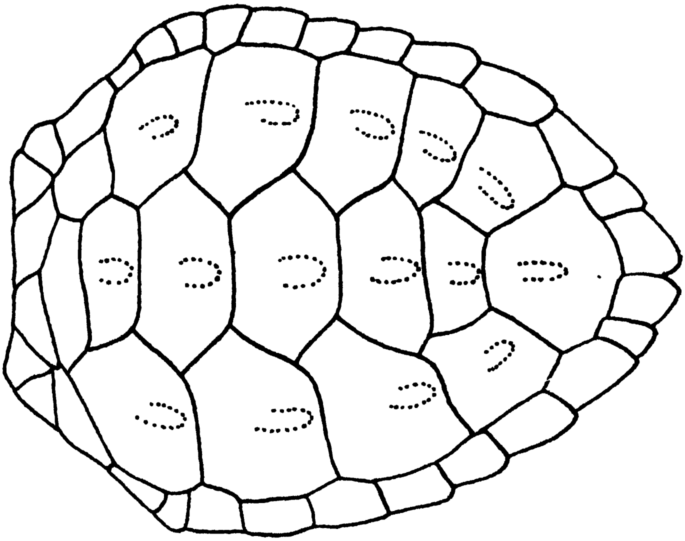

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Fig. 3. Carapace of *Lepidochelys* × 1·5

On the quadricostal side the nuchal is invariably separated from the first costal by the first vertebral as in other Thecophora. Why this always occurs when there are less than 5 pairs of costals is not known but these appearances denote that Carettidae evince a tendency to reduce their scutes to the number usual in other Thecophora.

This family probably developed a rigid corselet before scute enlargement reduced the number of costals to 4 pairs, and as it became aquatic before reaching this stage, the new environment slowed down the progress of numerical reduction of scutes and prevented the family from becoming quadricostate (for an explanation of this latter condition see Deraniyagala, 1930 b).

Turtles such as *gigas*,[1] *caretta*, and *kempi* display 5 pairs of costal scutes which are more or less constant by comparison with *olivacea* which shows less signs of terrestrial modification in its osseous structure than the rest of the family. As a result its scutes are less reduced numerically and consequently more variable than in the others, for 8 to 6 costals are common on each side and the animal very rarely reaches 5 pairs while 9 pairs of costals are rare enough to be considered atavistic.

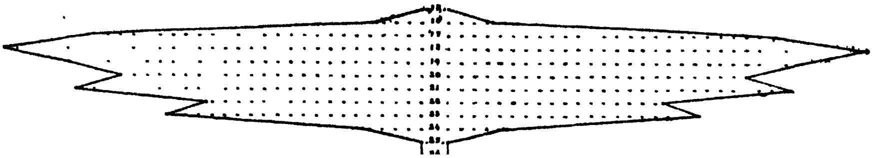

Fig. 4. Numerical reduction of inner carapace scutes in 377 *Lepidochelys*

The process of enlargement and numerical reduction of the inner carapace scutes from 26 to 15 was studied in 377 *Lepidochelys olivacea* and is depicted in Fig. 4 which shows the number of turtles with a common number of scutes.

The following is a grouping of 378 specimens of *Lepidochelys olivacea* depicting the number of turtles possessing a constant total of inner carapace scutes: —

| *Number of Scutes.* | *Number of Turtles.* |
|---|---|
| 12 | 1 |
| 15 | 2 |
| 16 | 9 |
| 17 | 52 |
| 18 | 66 |
| 19 | 56 |
| 20 | 48 |
| 21 | 55 |
| 22 | 35 |
| 23 | 41 |
| 24 | 11 |
| 25 | 1 |
| 26 | 1 |

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[1] See Deraniyagala (1933)

Basing a study of the costal scutes on the 10 pairs of ribs, these latter should be protected by 10 pairs of costals and the 10 vertebrae by as many vertebrals which gives an initial number of 30 inner carapace scutes. In the Carettidae this number is capable of reduction to half, viz., 15 scutes The first step in reduction is apparently due to 2 pairs of ribs becoming vestigial after which they are unable to produce more than 8 pairs of costal plates which seem incapable of supporting more than 9 pairs of costal scutes, a rare atavistic condition.

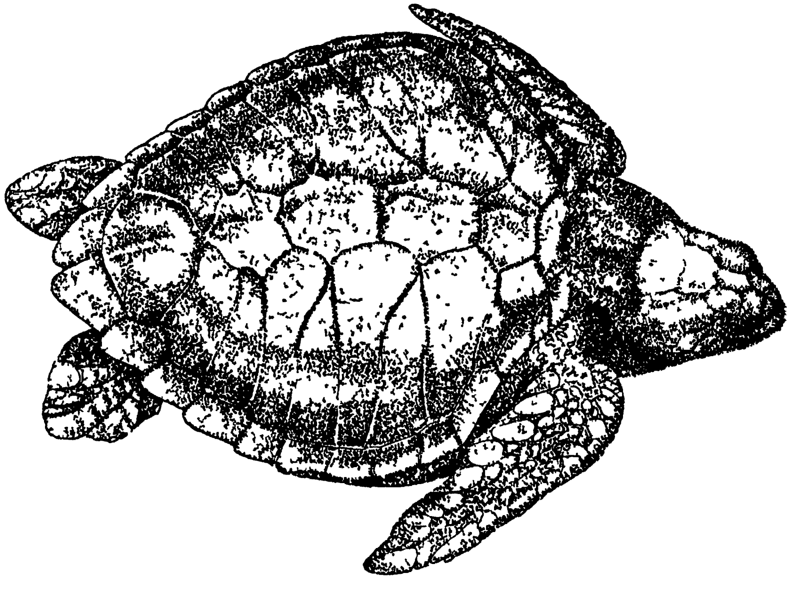

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Fig 5. Adult *Lepidochelys* with 9 pairs of costals × ⅓

An adult *L olivacea* with 5 vertebrals and 9 pairs of costal scutes is seen in Fig 5. The costals of each side are grouped into 4 pairs. Each pair is contiguous with the posterior lateral side of a vertebral and it is the anterior scute of every such pair that is the smaller. Should these anterior scutes disappear there will remain 5 costals on each side. This turtle and another specimen with 9 vertebrals and fewer costals (Fig. 6) show that atavistic reversal of one category of scutes does not necessarily involve the others.

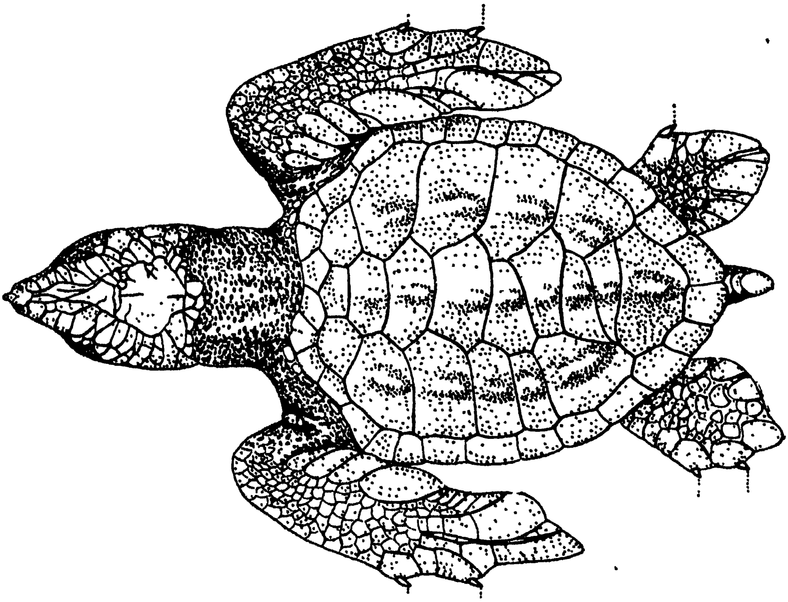

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Fig. 6. Young *Lepidochelys* with 9 vertebrals × 1.5

It is seen from Fig. 5 that costals are apt to disappear in pairs consisting of a scute from each side, as would be natural in a bilaterally symmetrical animal, but in many instances one side is more progressive than the other. There are numerous specimens with unpaired costals while the extreme limit of scute reduction in *Carettidae* usually appears to be unpaired, with 4 costals on one side 5 on the other. Generally speaking *L.olivacea* appears to range over from 18-10 costals in all, and specimens are often more advanced in scute reduction on one side than on the other. Those with fewer left costals may be termed sinistral, those with fewer right costals, dextral. It is usual for 2 scute combinations to yield a similar total and in the majority of instances the combination with a paired arrangement of costals possesses nearly twice as many turtles as the unpaired one.

Close examination of the latter type at times reveals that actually they possess a paired arrangement of costals, but as some on one side have fused together or altered their position they convey the impression of an unpaired arrangement. Hence specimens with unpaired costals denote the trend of transition from one paired costal condition to another with fewer pairs.

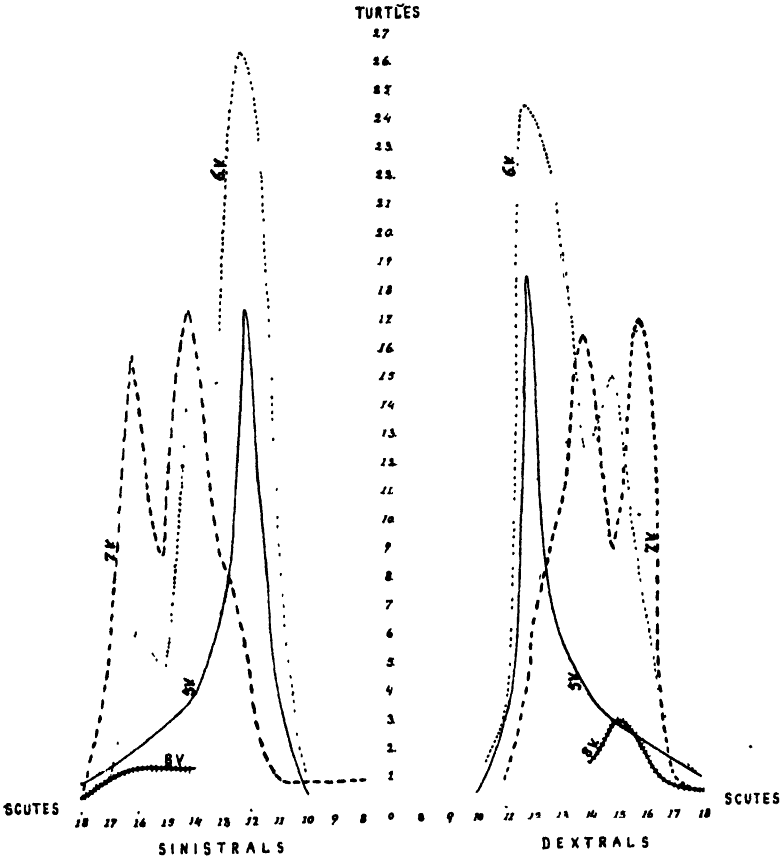

Fig. 7. Numerical reduction of left and right costal scutes in 378 *Lepidochelys*

Among the 378 *olivacea* dextrals and sinistrals occur in almost equal numbers and the inner carapace scutes range from a total of 26-15. These specimens are divisible into groups by taking each number of vertebrals as a constant and a graphic illustration of the stages of scute reduction they represent are seen in Fig. 7. In counting vertebrals, the nuchal scute is omitted while fused costals are regarded as separate. Sinistral specimens are plotted on the left, dextrals on the right and those with a paired arrangement have half their number assigned to each side. The numerator represents the number of turtles, the denominator the total of their costal scutes.

The number of turtles in each costal arrangement is limited by a constant number of vertebral scutes.

L.C.=left costals, R C.=right costals, V=vertebrals

| *Scute Total.* | *V.* | *L. C.* | *R. C.* | *Turtles.* |
|---|---|---|---|---|
| 12 | 4 | 5 | 3 | 1 |
| 15 | 5 | 5 | 5 | 1 |
| 16 | 5 | 5 | 6 | 4 |
| 16 | 5 | 6 | 5 | 3 |
| 17 | 5 | 6 | 6 | 35 |
| 17 | 5 | 7 | 5 | 1 |
| 18 | 5 | 6 | 7 | 7 |
| 18 | 5 | 7 | 6 | 6 |
| 19 | 5 | 7 | 7 | 8 |
| 23 | 5 | 9 | 9 | 2 |
| 16 | 6 | 5 | 5 | 2 |
| 17 | 6 | 5 | 6 | 12 |
| 17 | 6 | 6 | 5 | 3 |
| 18 | 6 | 5 | 7 | 2 |
| 18 | 6 | 6 | 6 | 49 |
| 19 | 6 | 6 | 7 | 15 |
| 19 | 6 | 7 | 6 | 20 |
| 19 | 6 | 8 | 5 | 2 |
| 20 | 6 | 7 | 7 | 23 |
| 20 | 6 | 8 | 6 | 1 |
| 20 | 6 | 6 | 8 | 4 |
| 21 | 6 | 7 | 8 | 5 |
| 21 | 6 | 8 | 7 | 14 |
| 21 | 6 | 9 | 6 | 1 |
| 22 | 6 | 8 | 8 | 13 |
| 22 | 6 | 9 | 7 | 1 |
| 23 | 6 | 8 | 9 | 1 |
| 23 | 6 | 9 | 8 | 2 |
| 24 | 6 | 9 | 9 | 1 |
| 15 | 7 | 3 | 5 | 1 |
| 17 | 7 | 4 | 6 | 1 |
| 18 | 7 | 5 | 6 | 1 |
| 18 | 7 | 6 | 5 | 1 |
| 19 | 7 | 6 | 6 | 10 |
| 19 | 7 | 7 | 5 | 1 |
| 20 | 7 | 6 | 7 | 9 |
| 20 | 7 | 7 | 6 | 10 |
| 21 | 7 | 6 | 8 | 2 |
| 21 | 7 | 7 | 7 | 31 |
| 21 | 7 | 8 | 6 | 1 |
| 22 | 7 | 7 | 8 | 9 |
| 22 | 7 | 8 | 7 | 9 |
| 23 | 7 | 8 | 8 | 32 |
| 23 | 7 | 9 | 7 | 1 |
| 24 | 7 | 8 | 9 | 5 |
| 24 | 7 | 9 | 8 | 2 |
| 25 | 7 | 9 | 9 | 1 |

L.C. = left costals, R.C. = right costals, V = vertebrals

| *Scute Total.* | *V.* | *L. C.* | *R. C.* | *Turtles.* |
|---|---|---|---|---|
| 22 | 8 | 7 | 7 | 3 |
| 23 | 8 | 8 | 7 | 3 |
| 24 | 8 | 8 | 8 | 3 |
| 26 | 8 | 9 | 9 | 1 |
| 20 | 9 | 6 | 5 | 1 |
| 21 | 9 | 7 | 5 | 1 |

Investigation of numerical scute reduction especially of the costals shows that alterations in shape or relative position occur in at least 5 ways in the Carettidae.

*Expansion* of some scutes causes *compression* of others which either *fuse* or are *squeezed out* or *extruded to the margin.*

The expanding scutes frequently squeeze out intervening ones which retain their position but reduce their size and ultimately disappear. Fusion usually occurs between scutes of the same category and is probably an after effect of expansion which tends to distort uniserial scutes, such as the vertebrals into a zig-zag pattern (Fig. 6).

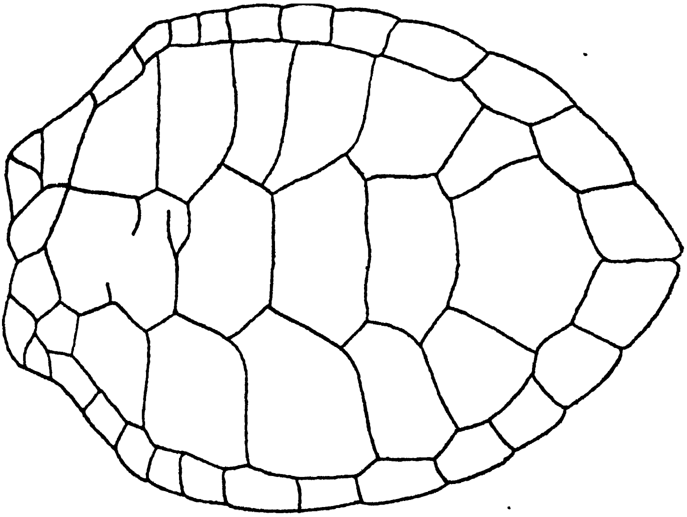

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Fig. 8. Carapace of *Lepidochelys* × 2

Another after effect is the extrusion of some scutes. In Fig. 8 the nuchal appears to be split into two, with a congestion of marginals on its right. In Carettidae there are usually 3 marginals anterior to the base of the second costal and 5 anterior to the base of the third;

but in this instance there are 5 on the right. As the left side of this specimen displays 5 marginals anterior to the base of the third costal these numbers suggest that a right costal has been omitted. It is also noticed that what appears to be the first right costal, is disproportionately large by comparison with the left first costal and is apparently a second right costal. This is supported by its size and position relative to the other scutes.

Evidence favouring the view that the third right marginal is really the first costal is the contiguity of this marginal with the nuchal and first vertebral, while the costal immediately behind it is contiguous with the first and second vertebrals. These associations denote that the two scutes in question are the first and second right costals respectively.

Fig. 3 displays 4 left costals and 5 rights and in this turtle extrusion similar to Fig. 8 occurs on the left side. The nuchal is split into two and 5 marginals are anterior to the base of the second left costal while the first left costal is much larger than its fellow on the right and is contiguous with the first three vertebrals. This denotes that the scute is really the second costal whereas the third left marginal which is contiguous with both nuchal and first vertebral is the extruded left first costal.

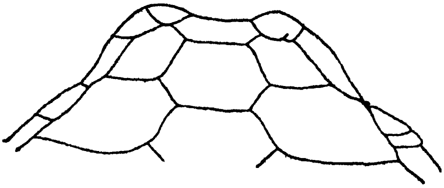

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Fig. 9. Anterior of carapace of *Lepidochelys* × 2.5

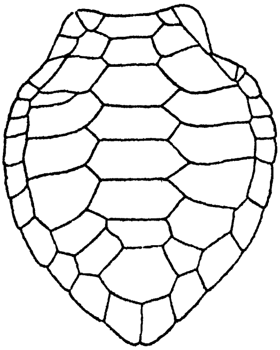

Fig. 10. Carapace of *Lepidochelys* × 1

In these two instances it will be noticed that the costals are extruded, anteriorly between the second and third marginals which are parting, see Figs. 9, 10. It is not known how many pairs of costals are thus extruded, because fusion and posterior extrusion also reduce their numbers. Fig. 11 depicts posterior extrusion of the last pair of costals. In the Carettidae no marginals are ever known to reach any vertebrals other than the nuchal and last vertebral or pygal scute. This latter is contiguous with 4 marginals. In Fig. 11 the last left costal which is in contact with the sixth or one but last vertebral has also entered the margin. It still retains the costal ridge which runs longitudinally along the costal scute. On the right side the costal ridge is continued on to the twelfth marginal which is probably an extruded costal.

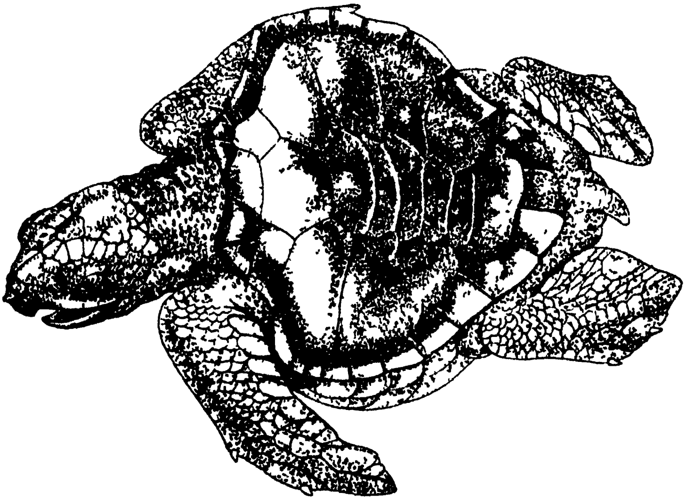

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Fig 11. Abnormal embryo of *Lepidochelys* × 1.7

Thus analysed the specimen possesses six pairs of costal scutes of which the last have entered the margin through extrusion while the third, fourth and fifth left costals have fused In passing it must be noted that the specimen is abnormal with a marked dorsal hollow from the third vertebral to the pygal scute and it may be that posterior extrusion of scutes is by no means as common as anterior extrusion. The course of scute reduction from 27 to 15 and from 15 to 12 is fairly evident.

After 5 vertebrals and 5 pairs of costals are obtained the first costals are replaced by the first vertebral and 4 pairs of costals are left. The nuchal scute which is separated from the costals subsequently undergoes reduction and loss (Fig. 2).

Under terrestrial conditions, scutes are of protective value to the slow moving animal but aquatic adaptation seems to dispense with scutes and scales. Instances are the Atheca which are born scaly but become smooth skinned, the Trionychoidea and the fossil marine *Archelon ischyros* Wieland, which have lost their scales and scutes while the genus *Lissemys* and the aquatic *Carettochelys insculpta* Ramsay, are in the process of losing their scales after losing the corselet scutes. As all these forms are among the most aquatic members of the order and no terrestrial species lacks scutes and scales it is reasonable to suppose that if testudinates continue to be aquatic they ultimately become smooth skinned. A study of the Carettoidea shows that the genus *Chelonia* by its comparatively greater loss of claws and corselet ossification has been aquatic longer than other genera and should be the first member of this superfamily to dispense with its scutes. The presence of such an adult [1] although doubtless an abnormality, proves that a smooth skinned *Chelonia* is not impossible (Fig. 12) and supports the view that smooth skinned Thecophora once possessed scutes.

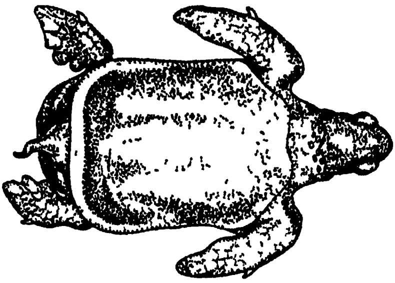

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Fig. 12. Smooth skinned *Chelonia mydas* from Karaduva × $\frac{1}{37}$

Another remarkable feature is that scute abnormalities are by no means uncommon in this genus and the number of variants in a nest at times exceeds corresponding ones in a nest of some genera of the Carettidae, *e g* In one nest of *Chelonia mydas*, Moorhouse (p 12) found that variants formed 33% while out of a total of 114 specimens he examined, 26 were variants, *i.e.*, 22 8%. This worker on examining a nest of *Caretta* (probably *gigas*) found that the variants formed only 27%.

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[1] This living adult (Fig 12) was examined at Karaduva Island, Gulf of Mannar, November 13, 1928 Beaks typical, head and neck in smooth skin with 2 vestigal rows of scales just behind head Corselet in smooth skin, carapace truncate with its margin turned up posteriorly. Flippers with vestigial scales and a single claw on each A dermal femuro-caudal fold Tail strongly kinked

The animal was very fat and the eyes were noticeably protuberant The head was olive with brown spots, carapace greenish yellow mottled with brown, plastron pale orange. Its dimensions were as follows: Snout to carapace 41 cm, tip of foreflipper to carapace 56 cm, tip of hind flipper to carapace 42 cm, length of carapace 96 cm, width of carapace 75 cm. length of tail 24 cm.

In *Eretmochelys imbricata* the percentage of variable young among 40 obtained by me after incubating 2 different batches of eggs showed a total of 13 or 32.5% which included variation of the marginals as well as the inner carapace scutes. Those which showed variation in the inner carapace scutes were only 5 in number. They consisted of 3 with 5 left costals and 2 with 4 and 6 vertebrals respectively giving a percentage of 12.5%.

It is not known whether Moorhouse dealt with marginal variations as well as inner carapace scutes in arriving at his percentages but his illustrations (p. 13, Fig. 1) convey the impression that the latter received his main attention. If this were so, it is seen that *Chelonia* has 22.8% of variants, *Eretmochelys* 12.5% and *Caretta gigas* 27%. The high percentage of variants in *Chelonia* is unusual in a quadricostal form and it is possible that these are phylogerontic reversals heralding the impending loss of scutes in this form which has already commenced inhibition of its osseous corselet.[1]

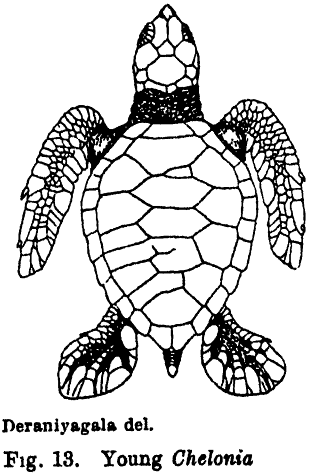

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Fig. 13. Young *Chelonia mydas* × ½

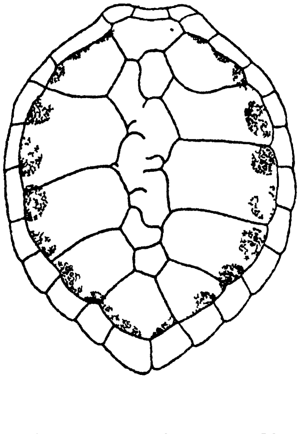

Fig. 14. Carapace of adolescent *Chelonia mydas* × $\frac{1}{12}$

The same explanation cannot be used with regard to the Carettidae which contains the highly variable *Lepidochelys olivacea* for this family possesses complete ossification and 2-3 claws on each flipper, evidence of a considerably shorter period of aquatic specialization.

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[1] This is the only marine turtle in which the plastron is white at birth, as in smooth skinned fresh water forms

A study of 878 specimens of *olivacea* showed a different type of scute fusion for none has been noticed either between scutes of different categories or over large areas of the carapace, as is usual in variants of *Chelonia* (Moorhouse, Text Fig. 1. Figs. 14, 15).

OSSIFICATION. It has been already suggested by me (Deraniyagala, 1930 b) that under terrestrial conditions the secondary osseous plates induced by the ribs and vertebrae supplanted the numerous osteoderms above them, and evolved the rigid Thecophoran corselet. Extreme specialization in this direction is seen by the corselet decreasing the number of its joints and strengthening its ossification. The first process was achieved by expansion of the costals which replaced both neurals and pygals. The second process is generally correlated to the first for in such forms the carapace is usually fused to the plastron at the bridges, while the pelvic girdle is ankylosed to the plastron. All these features occur in the Pleurodira which appear to have become aquatic secondarily. Such changes have also commenced in cryptdirous forms and the Trionychoidea [1] probably lost their pygals and several neurals after a period of terrestrial adaptation. In addition to these terrestrial features they possess aquatic ones which denote a long, secondary aquatic evolution. These are the loss of scales and scutes, the formation of fontanelles and a loss of marginals from the osseous corselet.

This last at once distinguishes osseous reduction due to an aquatic environment from that caused under certain exceptional terrestrial conditions as represented by *Testudo tornieri* [2] Siebenrock. The young of this African species possess 8-9 normal pairs of ribs, but the growth of the costal expansions is so retarded that large fontanelles appear and render the adult practically ribless (Proctor, 1922). The marginals however are unaffected, as they are essential to a terrestrial animal for raising the carapace off the plastron to permit respiration.

The mode of life of this tortoise requires a more or less flexible corselet to enable it to squeeze itself into crannies in the rock from where it defies extraction by inflating itself with air. However this mode of life requires the external protection of scutes and scales probably to guard the animal from constant friction against the rock, whereas the stiff protection of secondary bony plates not only ceases to be of service but is a hindrance to such an existence.

Thus it will be seen that in this solitary example of corselet inhibition under terrestrial conditions, the outer protection of scutes and

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[1] In the genus *Lissemys* Smith, the last neural is occasionally separated by the costals. There are always 4 to 6 crescentic scales dorsally on each manus, 1 under each pes.

[2] *T. tornieri* Siebenrock (1903) replaces *T. loveridgi* Boulenger (1920).

scales as well as the marginal bones persist but large fontanelles which involve the ribs and neural processes of the vertebrae exist in the reduced osseous corselet.

The necessity for corselet reduction under aquatic conditions is very different from the requirements of *Testudo tornieri* but it is possible that in both instances, lack of sunlight plays a considerable part and reduction is essentially by inhibition of growth. The ordinary terrestrial Thecophoran is a slow moving animal relying almost entirely on its corselet for protection. In water the animal depends on speed for its survival. Consequently the once valuable protection is now an actual impediment because it utilizes much vitality to build up, is heavy and less accommodating to stream lining than a boneless one. Under such circumstances the scales and scutes as well as the marginal bones disappear while the costal plates shrink centripetally towards the neurals exposing the ends of the ribs which also shorten in proportion to the length thus secondarily exposed.

In the Atheca which appear to be the earliest aquatic branch, ecdysis commences on the plastron and eventually leaves the animal entirely smooth skinned after the marks of the scale divisions have disappeared. The loss of osteoderms also commences ventrally. Fossil forms possess an almost complete ventral osseous armature but in modern *Dermochelys* this is more or less completely absent and the loss has extended on to the corselet bridges and anterior margin of the carapace. (See Deraniyagala on *Dermochelys* elsewhere in this volume.)

The absence of scales and corselet ossification seem to be correlated and this view is further supported by the Trionychoidea which are smooth skinned and lack all or most of the marginal bones, while dorsal and ventral fontanelles show that further inhibition of ossification is in progress.

The presence of these three features should rank this superfamily as the most specialized aquatic Thecophoran although general opinion assigns this place to the Carettoidea. Reasons for the latter view are their loss of retractility of the head and limbs and evolution of paddle limbs, with a greater loss of claws than in other Thecophora.

Although aquatic testudinates are generally classed as swimmers, it is evident that there are two types. One seeks food and safety by burrowing into the mud, the other relies on fast swimming across large bodies of water.

The first, which are represented by the three clawed Trionychoidea, need short limbs for burrowing while the anterior and at times the posterior opening of the strongly depressed corselet can be closed by compressing the valves, as the animal with head retracted ploughs through the mud. Scutes have been completely suppressed but vestigial scales occur on some.

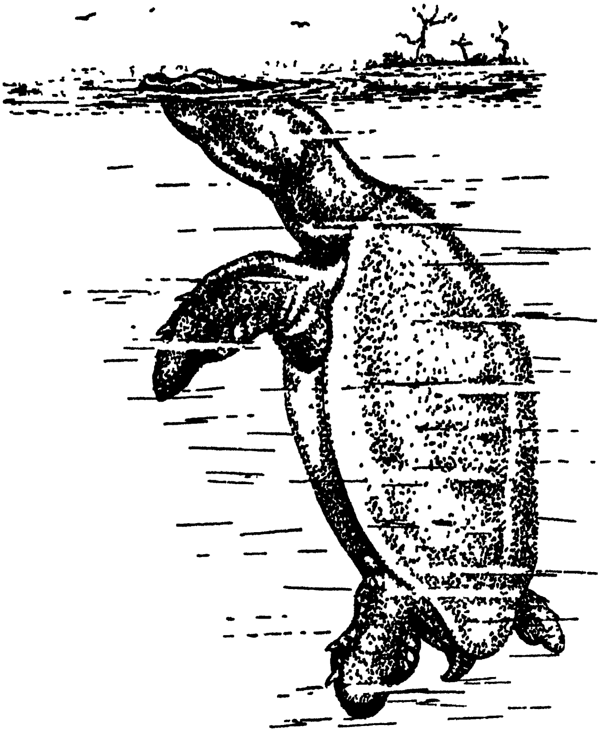

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Fig 15. *Careltochelys insculpta* × $\frac{1}{5}$

The second type is represented by the two clawed *Carettochelys insculpta* Ramsay. This form evolved in the fresh water 'inland seas' formed by the rivers of New Guinea. As is usual in natatorial testudinates, the animal has developed paddle like limbs and begun to lose its powers of retractility. The scutes are absent and with the exception of an anterior and posterior row of scales on each paddle shaped limb and a dorsal row on the tail, the skin is otherwise bare. The tubate snout has dorsal nostrils which possess valves and the head is incompletely retractile.

As both types externally resemble each other more than other testudinates, they probably became aquatic about the same time although corselet reduction is slower in the pleurodirous *Carettochelys* than in the cryptodirous Trionychoidea, owing to the stronger ossification of the former.

The cryptodirous Carettoidea show natatorial adaptation and their corselet bones evince signs of reduction even before their scales and scutes. As the Trionychoidea [1], which are also cryptodirous have progressed further in both respects besides displaying adaptation to their peculiar mode of life, which is quite as advanced as that shown by the Carettoidea, it is reasonable to consider the former as the most aquatically adapted Thecophora.

Examination of these two types of aquatic testudinates discloses that corselet reduction both external and internal is the ultimate result of an aquatic environment. The actual progress of this reduction is intricate. Terrestrial scute enlargement and numerical reduction is evidently retarded under aquatic conditions and corselet ossification, as seen in the Atheca and Cryptodira suffers similarly.

The first evidence of osseous inhibition in Cryptodira is when the costal plates fail to reach the marginal bones and examination of various genera shows that this inhibition, which begins at their distal terminations, extends towards the vertebral ends of the ribs, while the ribs themselves shorten in proportion to the length of their secondary costal plates.

Young Thecophora studied by me show that each costal plate commences at the vertebral end of a rib and extends distally to the marginal end. Hence the manner in which the ribs shorten and their plates disappear upholds the general view that in a structure or similar structures, the *first* to appear is the *last* to disappear.

In addition to inhibition of costal development, the marginals are also affected. In the Trionychoidea the marginals have disappeared, although in one genus *Lissemys* Smith (1931, Fig. 34) some of the posterior ones still persist. This shows that the anterior marginals are the first to disappear and suggest that marginals originated posteriorly. However, stained and cleared young of the Carettoidea and *Testudo elegans* Schoepff, show that the marginals commence anteriorly (Figs. 1, 2). It is now observed that the *first* to appear are the *first* to disappear.

This unusual procedure requires explanation which is best commenced by investigating the functions of these bones.

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[1] The Trionychoidea are probably derived from Emydoid ancestors which possessed both scutes and scales.

A study of Figs. 1, 2 and also of *Testudo tornieri* denotes that they act as guards to the free ends of the ribs, and form a rim to support the dermal carapace which they raise off the plastron. All three requirements are essentially terrestrial, for even if the loss of some anterior ribs rendered their marginals valueless as rib guards, they persisted as guards to the costal expansions of other ribs and strengthened the rim of the corselet.

In aquatic forms, inhibition of these costal plates isolated the marginals and in such a medium the carapace no longer needed them as a rim support. Hence these useless structures are the first to disappear. It is also seen that in water, the carapace no longer presses down upon the plastron, hence the other function of the remaining marginals disappeared. Finally they also ceased to be guards to the tips of the ribs [1] which were gradually shortening in proportion to the length of the inhibited costal plates. Thus rendered useless the marginals disappeared altogether.

The corselet now consists of a dermal corselet in which the osseous part of the carapace is a small central disk with shortened ribs. It is not known whether this stiff area is necessary to retain the shape of the corselet or whether inhibition will continue until the secondary costal and neural expansions disappear altogether leaving a boneless corselet supported by ordinary ribs and vertebrae, but the latter appears probable.

In conclusion the trend of corselet reduction may be summarized as follows:—There are two types of loss.

(1) One consists of the *atrophy* of some parts due to the *hypertrophy* of others (terrestrial); (2) The other is loss due to *inhibition* of growth (terrestrial and aquatic).

This *inhibition* affects the outer covering of scales and scutes as well as the inner osseous corselet.

(*a*) Under terrestrial conditions inhibition is noted to affect the osseous corselet but not the scales or scutes, *e.g.*, *Testudo tornieri*.

(*b*) Inhibition of both occurs in an aquatic environment. In pleurodirous forms loss of scales and scutes precedes osseous inhibition, *e.g.*, *Carettochelys*.

In Atheca and cryptodirous forms osseous inhibition commences before the lepidosis and scutes disappear, *e.g.*, *Dermochelys* and the Carettoidea.

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[1] In view of the apparent correlation between the ribs and marginals it is possible that this reptilian order once possessed more ribs than at present as is suggested by the number of marginals.

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CEYLON J. SCI. (B) VOL. XVIII, PT. 2. (*May 22, 1934*)

# Some new fossorial skinks of Ceylon

BY

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(With One Text Figure)

The genus *Acontias* Cuvier, displays a conspicuous tendency to suppress the limbs which at most are minute and almost without function. The posterior are the more persistent and may possibly be employed to some extent as claspers in reproduction. Apart from the loss of limbs another fossorial adaptation is the loss of the ear opening in some. Four species have hitherto been known from Ceylon and these differ sub-generically from those of Africa and Madagascar (Hewitt, 1929).

The two extremes are represented by the tridactyle *Acontias burtoni* Gray and the limbless *Acontias layardi* Kelaart. In 1932 (*a*) I assigned a species from Gammaduva, Central Province, to the latter but Dr. Malcolm Smith after examining a specimen I sent him is of the opinion that it is probably *sarasinorum* and not *layardi*.

According to him the distinctive points between these two species are:—

1. Interparietal broader than frontal; no visible ear opening; no limbs; 22-24 scales round body . . . . . . . . *layardi*
2. Interparietal narrower than frontal; an ear opening; a bud-like pair of hind limbs; 22 scales round the body . . . . . . . . *sarasinorum*

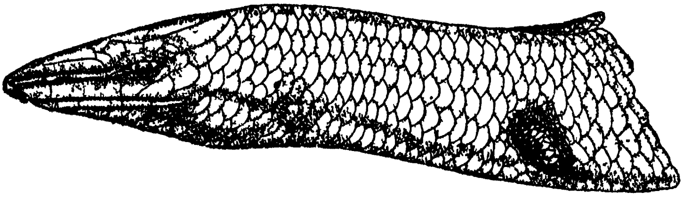
and 'The characters as regards *layardi* are quite constant.' On this information it is decided to relegate *layardi* to a separate sub-genus for which the name (*Anguinicephalus*) is proposed, to denote the absence of external ear openings. Its other generic feature is the total loss of limbs.

In the Fauna of British India (1890) Boulenger states that *Acontias sarasinorum* has 2 loreals. The Gammaduva form has only one and according to Smith 'Except for the broader interparietal and the number of scales round the body, the specimen you have sent me agrees with *sarasinorum*, known only from a single example which may be abnormal.'

Until it has been proved that the type specimen of *sarasinorum* is abnormal it is proposed to name the Gammaduva species for Dr. Malcolm Smith and this form will be *Acontias* (*Evesia*) *smithi* and generally has 26-28 scales round mid body. The type specimen is in the British Museum.

As the embryos of *A* (*E.*) *smithi* have the limbs no better developed than the adults (Deraniyagala, 1932 *b*) it is evident that the reduction is not post natal while a number of specimens of *burtoni* examined from Ambagamuva, Kadugannava (Central Province), Allagalla, Rakvana (Sabaragamuva Province), and Matugama (Western Province) in 1930, all possessed 4 tridactyle limbs. Hence it is evident that the number of digits may be accepted as a specific character, while their presence or absence is sub-generic; species with digits forming the sub-genus *Nessia* Gray, those without *Evesia* Gray [1] while those without ear openings or limbs are *Anguinicephalus*, sub-gen. nov.

Recently 2 specimens with didactyle limbs were kindly presented by Mr. W. Lang-Schofield of Polgahavela (Central Province). They display a further difference from the other species in that the unpaired cephalic scales increase in length posteriorly. This form is almost intermediate between *A* (*N.*) *burtoni* and *A* (*E.*) *monodactylus*. The type, of which the measurements are given, will be deposited in the British Museum.



P. Deraniyagala del.

Fig. 1. *Acontias* (*Nessia*) *didactylus*, sp. nov. × 4.5

## *Acontias* (*Nessia*) *didactylus*, sp. nov.

Anguiniform, with didactyle, clawed limbs. Snout bluntly acuminate, jaws overshot exposing anterior teeth of upper jaw. Lower eye lid scaly, ear small, about 7 scales behind eye which is midway between nostril and ear. Rostral covers about a third of the snout with the nostril pierced in its anterior region and connected to posterior

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[1] In living *Evesia monodactyla* the limbs are retractile and the scales feebly erectile, especially on the cephalic and nuchal regions.

margin of rostral by a groove. Frontonasal longer than rostral, slightly shorter than frontal which is shorter than the interparietal. This last is contiguous with the second and third supraoculars. Parietals comparatively wide, wider than the supraoculars and contiguous; behind them a row of 4 enlarged nuchals in a single transverse series.

Supraoculars 4, the first and second form emarginations in the frontal. Supralabials 4, the first equals loreal and is 1.5 times length of rostral, the second is sub-ocular. Mental moderate, contiguous with a single triangular chin shield behind which are 3 pairs of elongate shields which are separated from each other mesially by a single row of scales. Infralabials 3. Body scales directed ventrally, 26 round mid body and about 100 from axilla to groin, 7 longitudinal pectoral rows. Anterior limb 23 scales behind gape, as long as rostral, with 2 well developed clawed digits and 7 scales along its edge exclusive of the digits, posterior limb longer, with 10-13 rows of scales along its edge, exclusive of the digits. Preanals feebly enlarged. Caudals sub-equal. Extremity of the cylindrical tail is feebly compressed dorsally.

*Colours.* Brown, the dorsal scales outlined in darker, ventrally lighter.

*Dimensions.* Snout to ear 6.5 mm , gape 5 mm., ear to fore limb 7 mm., snout to cloaca 65 mm., tail 36 mm. (type).

*Distribution.* Polgahavela, altitude 241 ft. Ceylon.

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CEYLON J. SCI. (B) VOL. XVIII, PT. 2. (*May 22, 1934*)

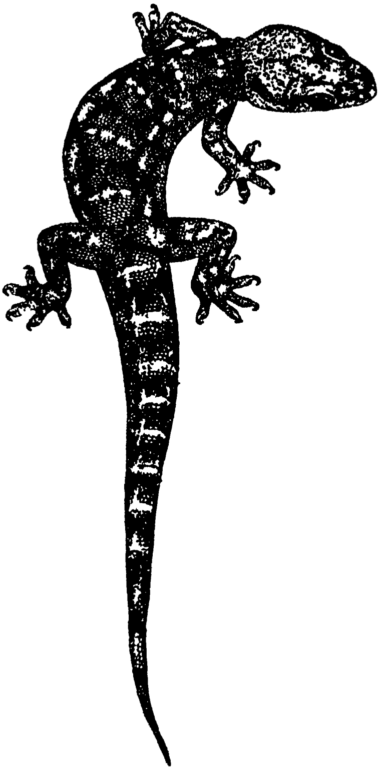
# A New Genus of Gecko

BY

## MALCOLM A. SMITH and P. E. P. DERANIYAGALA

The discovery of 3 male specimens of *Teratolepis scabriceps* Annandale, in Ceylon has led us to reconsider the generic status of this Gecko, hitherto known only from 3 female specimens from S. India.

It differs so distinctly, both in the character of the digits and in general scalation, from the true *Teratolepis*, type *fasciata*, that we have no hesitation in placing it in a genus by itself. We propose to name it *Lophopholis*, gen. nov.



P. Deraniyagala del.

Fig. 1. *Lophopholis scabriceps* gen. nov. × 1

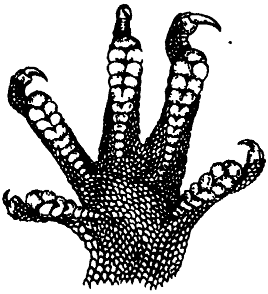


Fig. 2. Lower surface of left hind foot × 3.5

## **Lophopholis**, gen. nov.

Digits free, moderately dilated, with a double series of lamellae beneath; terminal phalanges long, slender, clawed, free, rising angularly from within the expansion. Dorsal scales imbricate, not much larger than the ventral scales; caudal scales uniform with the body scales. Pupil vertical. Male with preanal pores.

A single species.

Three examples from Ceylon obtained at Mariccukatti, in the Northern Province, do not differ in scalation and coloration from the specimens from Southern India; they are all males with 6 preanal pores in a wide-angled series, 3 on each side separated by a median scale.

CEYLON J. SCI. (B) VOL. XVIII, PT. 2. *(May 22, 1934)*

# The Short-nosed Fruit Bats (Cynopterus) of Ceylon

W. W. A. PHILLIPS F.Z.S.

For some years, the correct determination of the Ceylon *Cynopteri* has presented a puzzle which has proved to be solvable only by the examination and comparison of considerable new material from all parts of the Island.

Andersen (1912) stated that two species, *C. sphinx sphinx* and *C. brachyotis ceylonensis* are found in the Island but a casual examination of specimens from various localities showed that the determination of the two forms was not so simple a matter as Andersen appears to have thought.

In order to solve the problem satisfactorily, I have collected, with the kind assistance of the authorities of the Colombo Museum, during the past few years, specimens from as many localities as possible, with a view to a careful examination and comparison of material from all altitudes and climatic zones.

The Colombo Museum reserve collection, to which all specimens obtained have been sent, now contains 48 skins and skulls of both forms, in addition to which the Bombay Natural History Society has very kindly forwarded 9 specimens labelled *C. sphinx sphinx*, five of them being from India and the remaining four from Ceylon. I have also, on numerous occasions, examined and measured many other specimens in the flesh as well as live animals that have not been preserved. Although very few examples from the highest altitudes have been secured, the available material is sufficient to enable me to arrive at the following conclusions with regard to the two forms present in the Island.

As long ago as 1870, Gray had shown that a small race of *Cynopterus* existed in at least a part of the Island. This form he distinguished from the Indian mainland form under the name *C. marginatus* [vel *sphinx*] var. *ceylonensis*. His description of it was contained in a few lines, as follows: ' Fur blackish brown, underside rather greyer; white margin of ear narrow, indistinct; arm-bone 2 inches 4 lines '. But it was not until 1912, when Andersen's *Catalogue of Chiroptera in the collection of the British Museum* was published, that it was generally recognized that two distinct forms occur in the Island.

Andersen (1912, p. 624) states ' Ceylon is inhabited by two forms of *Cynopterus*, *C. sphinx sphinx* and *C. brachyotis ceylonensis;*' the former is common to the Indian Peninsula and Ceylon, the latter a local representative of an otherwise exclusively Indo-Malayan species and so closely similar to *C. b. brachyotis* (Malay Peninsula, Sumatra, Borneo, &c.) as to differ only by trivial average characters. The rostrum of *ceylonensis* is very nearly equal to, in *brachyotis* usually decidedly less than, one fourth of the total length of the skull; the dentition, particularly the third premolars above and below, and the mandible average a little heavier, but in all other respects there appears to be no appreciable difference between these two geographically so widely separated races. From *C. s. sphinx* (forearm 66—73.5 mm.) the present form [*ceylonensis*] differs by its distinctly shorter rostrum and conspicuously smaller size (forearm 59—64 mm.) '.

It will be noted from the foregoing that while Gray regarded *ceylonensis* as a small variety of *C. sphinx*, Andersen considered that it was a representative of a distinct species, *C. brachyotis*.

One cannot but feel distinctly diffident in advancing views that do not quite coincide with those of such an authority as Andersen but, on looking into the matter further, I find that Andersen examined only five specimens of the form *ceylonensis*, and that of these only two were adult males, one an adult female, one an unsexed, adult skeleton, and the remaining one a juvenile male. In the case of the last only is the locality—Punduloya—given.

With regard to *C. s. sphinx* the material from Ceylon, at Andersen's disposal, was even more meagre—one specimen only, with no locality given, was examined. Andersen's views were based, therefore, on an examination of six specimens only—five *ceylonensis* and one *sphinx*, and in the case of one specimen only was the locality of origin known. It would seem likely, therefore, that lack of sufficient material led him to believe that two distinct species were represented in the collection and that, had he been able to examine and compare a really good series of specimens from all altitudes, he would have come to other conclusions.

We may, I think, accept as correct his statement that typical *C. s. sphinx* occurs in the Island. This bat appears to be quite commonly distributed throughout the lowlands, both in the dry zone of the north and east as well as in the wet zone of the south west. Twenty-two specimens (15 females and 7 males) have been examined by me and compared with five (1 female and 4 males), which may be regarded as typical *C. s. sphinx*, from various localities on the Indian mainland and they are, for all practical purposes, identical in both colour and average measurements.

The average body and skull measurements of these specimens are as follows:—

*Body measurements, taken in the flesh*

| | *Head and body* mm. | *Tail* mm. | *Hindfoot* mm. | *Ear* mm. | *Forearm* mm. |
|---|---|---|---|---|---|
| *Ceylon—* | | | | | |
| Average of 7 males | 94.7 | 9.1 | 14.4 | 18.7 | 64.6 |
| Average of 15 females | 95 | 9 | 14.5 | 19.5 | 66 |
| *Indian—* | | | | | |
| Average of 4 males | 97 | 12.7 | 16.7 | 21 | 69·5 |
| One female | 93 | 10 | 15 | 17 | 64 |

*Skull measurements*

| | *Lambda to gnathion* mm. | *Condylo-basal length* mm. | *Rostrum, orbit to nares* mm. | *Zygomatic width* mm. | *Tooth row* mm. |
|---|---|---|---|---|---|
| *Ceylon—* | | | | | |
| Average of 4 males | 32.2 | 29.9 | 7.6 | 20.3 | 11.5 |
| Average of 6 females | 30.9 | 29.5 | 7.6 | 20.2 | 10.2 |
| *Indian—* | | | | | |
| Average of 4 males | 33 | 31.6 | 8.6 | 21.2 | 11 |
| One female | 31.5 | 29 | 7 | D | 10 |

*Note.*—D denotes damaged.

The lowland form then may be accepted definitely as *C. sphinx sphinx*. When we turn to the hills, however, we find that although typical *sphinx* does occur in the lower foot hills, there is a very distinct tendency among individuals towards a darkening of the pelage and a stunting of body size, and as we ascend into the mountains this tendency becomes more and more marked. It is however quite a gradual process; so much so, that in almost any collection from a medium altitude of, say, 2,000 ft. to 3,000 ft., both large and small individuals may be found, although the collection may consist of specimens taken from a single colony. In other words, in one and the same colony of *Cynopterus*, at medium altitudes, there may be found individuals that answer well either to typical *sphinx* or to typical *ceylonensis*, while the majority of the colony will most probably be found to fill a position somewhere between the two forms.

In the highest mountains, at altitudes of 4,000 ft. and over, very few, if any, individuals corresponding to the description of *sphinx*, will be found. The small, dark form, *ceylonensis*, alone is represented.

The following average measurements, of specimens taken from (A) above 4,000 ft., (B) between 4,000 ft. and 1,000 ft,, and (C) below 1,000 ft. show the gradual increase in size that takes place as the hills are descended but the tables of individual measurements given at the end of this paper show more clearly the great differences in size that are found among individuals at medium altitudes.

*Body measurements*

| | *Head and body* mm. | *Tail* mm. | *Hindfoot* mm. | *Ear* mm. | *Forearm* mm. |
|---|---|---|---|---|---|
| (*A*) ***From Highlands over 4,000 ft.***— | | | | | |
| One male | 80 | 15 | 12 | 18 | 58 |
| Average of 2 females | 76 | 13.5 | 11.5 | 17 | — |
| (*B*) ***From Medium altitudes below 4,000 ft. and above 1,000 ft.***— | | | | | |
| Average of 8 males | 91.1 | 12 | 14.2 | 19.8 | 63 |
| Average of 34 females | 91.5 | 10 | .13.5 | 18.5 | 63 (26 only) |
| (*C*) ***From Lowlands below 1,000 ft.***— | | | | | |
| Average of 7 males | 94.7 | 9.1 | 14.4 | 18.7 | 64.6 |
| Average of 15 females | 95 | 9 | 14.5 | 19.5 | 66 (13 only |

*Skull measurements*

| | *Lambda to gnathion* mm. | *Condylo-basal length* mm. | *Rostrum, orbit to nares* mm. | *Zygomatic width* mm. | *Tooth row* mm. |
|---|---|---|---|---|---|
| (*A*) ***From Highlands over 4,000 ft.***— | | | | | |
| One male | D | 27 | 5.5 | D | 9 |
| (*B*) ***From Medium altitudes below 4,000 ft. and above 1,000 ft.***— | | | | | |
| Average of 7 males | 30.7 | 29.7 | 7.3 | 19.4 | 10.4 |
| Average of 17 females | 29.7 | 28.3 | 6.9 | 19.3 | 10.1 |
| (*C*) ***From Lowlands below 1,000 ft.*** | | | | | |
| Average of 4 males | 32.2 | 29.9 | 7.6 | 20.3 | 11.5 |
| Average of 6 females | 30.9 | 29.5 | 7.6 | 20.2 | 10.2 |

*Note.*—D denotes damaged.

It will be seen from these measurements, and from the sub-joined tables, that Andersen's definition of his two so-called *species* is useless in most cases for purposes of determination when dealing with specimens from medium altitudes; Andersen gives the length of the forearm in *C. brachyotus ceylonensis* as 59-64 mm. and of *C. s. sphinx* as 66-73.5 mm., but in the medium-altitude specimens now examined it varies in length from 56 to 70 mm. In like manner it is impossible to determine the two forms by the colour of the pelage alone.

If, therefore, it is admitted that the highland form and the lowland form intergrade into one another so completely, at medium altitudes, that it is impossible to determine to which a given specimen is referable, the question naturally arises, was Andersen correct in referring the two forms to separate species? Personally, I think that we must consider them only as geographical races of the one species, *C. sphinx*, which we have definitely accepted as occurring in the lowlands.

I consider that, when it has been shown that two forms, however distinct in the extremes of their respective ranges, interbreed so freely and intergrade so completely that many of the intermediate specimens cannot be definitely referred to either, they cannot be maintained as two distinct species. They must, I think, be looked upon as merely well-marked races of one and the same species.

In this case, it would appear probable that the Malayan *Cynopterus brachyotis* (and its races) which is, according to Andersen, so very like the small, highland, Ceylon form, should, more correctly, be regarded as but a well-marked race of the widely distributed *C. sphinx;* but this is a point that will require elucidating by further research in the future. The Ceylon Highland Cynopterus, *ceylonensis*, will then, in future, have to be known under the name of *C. sphinx ceylonensis* and the lowland form as *C. sphinx sphinx*, if this view is accepted.

The descriptions that have been given of the two forms are substantially correct; they may be distinguished from one another by the following external characters:—

A. Size larger; forearm 64 to 72 mm.
Colour generally lighter, contrasting
conspicuously with the tawny russet
of the nape and sides of the neck ......... *Cynopterus sphinx sphinx*
B. Size smaller; forearm 56 to 64 mm.
Colour generally darker, contrasting
scarcely at all with the tawny russet
or yellowish of the nape and neck ......... *Cynopterus sphinx ceylonensis*

The occurrence in the Ceylon Hills of a small race of *Cynopterus*, evidently closely allied to the Malayan form, cannot but be of great interest to zoogeographers. It would appear to indicate a period of close association between Malaya and Ceylon and to help to confirm the theory that at one time a land connexion existed between these two countries. The occurrence can be satisfactorily accounted for only if we accept the theory that, at one period, Ceylon formed part of the same sub-continent as Malaya and that, when the gradual subsidence took place, the central mountain cluster of Ceylon remained above the ocean and became isolated as a small Island with only the higher hills showing above the surrounding sea.

At a later period, when a subsequent elevation of the land adjoining what we now term India took place, Ceylon was almost certainly rejoined to the Indian mainland. It was then that a second influx of the fauna of the Indo-Chinese region took place, the larger *C. sphinx*, among other species, working its way southwards until it met, in the Ceylon foothills, the smaller, original Ceylon race, *ceylonensis*. Having met, and being closely akin, the two forms commenced to interbreed and established an intermediate form in the neutral zone between the habitats of the two races. Evidently, isolation had not sufficiently changed *ceylonensis* to form a distinct species that would refrain from interbreeding with the larger northern *sphinx*.

A very similar occurrence is to be found in the case of some of the Ceylon shrews of the genus *Suncus*. In the central mountain cluster is found a small blackish shrew, *montanus*, which would at first sight be taken to be a distinct species. But in the lowlands of the dry zone is a larger ashy-grey Suncus (*S. caeruleus caeruleus*) of the same race as that found on the Indian mainland. These two animals would be taken as representing separate species were it not for the fact that, at medium altitudes of 1,000 ft. to 3,000 ft. there occurs another form, *kandianus*, which is intermediate between the two. The lowland form, *caeruleus* grades completely into *kandianus* and the latter grades equally completely, in the higher altitudes, into *montanus;* so much so, that some specimens are most difficult to determine as to their correct race.

In this case, *montanus* would appear to be the original Ceylonese form, which became isolated in the mountains when the subsidence took place, while the larger *caeruleus* would appear to have arrived in the Island at a later period when, after elevation, Ceylon become rejoined to the Indian mainland.

Both these cases are alike in that the hill forms and the lowland forms have become completely fused at medium altitudes. That being so, I do not consider that, in either case, the hill form can be granted specific rank.

It gives me much pleasure to record my grateful thanks to Dr. J. Pearson, of the Colombo Museum, for the loan of the specimens from the reserve collections of that Institution and to the Authorities of the Bombay Natural History Society for the loan of material from India.

TABLE I—*Body measurements of Ceylon Cynopteri (arranged according to altitude of locality)*

*Males*

| *Colltr's No.* | *Date* | *Locality* | *Altitude* Ft. | *Head and body* | *Tail* | *Hind-foot* | *Ear* | *Fore-arm* |
|---|---|---|---|---|---|---|---|---|
| | | *Highlands, over 4,000 ft.* | | | | | | |
| C. M. 7 | 23–xii–23 | Hakgalla | 5,580 | 80 | 15 | 12 | 18 | 58 |
| | | *Medium altitudes, under 4,000 ft. and over 1,000 ft.* | | | | | | |
| 282 | 29-viii-20 | Passara | 3,000 | 82 | 11 | 15 | 18 | 57 |
| 284 | do. | do. | do. | 97 | 13 | 15 | 20 | 65 |
| 285 | do. | do. | do. | 95 | 15 | 15 | 19 | 62 |
| 31A | 4–iv–31 | Kumbalgamuwa | 2,800 | 89 | 10 | 13 | 19 | 60 |
| 25 | 10–iv–31 | do. | do. | 101 | 12 | 13 | 21 | 69 |
| 33 | 2–vi–31 | do. | do. | 93 | 15 | 15 | 20 | 68 |
| 771 | 16-i–14 | Urugala | 2,500 | 88 | 11 | 14.5 | 21 | 59 |
| 815 | 23–i–14 | do. | do. | 84 | 8.5 | 13.5 | 21 | 64 |
| | | | Average of 8 | 91.1 | 12 | 14.2 | 19.8 | 63 |
| | | *Lowlands, below 1,000 ft.* | | | | | | |
| | 24–vi–31 | Elahera C. P. | 700 | 100 | 9 | 14 | 20 | 66 |
| 1 | 17–xi–31 | Sigiriya C. P. | 654 | 93 | 6 | 15 | 17 | 62 |
| 5 | 19–xi–31 | do. | do. | 96 | 9 | 16 | 19 | 67 |
| 6 | 20–xi–31 | do. | do. | 89 | 6 | 12 | 16 | 63 |
| 409 | 16–i–21 | Kurunegala N.-W. P. | 500 | 95 | 8 | 13 | 20 | 67 |
| | 20–v–21 | Matugama W. P. | 100 | 94 | 17 | 15 | 20 | — |
| | 25–viii–31 | Colombo District W. P. | — | 96 | 9 | 16 | 19 | 63 |
| | | | Average of 7 | 94.7 | 9.1 | 14.4 | 18.7 | 64.6 |

*Indian specimens of C. sphinx sphinx*

*Males*

| *Colltr's No.* | *Date* | *Locality* | *Head and body* | *Tail* | *Hind-foot* | *Ear* | *Fore-arm* |
|---|---|---|---|---|---|---|---|
| 4582 | 4–iii–14 | Pilibhit Rohilkund U. P. | 109 | 12 | 16 | 21 | 72 |
| V/793 | 4–ix–29 | Thummalabgla Rajampeta Range, South Cuddapah | 88 | 12 | 16 | 21 | 69 |
| 545 | 4–viii–9 | Cumballa Hill, Bombay | 98 | 15 | 18 | 21 | 71 |
| V/677 | 21–viii–29 | Koduru Balapalli Range, South Cuddapah | 93 | 12 | 17 | 21 | 66 |
| | | Average of 4 | 97 | 12.7 | 16.7 | 21 | 69.5 |

| | | Head and body | Tail | Hind-foot | Ear | Fore-arm |
|---|---|---|---|---|---|---|
| ABSTRACT. | *Highlands, over 4,000 ft.*— | | | | | |
| | Of one only .. | 80 | 15 | 12 | 18 | 58 |
| | *Medium altitude, under 4,000 ft. but over 1,000 ft.*— | | | | | |
| | Average of 8 .. | 91.1 | 12 | 14.2 | 19.8 | 63 |
| | *Lowlands, under 1,000 ft.*— | | | | | |
| | Average of 7 .. .. | 94.7 | 9.1 | 14.4 | 18.7 | 64.6 |
| | *Indian*— | | | | | |
| | Average of 4 .. .. | 97 | 12.7 | 16.7 | 21 | 69.5 |

## TABLE II—*Body measurements of Ceylon Cynopteri (arranged according to altitude of locality)*

### *Females*

*Highlands, above 4,000 ft.*

| Colltr's No. | Date | Locality | Altitude Ft. | Head and body | Tail | Hind-foot | Ear | Fore-arm |
|---|---|---|---|---|---|---|---|---|
| 8 | 23-xii-23 | Hakgala | 5,580 | 77 | 15 | 12 | 17 | — |
| 9 | do. | do. | do. | 75 | 12 | 11 | 17 | — |
| | | | Average of 2 | 76 | 13.5 | 11.5 | 17 | — |

*Medium altitudes, below 4,000 ft. and above 1,000 ft.*

| Colltr's No. | Date | Locality | Altitude Ft. | Head and body | Tail | Hind-foot | Ear | Fore-arm |
|---|---|---|---|---|---|---|---|---|
| 710 | 14-v-22 | Passara | 3,000 | 85 | 10 | 12 | 17 | — |
| 711 | do. | do. | do. | 89 | 8 | 12 | 18 | - |
| 712 | do. | do. | do. | 89 | 6 | 12 | 19 | 60 |
| 713 | do. | do. | do. | 93 | 8 | 13 | 17 | 56 |
| 714 | do. | do. | do. | 85 | 6 | 11 | 17 | 58 |
| 715 | do. | do. | do. | 91 | 6 | 13 | 17 | 56 |
| | do. | do. | do. | 86 | 6 | 11 | 16 | — |
| | do. | do. | do. | 90 | 6 | 12 | 17 | — |
| | do. | do. | do. | 89 | 8 | 13 | 17 | 58 |
| 281 | 29-viii-20 | do. | do. | 85 | 11 | 15 | 19 | 58 |
| 283 | do. | do. | do. | 85 | 11 | 15 | 18 | — |
| 295 | 31-viii-20 | do. | do. | 86 | 13 | 13 | 17 | — |
| 296 | do. | do. | do. | 84 | 11 | 15 | 19 | — |
| 29 | 9-iv-31 | Kumbalgamuwa | do. | 85 | 8 | 13 | 18 | 61 |
| 37 | do. | do. | do. | 90 | 7 | 13 | 18 | 58 |
| 24 | 10-iv-31 | do. | do. | 102 | 11 | 14 | 22 | 69 |
| 30 | 9-iv-31 | do. | do. | 89 | 8 | 13 | 16 | 58 |
| 32 | do. | do. | do. | 85 | 12 | 13 | 19 | 58 |
| 28 | do. | do. | do. | 88 | 7 | 21 | 18 | 61 |
| 19 | 10-iv-31 | do. | do. | 99 | 9 | 13 | 19 | 67 |
| 22 | do. | do. | do. | 99 | 0 | 13 | 21 | 68 |
| 20 | do. | do. | do. | 100 | 10 | 13 | 19 | 70 |

| *Colltr's No.* | *Date* | *Locality* | *Altitude* | *Head and body* | *Tail* | *Hind-foot.* | *Ear* | *Fore-arm* |
|---|---|---|---|---|---|---|---|---|
| | | | Ft. | | | | | |
| 27 | 9–iv–31 | Kumbalgamuwa | 2,800 | 102 | 14 | 13 | 22 | 67 |
| 21 | 10–iv–31 | do. | do. | 99 | 10 | 13 | 21 | 66 |
| 91 | 2–vi–31 | do. | do. | 103 | 17 | 16 | 20 | 68 |
| 32 | do. | do. | do. | 99 | 17 | 16 | 20 | 66 |
| 27 | 31–v–31 | do. | do. | 92 | 16 | 15 | 17 | 67 |
| 29 | do. | do. | do. | 98 | 16 | 13 | 20 | 67 |
| 26 | do. | do. | do. | 88 | 15 | 13 | 20 | 66.5 |
| 28 | do. | do. | do. | 98 | 19 | 15 | 20 | 67 |
| 30 | do. | do. | do. | 80 | 12 | 15 | 16 | 58 |
| | 17–i–28 | Galaha | 2,500 | 91 | 11 | 15 | 21 | 65 |
| | 17–i–28 | do. | do. | 96 | 8 | 15 | 21 | — |
| 766 | 16–i–14 | Urugala | do. | 89 | 7 | 15 | 20 | 64 |
| | | | Average of 34 | 91.5 | 10 | 13.5 | 18.5 | 63 |
| | | *Lowlands, below 1,000 ft.* | | | | | | |
| 408 | 16–i–21 | Kurunegala | 500 | 87 | 8 | 14 | 18 | — |
| 4 | 19–xi–31 | Sigiriya | 650 | 100 | 8 | 15 | 18 | 68.5 |
| 8 | 21–xi–31 | do. | do. | 101 | 9 | 18 | 20 | 70 |
| 7 | do. | do. | do. | 94 | 8 | 15 | 19 | 65 |
| 10 | do. | do. | do. | 96 | 15 | 14 | 20 | 63 |
| 11 | do. | do. | do. | 97 | 9 | 13 | 18 | 65 |
| | 24–vi–32 | Elahera | 500 | 101 | 11 | 15 | 21.5 | 69 |
| | do. | do. | do. | 100 | 7 | 15 | 20 | 67 |
| | do. | do. | do. | 95 | 10 | 12 | 21 | 66 |
| | do. | do. | do. | 95 | 9 | 13 | 20 | 66 |
| | do. | do. | do. | 96 | 10 | 13 | 20 | — |
| | do. | do. | do. | 98 | 8 | 14 | 20 | 67 |
| | 25–xii–26 | Matugama | 200 | 97 | 10 | 15 | 20 | 69 |
| | 6–vii–31 | Colombo District | 100 | 84 | 6 | 17 | 18 | 60.5 |
| 1202 | 8–v–14 | Tammanwewa | 200 | 83 | 9 | 15.5 | 20.5 | 65 |
| | | | Average of 15 | 95 | 9 | 14.5 | 19.5 | 66 |

## *Indian specimens of C. sphinx sphinx*

### *Females*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 838 | 8-iv-12 | Sirsi Kanara | | 93 | 10 | 15 | 17 | 64 |

| | *Head and Body* | *Tail* | *Hind-foot* | *Ear* | *Fore-arm* |
|---|---|---|---|---|---|
| **ABSTRACT.** *Highlands, over 4,000 ft.*— | | | | | |
| Average of 2 | 76 | 13.5 | 11.5 | 17 | — |
| *Medium altitudes, below 4,000 ft. and above 1,000 ft.*— | | | | | |
| Average of 34 | 91.5 | 10 | 13.5 | 18.5 | 63 (average of 26) |
| *Lowlands, below 1,000 ft.*— | | | | | |
| Average of 16 | 94 | 9 | 14.5 | 19 | 65.5 (average of 14) |
| *Indian*— | | | | | |
| Average of 1 | 93 | 10 | 15 | 17 | 64 |

### TABLE III—*Skull measurements of Ceylon Cynopteri (arranged according to altitude of locality where obtained)*

*Males*

*Highlands, over 4,000 ft.*

| *Colltr's No.* | *Date* | *Locality* | *Altitude* | *Lambda to gnathion* | *Condylobasal length* | *Rostrum, orbit to nares* | *Zygomatic width* | *Tooth row* |
|---|---|---|---|---|---|---|---|---|
| | | | Ft. | | | | | |
| C.M. 7 | 23–xii–23 | Hakgala | 5,580 | D | 27 | 5.5 | D | 9 |
| *Medium altitude, under 4,000 and over 1,000 ft.* | | | | | | | | |
| 282 | 29–viii–20 | Passara | 3,000 | 28.4 | 26.5 | 6.5 | 17.3 | 9.5 |
| 284 | do. | do. | do. | 31.5 | 30.3 | 7.5 | 21 | 11.2 |
| 285 | do. | do. | do. | 32.6 | 30.7 | 8 | — | 11 |
| 31A | 4–iv–31 | Kumbalgamuwa | 2,800 | 27.3 | — | 6.3 | 17.7 | 9.5 |
| 25 | 10–iv–31 | do. | do. | 32 | 30.7 | 8.2 | 21 | 11.4 |
| 771 | 16–i–14 | Urugala | 2,500 | 31.5 | 29.5 | 7.5 | 20 | 10 |
| 815 | 23–i–14 | do. | do. | 31.5 | 30.5 | 7.5 | 19.5 | 10 |
| | | | Average of 7 | 30.7 | 29.7 | 7.3 | 19.4 | 10.4 |
| *Lowlands, under 1,000 ft.* | | | | | | | | |
| 1 | 17–xi–31 | Sigiriya | 654 | 31 | 28.9 | 7.5 | 19.7 | 12 |
| 409 | 16–i–21 | Kurunegala | 500 | 33.7 | 30.7 | 7.5 | D | 12 |
| 5 | 19–xi–31 | Sigiriya | 654 | D | 30 | 7.5 | 21 | 11 |
| 10-30 | 25–viii–31 | Colombo District | 50 | 32 | 30.3 | 8 | D | 11 |
| | | | Average of 4 | 32.2 | 29.9 | 7.6 | 20.3 | 11.5 |

*Indian specimens of C. sphinx sphinx*

*Females*

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 4582 | 4–iii–14 | Philibhit Robilkande U. P. | | 34 | 33.3 | 9 | 21.2 | 11.7 |
| V/793 | 4–ix–29 | Thummalabgla Rajampeta Range, South Cuddapah | | 32 | 30 | 8.3 | — | 10.6 |
| 545 | 4–viii–09 | Cuballa Hill, Bombay | | 34.5 | 33.5 | 9 | 22.6 | 11.8 |
| V/677 | 21–viii–29 | Kodura Balapalla Range, S. Cuddapah | | 31.5 | 29.5 | 8 | 20 | 10 |
| | | | Average of 4 | 33 | 31.6 | 8.6 | 21.2 | 11 |

| | | | | | |
|---|---|---|---|---|---|
| ABSTRACT. *Highlands, over 4,000 ft.*— | | | | | |
| One only | D | 27 | 5.5 | D | 9 |
| *Medium altitude, under 4,000 ft. but over 1,000 ft.*— | | | | | |
| Average of 7 | 30.7 | 29.7 | 7.3 | 19.4 | 10.4 |
| *Lowlands, under 1,000 ft.*— | | | | | |
| Average of 4 | 32.2 | 29.9 | 7.6 | 20.3 | 11.5 |
| *Indian*— | | | | | |
| Average of 4 | 33 | 31.6 | 8.6 | 21.2 | 11 |

*Note.*—D denotes damaged.

## TABLE IV—*Skull measurements of Ceylon Cynopteri (arranged according to altitude of locality)*

### *Females*

| *Colltr's No.* | *Date* | *Locality* | *Altitude* Ft. | *Lambda to gnathion* | *Condylobasal length* | *Rostrum, orbi to nares* | *Zygomatic width* | *Tooth row* |
|---|---|---|---|---|---|---|---|---|
| | | *Highlands, over 4,000 ft.* | | | | | | |
| | | No skulls available. | | | | | | |
| | | *Medium altitude, under 4,000 ft. and over 1,000 ft.* | | | | | | |
| 37 | 9–iv–31 | Kumbalgamuwa | 2,800 | 28.8 | 27.5 | 6.5 | D | 9.2 |
| 30 | do. | do. | do. | 27.3 | 26 | 5.7 | 18 | 9.2 |
| 32 | do. | do. | do. | 28.5 | 27.2 | 6 | D | 9 |
| 28 | do. | do. | do. | 27.2 | 25.8 | 6 | 18.1 | 9 |
| 27 | do. | do. | do. | 32.1 | 31 | 8 | 20 | 11.5 |
| 24 | do. | do. | do. | 31.5 | 30 | 7.7 | 19.7 | 11.6 |
| 19 | do. | do. | do. | 31.5 | 29.8 | 7.4 | 20 | 11.1 |
| 22 | do. | do. | do. | 31.1 | 29.5 | 7.2 | 20.1 | 11 |
| 20 | do. | do. | do. | 31.5 | 30.5 | 7.5 | 20.2 | 11.1 |
| 27 | 31–v–31 | do. | do. | 31 | 30 | 7 | 20 | 11.1 |
| 28 | do. | do. | do. | 31.5 | 29.7 | 6.7 | 21 | 10.4 |
| 91 | 2–vi–31 | do. | do. | 32 | D | 7.5 | D | 10.5 |
| 10P.A. | 14–v–22 | Passara | 3,000 | 29.2 | 27.6 | 7.3 | 18 | 9 |
| 10P.B. | do. | do. | do. | 27.6 | 25.5 | 6.3 | D | 9 |
| 10K | 29–vii–20 | do. | do. | D | 26.7 | 6.5 | 17.5 | 9 |
| 838 | i 14 | Urugala | 2,500 | 29 | 28 | 7 | D | 9.5 |
| 766 | | | | 29.5 | D | 7.5 | 19 | 10.5 |
| | | Average of 17 | | 29.7 | 28.3 | 6.9 | 19.3 | 10.1 |
| | | *Lowlands, under 1,000 ft.* | | | | | | |
| 408 | 16–i–21 | Kurunegala | 600 | D | 30.3 | 7.2 | 19.4. | 10 |
| 10 | 14–v–13 | Colombo District | 50 | 31.4 | 29.7 | 8 | 20.5 | 10 |
| 10-29 | 25–viii–31 | do. | do. | 30.5 | 29 | 7.5 | 20 | 10.7 |
| 10A | 10–x–13 | Kesbewa | — | 30.5 | 29 | 7 | D | 10 |
| 4 | 19–xi–31 | Sigiriya | 654 | 31 | D | 8 | 20.5 | 10.5 |
| 7 | 21–xi–31 | do. | do. | 31.5 | 29.5 | 8 | 20.5 | 11 |
| | | Average of 6 | | 30.9 | 29.5 | 7.6 | 20.2 | 10.2 |
| | | *Indian specimen of C. sphinx sphinx*<br>*Females* | | | | | | |
| 1202 | — | — | — | 31.5 | 29 | 7 | D | 10 |

| | | | | | |
|---|---|---|---|---|---|
| **Abstract.** *Highlands, over 4,000 ft.*— | — | — | — | — | — |
| *Medium altitudes, under 4,000 ft. but over 1,000 ft.*—<br>Average of 17 | 29.9 | 28.3 | 6.9 | 19.3 | 10.1 |
| *Lowlands, under 1,000 ft.*—<br>Average of 6 | 30.9 | 29.5 | 7.6 | 20.2 | 10.2 |
| *Indian*—<br>One only | 31.5 | 29 | 7 | D | 10 |

*Note.*—D denotes damaged.

## REFERENCES TO LITERATURE

**Andersen, Knud**, 1912—*Catalogue of the Chiroptera in the collection of the British Museum.* Second Edition

**Gray, J. E.**, 1870—*Catalogue of Monkeys, Lemurs, and Fruit-eating Bats in the collection of the British Museum*

CEYLON J. SCI. (B) VOL. XVIII, PT. 2. (*May 22, 1934*)

# NOTES

## The embryo of the dog fish Chiloscyllium indicum

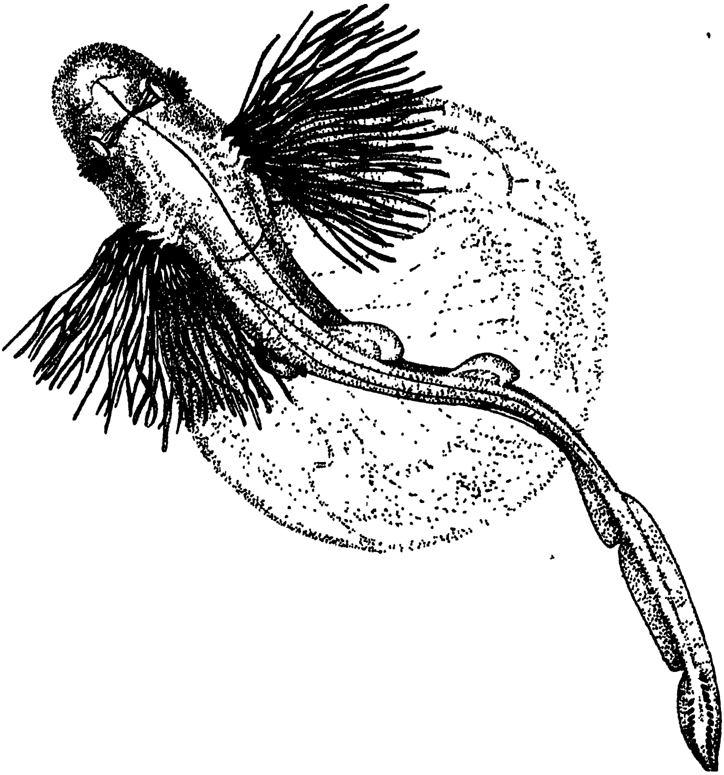
Several eggs were dredged up in March, 1933, on the Pearl Banks from 5-6 fathoms, at 7-9 miles from land. The brown egg cases ranged from 66-82 mm. in length, 35-40 mm. in width and 16 mm. in depth.

Two short tufts of anchoring filaments were present on one long edge of the oblong case, whereas about half the opposite edge was covered with elongate anchoring filaments which were attached to a piece of *Pinna* or echinoid test. The eggs contained a clear, viscous albumen and a pale yellow yolk, but one with an advanced embryo possessed only the yolk. As there was an opening at the edge of one corner which permitted water to enter, it is possible that the albumen disappeared for this reason. It is also probable that such an opening occurs normally after the albumen is absorbed by the embryo. The latter view is supported by the nature of the opening through which the young leaves the egg case. This is along one of the short edges of the case and appears to be an extension of the first opening which lets in water for, as seen in this instance, the sea water ran out of the egg case when it was held up by one end. After the case was cut open in a basin of sea water, the head, trunk, and yolk sac of the embryo emerged but in spite of the animal's struggles the tail could not be freed from the egg case which was eventually pulled away by hand.

The living embryo was a pale pink with a black rim round each eye. Crimson branchial filaments protruded externally from each spiracle and the branchial openings. The yolk as seen in electric light was a pale yellowish green.

The specific identity of the fish was easily ascertained by the position of the spiracles, contiguity of the last branchial openings and the shape and relative positions of the fins. The embryo which was a male with distinct claspers possessed the following dimensions: Total length to tail tip 50 mm., snout 4 mm., snout tip to first dorsal 19 mm., axilla to groin 4.5 mm., dorsal lobe of caudal which had its tip broken 14 mm., anterior ventral lobe of caudal 7 mm., posterior ventral lobe of caudal 5 mm. Diameter of yolk sac 24 mm.

Two features of interest were present in the embryo. The external branchial filaments which extended from the branchial openings to the origin of the dorsal were apparently used for respiration in this specimen. Some authorities such as Alcock and Chaudhuri consider that their function is to absorb egg material [1]. In this instance the respiratory function might have been a premature adaptation to unnatural conditions caused by an accidental perforation of the egg case. On the other hand it is possible that the external branchial filaments were trophonematous so long as there was albumen, but when this disappeared an opening developed in the egg case to let in sea water and the filaments became respiratory. Reasons for supposing this opening to be normal have already been stated.



P. Deraniyagala del.

Fig. 1. Embryo of *Chiloscyllium indicum* × 2.5

The other feature of interest is the presence of two lateral rows of barbed denticles on the terminal lobe of the caudal fin. Attention

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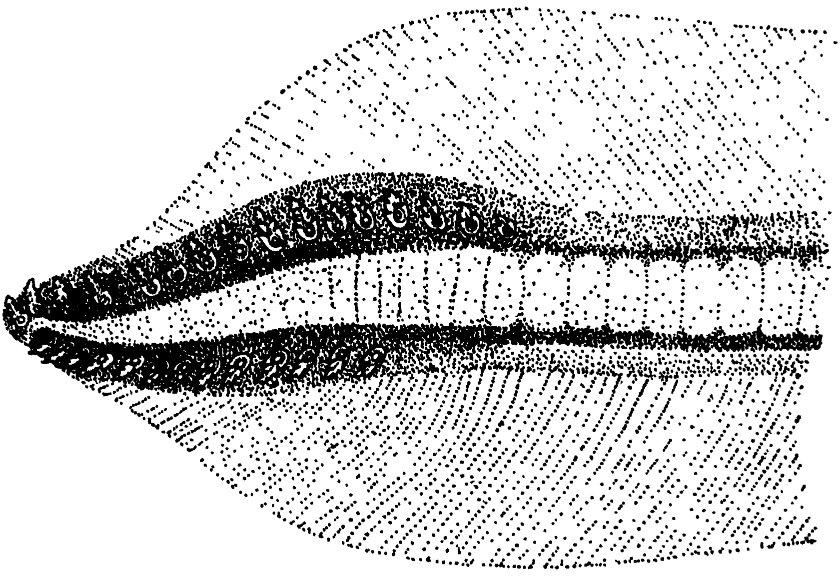
[1] *See* Southwell et Prashad, 1919. *Rec. Ind. Mus.* Vol. XVI, p. 239.

has been drawn to the inability of the embryo to liberate its tail from the egg case. Examination of the living specimen showed that half the terminal caudal lobe had broken off while on the remainder of this lobe was a double row of translucent pale blue, barbed denticles by which in all probability the tail was attached to the egg case. Unfortunately the empty case was not examined immediately but preserved in alcohol. When scrutinized in September, 1933, the broken piece of caudal fin was not to be found inside as it had probably floated out. Hence the exact area to which the terminal caudal lobe was fixed is unknown.

Two reasons can be assigned for fixing the embryo by its tail tip (*a*) the fixed tail tip may assist the animal to orient itself within the egg, (*b*) the fixed tail tip may prevent the embryo from struggling so violently as to widen the opening in the egg case and thereby escape prematurely into the surrounding water.

The number and arrangement of these barbed denticles were studied in another embryo without any data, found in an old collection of the Fisheries Department. This specimen a female was 53 mm. long with a yolk sac 20 mm. in diameter. The extreme tip of its tail appeared to be slightly injured but the barbed caudal denticles were well preserved.



**P. Deraniyagala del.**

**Fig. 2. Caudal denticles of undated embryo × 16**

They formed two rows in line with the upper and lower edges of the notochord which appeared to bend downwards at the tip of the tail. There were 16 denticles in the upper row, 13 in the lower which began under the 4th upper denticle. The denticles were ·022—·024 mm. long ·01—·012 mm. wide. Each commenced from a translucent, crescentic basal plate in which the pointed tips of the crescent were directed away from the mid lateral line. The transparent, projecting portion consisted of 3 or 4 lateral cusps on each side and a terminal point. Each denticle had a large basal pulp cavity which extended mesially upward and gave a branch to each cusp. The shape of these denticles and the presence of the pulp cavity suggests that they are vestiges of a very primitive type of selachian scale modified for a special purpose as are the ' stings ' of Rays.

P. E. P. DERANIYAGALA.

## Note on a nesting site of The Alpine Swift (Micropus melba melba)

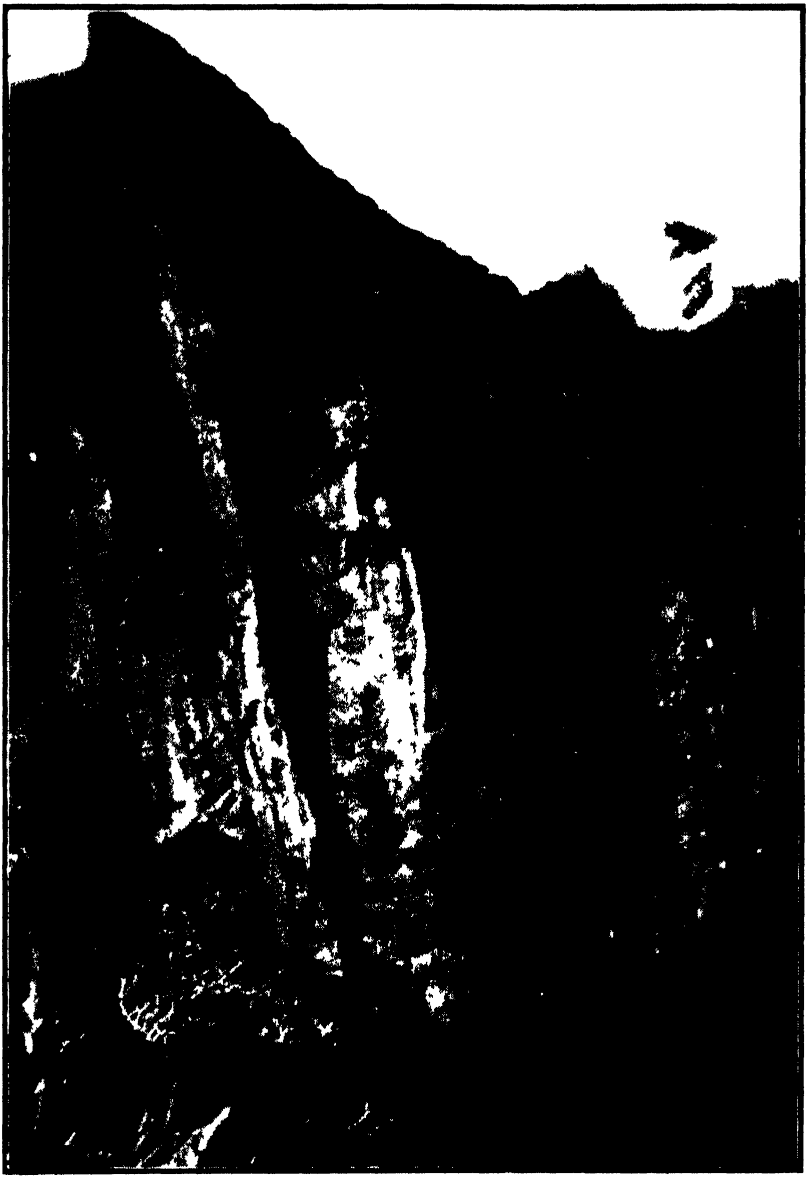
Plate XIX

On March 19 this year, while crossing the Dumbanagala range (5,000 ft.) on our way from Dehigolla to visit Nitre Cave, Rangala, to ascertain the species of bats inhabiting that well known cave, our guide took us out along the Dumbanagala spur (3,784 ft.) to admire the view.

The view from this spur is one of the finest that it has been my good fortune to see. The country is magnificently wild and broken, forest clad for the most part, the hills breaking up and dropping in superb precipices and slopes, into the lowlands of Laggala and Bintenne.

In the foreground stand the peaks of the Knuckles (6,112 ft.) and Kalupahana (5,341 ft.) wreathed in mist and overshadowing seas of mountain forest, while further to the north are the twins Lakagala (4,324 ft.) and Labulessapatana (4,009 ft.) falling away almost straight to the low country below; with many more, equally fine, peaks stabbing the further distance. At our feet lay lower St. Martin's Estate, over 2,000 ft. sheer below us, laid out in detail, with the red-roofed buildings looking like miniature dwellings modelled on a large scale relief-map.

As we gazed in admiration at this delightful scene, we became aware of birds swishing close over our heads, in ones and twos or small parties, sometimes silently, sometimes noisily. The Dumbanagala spur stands well out from the main mountain wall and many



W L Hicks

Dumbanagala above St Martin's Estate, Rangala

of the birds—Alpine Swifts as we saw they were—were skimming it on their homeward and outward flights, passing but a few feet above our heads.

As we watched these magnificent fliers sweeping on their majestic flights over mountain and valley we became aware that most of them were making for, or coming away from, the cliff face opposite to us and we then saw that the majority of them were entering or leaving a crevice, some two-thirds of the way up the precipice. Watching them, one could see that many of them went in and stayed there for some minutes while others wheeled round and round in shrilling circuses, after the manner of the common Indian House-Swift (*Micropus affinis affinis*) when it is breeding.

The cliff was too far away for us to see any actual nests but I do not think that there can be any doubt whatsoever that these birds were nesting in this crevice. Although the Alpine Swift has been presumed to breed in some of the precipices of the Central and Uva Provinces, there does not appear to be a previous record of any definite breeding place; I therefore give this present instance.

On this trip, I was accompanied by Mr. Hicks, of Karagahatenne, and Mr. H. S. Haynes, of Dehigolla. The Bats inhabiting the Nitre Cave proved to *Hipposideros speoris speoris*, Syke's Leaf-nosed Bat, a very common species in Ceylon.

W. W. A. PHILLIPS.

# Review

With one Plate XX.

*A biographical sketch of the late Lt.-Col. E. F. Kelaart*, M.D. (Edin.), M.R.C.S. (London), Army Staff Surgeon, F.L.S., F.G.S., etc.

Compiled by E. P. H. Kelaart. 8vo. pp. 55 plate 1.

(Publishers Frewin & Co., Colombo, 1932).

E. F. Kelaart, well known for his systematic work on the fauna of Ceylon, was born in Colombo in 1819 and was of Dutch extraction. After completing his medical studies in England he returned to Ceylon and in 1852 published his " Prodromus Faunae Zeylanicae ". At a later date the Government of Ceylon appointed him to investigate the bionomics of the pearl oyster. This work was conducted from 1857-59. In 1857 he had with him at Aripu the Swiss zoologist A. Humbert and both considered that pearl formation in the Ceylon oyster was due to vermean parasites.

It was during this period that Kelaart commenced a series of coloured illustrations of the Nudibranchs of the Gulf of Mannar and although he died before their completion several have been published.

The present sketch deals with his life and work and also contains an ' appreciation ' by Mr. W. W. A. Phillips and an account of the members of the Kelaart family.

The bust of Kelaart (Plate XX) which forms the frontispiece to the book has been presented to the Colombo Museum by his nephew Mr. E. P. H. Kelaart.

PLATE XX

E F Kelaart

CEYLON J. SCI. (B) VOL. XVIII, PT. 2. (*May 22, 1934*)

# PROCEEDINGS OF THE CEYLON NATURAL HISTORY SOCIETY, 1932 SESSION

## Twentieth Annual General Meeting

Minutes of the Twentieth Annual General Meeting of the Society, held on February 9th, 1932, in the Reading Room of the Colombo Museum Library.

The President, Professor N. G. Ball, took the Chair, and there were 25 members and 4 visitors present.

The Minutes of the previous General Meeting were read and confirmed.

The Honorary Secretary's Report, and the Honorary Treasurer's Statement, which were in the hands of the members, were adopted.

Mr. Wait took the Chair temporarily and explained that the Council had decided that in selecting candidates for the office of Vice-President, the retiring President should be nominated as a Vice President, and that one other new Vice-President should be nominated yearly, the two Vice-Presidents with the longest service retiring but being eligible for nomination to the Council.

Mr. Wait called on the Honorary Secretary to read the names of those nominated by the Council.

Mr. Burt intimated that H. E. Sir Graeme Thomson has consented to become Patron of the Society, and that the Vice-Patrons were Sir Bernard Bourdillon and Sir Solomon Dias Bandaranaike.

The following were elected:—

*President* : G. M. Henry, Esq.

*Vice-Presidents* : The Very Rev. Father M. J. LeGoc, O.M.I., M.A., B.S.c.; C. T. Symons, Esq., B.A., F.R.G.S.; Dr. Andreas Nell, M.R.C.S ; Prof. N. G. Ball, M.A., Sc.D.; Prof. F. O'B. Ellison, M.D., B.Ch., B.A.O., B.A.

*Honorary Secretary* : D. R. R. Burt, Esq., B.Sc., F.L.S., F.R.S.E.

*Honorary Treasurer* : A. H. Malpas, Esq., F.L.S., F.Z.S.

*Council* : Dr. J. Pearson, D.Sc., F.L.S., F.R.S.E.; W. E. Wait, Esq., M.A., M.B.O.U., F.Z.S., C.M.G.; W. W. A. Phillips, Esq., F.Z.S., M.B.O.U.; E. C. T. Holsinger, Esq., F.R.M.S.; Dr. S. E. Fernando; Prof. W. C. O. Hill, M.D., Ch.B., C.M.Z.S., F.L.S.; C. L. de Zilva, Esq. (Student Member). The latter elected by Student Members.

Mr. G. M. Henry took the Chair and thanked the Society for the honour they had conferred in electing him. Before calling on Professor Ball to give his lecture on Orchids, he drew the attention of the Society to an exhibit of a rare mantis and a rare fulgorid bug (*Aethalochroa ashmoliana* and *Pyrops dohrni*).

Professor Ball said that the term Orchid is applied to a member of the family Orchidaceae. With regard to the evolution of Orchids they probably represent a line of descent which has passed from the Lilies through the Iris family and then ended blindly.

On the basis of vegetative structure, the orchids may be divided into two groups, terrestrial and epiphytic. In the temperate regions, the former predominate. The association of orchids with fungi is an interesting feature. Fungi inhabit the cells of the roots in the manner of parasites, but instead of being killed, the cells resist the attack and probably digest the intruder. In some cases the dependence on fungi is so great that the orchids can dispense with chlorophyll and cease manufacturing their own food, obtaining all they require from decaying matter through the agency of fungi.

Some common Ceylon orchids were then described and specimens were exhibited which illustrated some of the variations in habit which may occur.

The problem of resistance to drought has to be faced by many epiphytic orchids. They show arrangements for storing water and for minimizing its loss, and in addition the roots often have a remarkable capacity for rapidly soaking up water by means of empty cells which cover the surface.

The structure of the flower in orchids follows a well-defined fundamental plan, although there is remarkable variation in the size, shape, and colour of the different parts of the flower.

Illustrations were shown of a number of different orchids, and the pollination mechanism of each was described. It was shown that the structure of the flower is such that insect visitors are constrained to enter it in a certain way, so that pollen masses become attached to them and are carried away when they leave. When they enter another flower, things are so arranged that the pollen comes into contact with the stigma.

The horticultural aspect of orchids was briefly touched upon, and a plea was made for the cultivation and study of some of the common Ceylon orchids which are easily obtained and easily grown.

In the discussion following, Mr. Wait, Mr. Henry, and Mr. Burt took part. Mr. Henry deplored the wanton destruction of the Wesak Orchid, and suggested that the Society make representations regarding its protection. Mr. Wait pointed out that the Wesak Orchid was already protected and that the Society might make representations to the G. A., Western Province, regarding the enforcing of the Ordinance.

The Meeting passed a hearty vote of thanks to Professor Ball which was carried with acclamation.

## One Hundred and Seventh General Meeting.

The Minutes of the One Hundred and Seventh General Meeting of the Ceylon Natural History Society, held on March 9th, 1932, at 5.30 P.M., in the Lecture Hall of the Colombo Museum.

The President, Mr. G. M. Henry, took the Chair, and there were 22 members and 6 visitors present.

The Minutes of the previous General Meeting were read and confirmed.

The Secretary read a letter from Mr. E. P. H. Kelaart with regard to a Biographical Sketch of the late Dr. E. F. Kelaart, which he had prepared, and which he desired to bring to the notice of the Society.

The Chairman, before calling on Professor Ellison to deliver his lecture on Blood, remarked that this was the first occasion on which the Society had met in the new Lecture Hall, which was previously part of the Land Settlement Building, and that the Society was to be congratulated on having acquired such a meeting place.

Professor Ellison said that blood was popularly and rightly associated with life. The red colour of blood was due to the iron-containing pigment haemoglobin. This was true of vertebrates, but some worms had green blood due to a copper pigment.

Blood was made up of red cells, white cells and plasma. The red cells differed in shape and size in different animals. They were largest in the amphibia and smallest in deer. There were five kinds of white cells or leucocytes, these are the scavengers and protectors of the body. The plasma of the blood carries carbon dioxide, food and waste products.

The lecturer illustrated the process of dissolving out the haemoglobin from the red cells, and showed how blood could be made to give up its oxygen. the haemoglobin forming haemin, and how the compound of blood and carbon monoxide could not be reduced.

Professor Ellison showed how blood could be detected by means of chemical tests such as that with guaiacum and phenol-phthalein. These experiments were projected on the lantern screen.

The lecturer then explained the meaning of blood groups and their importance with regard to the transfusion of blood. He projected on the screen slides showing the agglutination test for blood used in transfusion.

At the conclusion of the lecture questions were asked of the lecturer and a discussion took place in which Dr. Pearson, Dr. Hill, Mr. Nelson and Mr. Burt, took part.

The President thanked the lecturer on behalf of the Society and a hearty vote of thanks to Professor Ellison was carried with acclamation.

## One Hundred and Eighth General Meeting

The Minutes of the One Hundred and Eighth General Meeting of the Society, held on 14th June, 1932, at 5.30 P.M., in the Lecture Hall of the Colombo Museum.

The President, Mr. G. M. Henry, took the Chair, and there were 2 visitors and 8 members present.

The Minutes of the previous General Meeting were read and confirmed.

The following:—Mrs. W. Worth, 'Rippleton,' Elibank road, and Mr. P. E. P. Deraniyagala, Colombo Museum, were elected ordinary members of the Society.

The President, on behalf of Dr. Pearson, who was unable to be present, exhibited a shrunken human head, prepared as a trophy by the Jivaros, a savage tribe inhabiting Equador. The head was shrunken to about the size of an orange but retained the human features to a remarkable extent. It was quite firm to the touch, but hollow, and the hair was closely cropped.

The President next exhibited a pair of Hump-nosed Lizards, *Lyriocephalus scutatus*, which had been sent down from Gammaduwa, by Mr. W. W. A. Phillips and kept in captivity for some time. This curious lizard is peculiar to Ceylon and is the only representative of its genus. Although, when teased, it demonstrates violently by elevating its large nuchal crest and gular pouch and opening its blood-red mouth, it does not appear to bite readily.

The President then called on Mr. M. Fernando, B.Sc., to deliver his lecture on 'The Inheritance of Acquired Characters.' Mr. Fernando said:—Since 1810, when Lamarck stated the theory of the inheritance of acquired characters, biologists have been tinkering irresponsibly at the subject, so that the question is still hopelessly involved.

Acquired characters are the special characters exhibited by organisms in response to deviations from the normal environment. Acquired characters to be inherited must receive representation on the germ plasm. Weismann claimed that the germ plasm was isolated from the soma. Castle's work on the transplantation of ovaries favours this contention. Various mechanisms have, however, been suggested by which somatic modifications can get represented on the germ plasm, *e.g.*, Darwin's pangenesis and Hammett's thyroid mechanism.

A large volume of experimental evidence has been advanced in support of the inheritance of acquired characters. Weismann's experiments on docking tails of mice, Kammerer's work on salamanders, *Alytes*, *Proteus*, and *Ciona*, Sumner's work on shortened tails of mice, Stockard on the effects of alcohol on guinea pigs, Durkhen, Harrison, and Garrett's work on moths, Guyer and Smith's experiments on induced eye defects in rabbits, Macdougall and Pavlov's work on the inheritance of the effects of education in white mice and Agar's work on the regeneration of lost parts in *Daphnia* and *Simocephalus*.

Many claims have been advanced for the inheritance of characters acquired in a single generation. But, if a single generation can undo the summed-up experience of generations of forebears, the inheritance of acquired characters is a myth. After sifting off the questionable fraction, the meagreness of the experimental evidence left over makes us chary of accepting the pretensions of Neo-Lamarckians without the proverbial pinch of salt.

In the discussion which followed, Mr. Wait spoke in favour of the inheritance of acquired characters, and pointed out that the evidence of field naturalists favoured this view. Dr. Ellison remarked on the peculiarity seen in wild rabbits in the wild state when black individuals were frequently found. Mr. Burt paid a tribute to the excellency of the lecture, but pointed out that although the work in favour of the inheritance of acquired characters was small in amount, much of it gave positive results, which could not be overlooked or explained away by calling acquired characters induced modifications.

The meeting concluded with a hearty vote of thanks to the lecturer which was carried with acclamation.

## One Hundred and Ninth General Meeting

Minutes of the One Hundred and Ninth General Meeting of the Ceylon Natural History Society, held on 19th July, 1932, in the Lecture Hall of the Colombo Museum.

The President, Mr. G. M. Henry, took the Chair, and there were 6 visitors and 9 members present.

The Minutes of the previous General Meeting were read and confirmed.

The following were elected members of the Society:—

Ordinary Members: Miss S. V. Parker.

Student Members: Messrs. A. R. Majid, M. J. Waas, P. D. H. de Silva, V. N. Rajaratnam, J. A. Selva Ratnam, A. S. Antony Samy, P. Arumanayagam, M. E. Piyasena, M. O. R. Medonza, A. Thanabalasingam.

The following exhibits were shown to the Society:—

A large specimen of *Gryllacris*, believed to be a new species, which was obtained by Mr. Burt in Dambulla.

Several specimens of young Green Pit-vipers. Mr. Henry explained that he had received an adult female snake *Trimeresurus trigonocephalus*, which had refused to take food. After starving for 2 months, 17 young snakes were born. Mr. Henry said he hoped to discover whether the young of this snake behaved in the same way as the young of *Ancistrodon hypnale*, in using the tip of the tail as a lure to attract their prey.

The Chairman then called on Dr W C O Hill to give his lecture on Parrots.

The Parrots form an easily defined and superficially recognizable group of birds, marked chiefly by their strongly hooked beaks, zygodactyle feet and peculiar tongues. They are also characterized by a number of internal characters, some of which, *e g* , their moveable upper jaws, bony orbits, and peculiar arrangement of the carotid vessels, were illustrated in the accompanying dissections and skeletal preparations At only one point do the Parrots approach any other birds, viz , the owls A rare Parrot in New Zealand called the Owl Parrot (*Stringops habroptilus*) has facial disks similar to those of the Owls, and, in many points of structure departs from most of the Parrot kind and approaches the Owls It is interesting, moreover, in that it has almost completely lost the power of flight, having very short wings, no keel to its sternum, and no collar bones It is a ground bird, feeding on mosses and lichens Parrots are therefore, probably, highly modified Birds of Prey

Apart from this example, all Parrots agree pretty closely among themselves, so that it becomes a matter of difficulty to divide them into natural groups There is one factor, however which helps to separate the remaining Parrots into two fairly well marked sets, viz , the structure of the tongue The majority of Parrots, including all the more familiar forms, have thick fleshy tongues, shaped like a human finger with a nail like structure at the end Such Parrots are, in the main, seed eaters, and therefore, do not need saliva Their mouths are dry The other group constitutes the Lories In these the tongue is also fleshy, but by no means so large as in the true or dry mouthed Parrots It is further characterized by the fact that the nail like structure is transformed into a tuft of bristles This is used by the bird for brushing up the semi fluid food on which it subsists Lories feed almost entirely on honey exuded from flowers They, therefore, have wet mouths because they need saliva to digest this type of food Internal differences, of course, are correlated with these differences in tongue structure, and are concomitant with the gross difference in dietetics of the two types of birds Lories have thin walled stomachs like a mammalian stomach, whilst the more typical Parrots possess a crushing type of gizzard as seen in the majority of birds

For many reasons, Parrots have long attracted attention First they are mostly birds of gorgeous colouring Secondly, all Parrots are wonderfully intelligent They have large brains, even among birds, which are, as a class, large brained creatures Their intelligence is portrayed pre eminently in their powers of mimicry Parrots of all kinds mimic something or other, whilst many species are well known for their powers of imitation of the human voice The best talkers are the African Grey Parrots and the South American Amazons The Grey carries the better name, but Amazons, if they talk at all, usually talk well It is always a matter of the individual bird It is not connected with sex, like the singing of song birds Most Parrots are affectionate to those they know, but may be vicious with strangers. They are capable of great attachment to individuals, and as pets one of their greatest recommendations is their longevity Any man who possesses a Parrot, may confidently expect, other things being equal, that the Parrot will live longer than he will himself

Despite their many beauties and other attractive features, it must be admitted that, as pets, many kinds possess objectionable features. Perhaps, their greatest drawback is their noisiness The worst offenders are the Conures and Macaws of

South America. Another bad feature of Parrots is their destructiveness. Their powerful beaks need exercise, and consequently, in captivity this involves the eating-up of all their perches, or all the greenery in their aviary. Many Parrots cannot be kept in a cage in which wood enters into the structure at all. But, in all fairness, it must be stated that no Parrot combines all these faults, and those that do possess any have usually some counter attraction. Thus the Lories, though rather noisy, are among the most gorgeously coloured of all birds, and are not destructive to growing plants. Again, the Conures, though amongst the noisiest of Parrots, are very beautiful creatures, and are affectionate and occasionally make fine talkers. Taking all together, the balance seems to be in favour of the Parrot.

Parrots were first mentioned in literature by the Greek historian and physician, Ctesias, by whom a bird called βίτταϰος was mentioned in such a way that the description fits admirably with the Blossom-headed Parrakeet (*Psittacula cyanocephala*), of India and Ceylon. Soon after, a more scientific description was given by Aristotle, whose account seems to relate to a Parrot from Ceylon. This bird was probably sent home from Ceylon by one of the naturalists who accompanied Alexander the Great or one of his Admirals. The emissaries of Alexander were known to have visited this country and as Alexander and his naturalists were all pupils of Aristotle it is not surprising that examples of the Ceylonese Parrots should reach his hands. The bird was accordingly named the Alexandrine Parrakeet (*Psittacula eupatria*) in honour of the great general. Once specimens had drifted into Europe, there came a great demand for them and no less than five birds allied to the Alexandrine and the common Indian Ring-neck (*Psittacula krameri manillensis*), were imported into Europe during later Greek and Roman times. They became so popular that the Roman Emperors kept large numbers of them. Some of the later Emperors went so far as to consider them a table delicacy; whilst Heliogabalus is reputed to have fed the gladiatorial lions on Parrots. It was not till the close of the Roman times that the African Parrots came to Rome—probably through the medium of Egypt, or by stray voyages who coasted round the west of Africa and brought back a few Greys from the Gold Coast or Sierra Leone.

The geographical distribution of the Parrot tribe gives rise to some interesting zoological problems, many of which still await solution. Most Parrots are birds of of the tropics; but not all. At least one Parrot has, in historic times, ranged as far north as the latitude of New York. This bird, the Carolina Conure (*Conuropsis carolinensis*), has for some years been believed to be extinct, but persistent rumours still leave hope that a few of these beautiful creatures are yet to be found in the Everglades of Florida. In the Southern part of the same continent the Conures are represented in the cool climate of Patagonia by the Patagonian and Golden Conures (*C. patachonicus* and *C. solstitialis*). In Europe there are no Parrots, but in earlier geological times Parrots allied to the African Grey and to the Indian Ring-neck were to be found, as is evidenced by the discovery of fossilized remains. In Asia, Parrots. seem to be limited on the north by the Himalayas, but elsewhere they are plentiful. Eastwards they extend across Wallace's line into the Australian realm, where they are represented by a wealth of characteristic forms. All the Lories, for example, are found on the eastern side of Wallace's line which also forms a barrier to the western distribution of the *Eclecti* and the Broadtails, and to the eastern range of the Parrots of the Ring-neck (*Psittacula*) type. On the contrary the Hanging Parrots (*Coryllis*), diminutive forms with the shape of a typical Parrot, but with the diet and stomach of Lories, are found on both sides of Wallace's line. They have a sporadic type of distribution. One form (*Coryllis* *beryllinus*) occurs in Ceylon. Its nearest neighbour (*C. vernalis*) is found in India. Another (*C. galgulus*) occurs in Malaya. The remainder are scattered in the various islands of the Far East, each island having its own form.

New Guinea, a little-known land from most points of view, is a veritable paradise of Parrots. It harbours many of the most beautiful Lories as well as the large *Eclecti*. The latter are beautiful forms in which the males are brilliant green with red flanks, whilst the females are adorned in a garb of scarlet and blue. The numerous small islands off the coast of New Guinea each possesses its own varieties of Parrots and Lories, different from all others.

Reaching south into colder climates again a whole group of peculiar Parrots occurs in New Zealand. In addition to the Owl Parrot already noticed, it is the home of a group known as the Nestors. These are Lory-like in structure and their tongues are of a modified brush type. The most interesting is probably the Kea or Mountain Nestor, (*N. notabilis*), which is the only Parrot that relishes animal food. This bird is considered a pest by the New Zealand farmers, for it settles on the backs of sheep and with its strongly hooked and elongated bill, excavates a wound in order to obtain the fat which surrounds the kidneys. This is the only part eaten, but of course, the sheep usually dies as a result. Probably the stories concerning the activities of Keas have been over rated Other Nestors, all having elongated bills, are to be found in neighbouring islands. The large Kaka (*N. meridionalis*), seems to be confined to the coastal districts on the eastern side of both the N and the S Islands It is now very scarce Philip Island had its own Nestor (*N productus*), but this is now extinct. The same applies to *N norfolcensis*, from Norfolk Island New Zealand is also the home of a genus of the Broadtails (*Cyanorhamphus*) They are rather dull green birds, not comparing very favourably with the wealth of forms and colours to be found on the Australian mainland

Tasmania possesses a few Parrots, but many of these, like the rare Blue-winged Grass Parrakeet (*Neonanodes chrysostomus*) spend only the summer in Tasmania, returning to the mainland after breeding These Grass Parrakeets are members of a group of small Broadtails which spend their time in the large grasses that cover so much of the Australian Continent. Many of them are now very rare since the introduction of cats into the country. One, however, has become very common, and has bred in captivity so readily and so frequently that it may almost be considered a domestic bird. This is the well known Budgerigar or Warbling Grass Parrakeet (*Melopsittacus undulatus*). This diminutive bird possesses all the attributes of a Parrot despite its size. I know of one example that has been taught to talk. One of the most interesting facts concerns the readiness with which, when bred in captivity, it throws out colour forms which differ from the wild green type. At the present time, blue, yellow, olive. mauve, cobalt, and white varieties are known, many of these fetching high prices in the market.

The larger Broadtails are confined to Australia and the neighbouring islands. They include some of the most beautiful of the Parrot tribe. Bauer's Parrakeet (*Barnardius semitorquatus baueri*) exhibited, is an example. Others are the peculiarly coloured Brown's Parrakeet (*Platycercus venustus*), and the more commonly imported Rosella (*Platycercus eximius*).

An important group represented only in the Australian region is that of the Cockatoos. These are large Parrots, often pure white in general colour, but with an erectile crest of some contrasted colour. Of the White Cockatoos, the commonest are the Sulphur-crests, of which there are a number of species. Others are the

Citron-crested (*Cacatua citrino-cristata*), the White-crested (*C. alba*), and the Great Salmon-crested (*C. moluccensis*). The most beautiful of all is probably the Leadbeater Cockatoo (*Lophochroa leadbeateri*), in which the general body colour is coral pink, and the crest has alternate hues of red, yellow, red and white, from base to tip. Another pink Cockatoo is the common Roseate Cockatoo (*Eolophus roseicapillus*), often sold as an 'Australian Grey Parrot.' It will talk, though not freely, and at most in a very feeble voice. Of the Black Cockatoos, mention may be made of the Great Palm Cockatoo (*Probosciger aterrimus*) of the Cape York Peninsula and the neighbouring part of New Guinea. The Banksian Cockatoo (*Calyptorhynchus banksii*), and the Red-headed Gang-Gang Cockatoo (*Callocephalon galeatum*), are both of the Australian mainland, and rarely exported therefrom.

Allied to the Cockatoos in general structure, but differing in their diminutive size, are the Pygmy Parrots (*Nasiterna*) of New Guinea and the neighbouring islands. Each island has its own species. All are very small—some of them only as large as a Munia. They are mostly green in colour, with red markings here and there. They are characterized externally by the fact that their tail feathers are spined at the tips so that the bird can use its tail in the same manner as a Woodpecker. For this reason they are often called Woodpecker-Parrots.

In Mauritius and the neighbouring island of Rodriguez, a Parrot with a large permanently-erected crest, existed within the historic period. It has been named *Lophopsittacus*, and placed provisionally among the Cockatoos, but its geographical position does not favour this view. The other Parrots of these islands belong to the Oriental genus *Psittacula*.

Ceylon possesses five kinds of Parrots, one a Hanging Parrot related to the Lories, and the rest belonging to the genus *Psittacula*. The largest is the Alexandrine, characterized by its huge cherry-red bill, a general green plumage relieved by a blood-red patch on the bend of the wing, and in the male, a broad rose-coloured ring round the neck. The typical Alexandrine is peculiar to Ceylon, but related races occur in various parts of India, Nepal, and into the Malay Peninsula. Next comes the Common Ring-neck (*Psittacula krameri manillensis*) perhaps the commonest and most widely distributed Parrot in the world. It occurs in pretty much the same form in Ceylon, India, and Africa. The African bird has by some been separated as a distinct form under the name of *Psittacula k. krameri*. It is smaller than the Alexandrine, and brighter green in general colour. It lacks the red wing patch, and the rose-ring round the neck is narrower. The back of the head is suffused with a delicate bloom of lilac. This bloom-like effect is carried to extremes in the Blossom-head, (*Psittacula cyanocephala*), in which the whole of the head is a gorgeous plum colour. The bird is smaller than the Ring-necked species and has a red wing-patch, and a bright ultramarine-blue tail with a white tip. It occurs in Ceylon and India. Finally there remains the beautiful Layard's Parrakeet (*P. calthropae*), confined to Central Ceylon. This lovely bird is rather smaller than a Ring-neck, and is characterized by the lavender shade of the head, back, and rump. The head is separated from the patch on the back by a broad collar of very vivid green. A patch of the same colour occurs on the cheeks. The tail is dark violet, and the rest of the bird green. The bill differs in the two sexes, being red in the male and black in the female. The nearest relative of the Layard is the Banded or Moustached Parrakeet (*P. fasciata*), of Eastern Bengal and Assam.

The lecturer exhibited many of his own living parrots, and through the kindness of the Director, Colombo Museum, a number of skins.

In the discussion which followed, Professor Ellison pointed out that the historian Ctesias was the same man that discredited the work of Herodotus, but that it is now known that the work of Herodotus is authentic. On this ground he suggested that too much importance should not be placed on any Parrot described by Ctesias.

Dr. Pearson made some comments on the Owl Parrot (*Strigops habroptilus*). He also said that the report of the New Zealand farmers on the damage done by the Kea was not an exaggeration, and the damage done to sheep had unfortunately foundation in fact.

Mrs Wynne Jones pointed out that from her own experience, she concludes that Parrots talk with intelligence and can even enjoy a joke.

The meeting closed with a hearty vote of thanks to the Lecturer, and the exhibits of live Parrots, dissections and skins were examined by the audience.

## One Hundred and Tenth General Meeting

Minutes of the One Hundred and Tenth General Meeting of the Ceylon Natural History Society, held on September 13th, 1932 at 5 30 P M, in the Lecture Room of the Colombo Museum.

The President, Mr G M Henry, took the Chair, and there were 31 members and 11 visitors present.

The Minutes of the previous General Meeting were read and confirmed.

Mr A M Thassim was elected a Student Member.

The President intimated that he had received a specimen of an adult frog with six legs, and asked Mr Burt to explain to the meeting both the frog and another teratological exhibit, of a chick with four legs and four wings, which Mr Burt had brought to the meeting. Mr Burt gave as his opinion that the duplication of limbs in the frog, amounting to an additional pair of hind limbs arising from the pelvic region on the right side was due to a fault in development, perhaps through injury and that the case of the chick was one of incomplete twinning when the separation of the two embryos had taken place from the posterior end, but had stopped short at the region behind the head.

The President then called on Dr W Fernando, Ph D, D I C, to read his paper on Embryology and Evolution'.

Embryology deals with the development of an individual from the moment it begins as a fertilized egg until it becomes a sexually mature adult, on the other hand, the series of changes which have taken place in the history of the race to which an animal belongs is known as Evolution. Thus Embryology is the study of the modern history of an individual and Evolution that of the ancient history of the race. The main problems of Embryology are concerned with the relation of individual development to the racial history and what bearing the experimental work on development of lower animals have on the Evolution of the human race. The lecturer described briefly the developmental histories of a few well known animals —*Vivipara* (Mollusca), Frog (Amphibia), Chick (Aves), and Man (Mammalia).

A critical study of development showed that the phenomena cannot be wholly traceable to chemical and physical principles. This was illustrated by a few examples. However, the well known experiments of Driesch, to which confimatory experiments were taken from other workers as well, conclusively prove that there exists a non physical agent which controls the development of an animal, enabling it to arrive at what appears to be a pre-determined structure. This non-physical agent is known by various names. The older naturalists called it vital force, some call it God, and Driesch called it Entelechy.

The significance of the complicated changes which take place during ontogeny was next considered. Thus it was shown that there occurs during the development of a Gastropod Mollusc a torsion of its body, and this can only be interpreted as a condition when the body of a symmetrical ancestral Gastropod fell over to one side. Further examples in other animals illustrating similar phenomena of development showed that every animal during its life-history recapitulates the principal stages passed through by its ancestors.

The meaning of recapitulation was then considered. The tadpole metamorphosing into a frog indicated that the frog of to-day recalled the changes in structure and habit involved during the transformation of its aquatic ancestor to a terrestrial form. This was shown better in the case of *Alytes*, where the embryo inside the egg possesses gill-structures inexplicable on any assumption other than that the embryo recalls the aquatic habits of its ancestors. Thus recapitulation is only a recalling of 'memories' of former conditions in the ancestral history—the memories of the habits of the animals' ancestors. Now changes of habits always involve changes of structure which are heritable so that a study of recapitulation in animals shows that acquired characters are inherited.

The application of embryological knowledge to the welfare of the race was then considered. Experiments on lower animals clearly indicated that bad environmental conditions during the early life of an animal produced harmful hereditary effects. The experiments of Tornier were cited to illustrate this. As degeneracy in lower animals is induced by overcrowding and by the injurious effects of toxic substances, so in the human race the same factors operate in the production of degenerate individuals. It was pointed out that the one cause of degeneracy is over-population due to reckless reproduction. This was shown in the case of members of large families where the younger members always showed signs of degeneration, for a great burden was exerted on the mother with the result of ' germinal weakness ' in the offspring. Examples of these are extremely common in Ceylon. In Ceylon, eugenic principles are neglected; the general social customs are against them. Every individual, even if mentally defective or physically unfit, is allowed to reproduce with no regard to the health of the progeny. It was suggested that Government should take up the problem and bring about the compulsory sterilization of unfit individuals.

In the discussion following, Mr. Burt expressed his appreciation of the lecture, but objected to the ridiculing of mechanists by the lecturer when he said that they tried to explain the development of an embryo in terms of soap bubbles. He pointed out that physical forces acted alike on living and non-living matter. He said that both chemico-physical and teleological concepts led to Reality, but by separate ways. He commented on the lecturer's opinion regarding the degeneration of the human race, and attributed this degeneracy rather to the fact of civilization. He traced the evolution of civilization comparing the conditions existing in savage and barbaric tribes to those existing now, where, as the relative birth rate of the higher classes was less than that of the lower, promotion by merit from a lower to a higher class led to sterilization and the ultimate degeneracy of the human race.

Mr. Deraniyagala likewise took exception to the lecturer's teleological interpretation of embryology, and cited cell-division as a phenomenon where in the dividing cell a physical force was apparent in the polarized fields around the centrosomes, likening this force to that made manifest by a magnet in the presence of iron filings. He also questioned the fact whether gill-slits were actually completely formed in the developing reptilian embryo.

Dr. Fernando, in replying, stated that he found physical grounds inadequate to explain the facts of embryology.

The meeting terminated with a hearty vote of thanks proposed from the Chair. This was carried with acclamation.

## One Hundred and Eleventh General Meeting

Minutes of the One Hundred and Eleventh General Meeting of the Ceylon Natural History Society, held on October 11th, 1932, at 5.30 P.M., in the Lecture Hall of the Colombo Museum.

The Patron of the Society, His Excellency Sir Graeme Thomson, took the Chair, and there were 86 present, of whom 16 members and 9 visitors signed the attendance book.

The Minutes of the previous General Meeting were read and confirmed.

His Excellency called on Professor Hill to exhibit some Australian mammals:—*Ornithorhynchus*, *Dasyurus* and *Perameles*, which he had received from Professor Wood Jones, and on Mr. Burt to exhibit a specimen of *Glaucus*—a pelagic Nudibranch which was found on the shore at Bentota, the first record of this mollusc from Ceylon.

His Excellency then called on Mr. G. M. Henry to read his paper on Grasshoppers.

Mr. Henry defined the scope of the lecture as 'Grasshoppers,' taken in their widest sense, comprising the whole of the *Orthoptera Saltatoria*. In this group there are three families, the Acrididae, Tettigoniidae, and Gryllidae. The Acrididae are characterized by the following features:—they have short antennae, 3-jointed feet, abdominal auditory organs, tegmina unmodified at the base, short ovipositor, of 4 pieces, which is a digging implement. The Tettigoniidae on the other hand have long antennae, 4-jointed feet, tibial auditory organs, modified tegmina, and a sabre-shaped, flattened ovipositor; while the Gryllidae have long antennae, 3-jointed feet, tibial auditory organs, modified tegmina, and a long cylindrical ovipositor.

The most striking feature of grasshoppers is their musical talent although sound production is not confined to them; with the exception of the cicadas, the grasshoppers are the most gifted.

Mr. Henry then described the methods of sound production in the different families, illustrating his description with lantern slides. The ability to produce music would be useless, unless the music could be heard, and grasshoppers possess good auditory apparatus, while it is noteworthy that in the species which are mute, the auditory organs are lacking. Mr. Henry then described the auditory apparatus in the Tettigoniidae, Gryllidae, and Acrididae.

In the grasshoppers, cryptic coloration is frequently seen, also mimicry. The case of the larva of *Leptoderes*, which resembles the beetle *Tricondyla* is an example of 'Pseudaposematism' or False Warning Coloration. This larva misled even the great Entomologist, J. O. Westwood, and he at one time placed it among his beetles.

The young of the grasshoppers resemble the adults in every respect except size, the presence of wings, and the development of the reproductive organs. The newly emerged larva or nymph increases in size at each successive moult, moulting from four to seven times, according to the species, before it becomes adult. The egg-laying habits are interesting, especially in the Tettigoniidae where the sabre- or dagger-shaped ovipositor is used to insert the eggs either into the soil or into leaves, or even deep into the wood of a tree.

Grasshoppers are historic pests, particularly those which develop gregarious habits and migratory instincts and are called locusts. The number of species of locusts is small. The most noticeable is the Desert Locust (*Schistocerca gregaria*), and the Migratory Locust (*Locusta migratoria*). In both there are two distinct phases. In the case of the Migratory Locust the normal phase is *danica*, which is a solitary, harmless grasshopper of wide distribution. The migratory phase (*migratoria*) develops periodically in S. Russia, Madagascar, parts of Africa, Malaya, and China. The two phases were considered for long to be two distinct species, but Uvarov's researches disprove this. Breeding experiments prove that overcrowding of the nymphs produces *migratoria*, and in nature it is seen that where *danica* deposits her eggs in places where there is plenty of food and there are ideal conditions for egg-laying, overcrowding of the nymphs results and the *migratoria* phase appears

The most famous, or infamous, locust is the Desert Locust. Its normal habitat is the desert areas in Africa, Arabia, Persia, and N. India, and it is occasionally captured at sea, hundreds of miles from land.

Ceylon is comparatively free from locusts. The only one which causes considerable damage is *Aularches miliaris*, which attacks dadap and other cultivated plants.

Grasshoppers are of little economic importance apart from that of causing damage. Some tribes utilize them as food, and it has been suggested that the oil in the locust would be a suitable source of oil for soap making. The Japanese keep grasshoppers as pets for the music they make—in the same way as we might keep canaries.

The lecture was concluded with a series of lantern slides and pictures shown through the Epidiascope, illustrating the more striking of the Ceylonese grasshoppers, many of which were new species

In the discussion which followed, Prof Hill, Prof. Ellison, Mr. Burt and Mr. Bantock took part His Excellency described some of his experiences in West Africa with Locusts, and commented adversely on the manufacture of soap from locust oil.

Dr. Pearson proposed a vote of thanks to His Excellency. He expressed the hope that His Excellency would repeat his visit to the Society. He drew attention to the fact that the present flourishing state of the Society was due to the keenness of the younger members in it.

His Excellency proposed a vote of thanks to Mr. Henry on behalf of the Society and this was carried.

The meeting then terminated.

## One Hundred and Twelfth General Meeting

Minutes of the One Hundred and Twelfth General Meeting of the Ceylon Natural History Society, held on November 8th, 1932, at 5.30 P.M., in the Lecture Hall of the Colombo Museum.

The President of the Society, Mr. G. M. Henry, took the Chair, and there were 19 members and 6 visitors present.

The Minutes of the previous General Meeting were read and confirmed.

Mr. D. R. R. Burt exhibited a skeleton of *Arius*, the Crucifix Fish which had been presented to the University College Museum, by Lady Thomson.

Mr. Henry called on Mr. B. L. T. de Silva, M.Sc., to give his lecture on 'The Evolution of the Land Habit in Plants.'

Mr. B. L. T. de Silva said:—

It is a fairly generally accepted view that all life started in the water. Therefore, we should expect to find the original ancestors of plants among the Algae. Further, it would be only natural to seek the origins of the green terrestrial plants in that group of Algae with plastid pigments and the same metabolism. Thus the earlier members to break away from the aquatic habit would be those belonging to the Chlorophyceae—probably some members of the filamentous Isokonta It is best, however, to start with the study of the Mosses and Ferns, the best known of the primitive land flora. These show a definite alternation of two generations distinct in form, in function, and cytological character. One has organs of sex, functioning in external fluid—water—owing to the presence of ciliated sperms. It is haploid in character. The other has non sexual reproductive bodies dispersed in dry air—diploid in character. The former, also, is delicate in structure and semi-aquatic, while the latter is robust and can endure exposure to dry air. Thus, there are two groups of plants, with, as it were, one foot in water and the other on dry land. They are truly vegetable amphibians

It is possible that some form of Algae, escaping competition established themselves on dry land, where they had only occasional access to water. Thus sexual reproduction could take place at times of rain or heavy dews Under these circumstances sexual reproduction is not a sure form of dispersal The zygotes, therefore, developed a new phase, the sporophyte The fertilized egg, instead of giving rise to a new individual, gave out a number of smaller portions, carpospores, each of which gave rise to a new individual. The spores are well disseminated in dry air, and the large number ensured survival. But increase in number of spores necessitated independent nourishment, and the higher forms of sporophyte assumed the function of nourishment . . . .

The development of the gametophyte has reached its highest among the mosses where a leaf like structure, and a root-like structure are met with. But the development stopped here as the whole generation is an impossible one. It is not capable of exposure to dry air. Further, most vital process of fertilization can take place only in the presence of full water. In the simple forms of Algae, the ova are shed into the water Later on the ova were retained in a simple organ, oogonium, which consisted of just one cell But when migration to land took place, the ovum was more securely encapsulated in a structure called the archegonium. This reaches its greatest development in the mosses but as the whole generation started reducing, this structure too underwent reduction. In the ferns it is a simple structure with a shorter neck. In the Gymnosperms, there is hardly any neck, and in Angiosperms, the whole archegonium is dispensed with and the ova are naked.

As a corollary to the reduction of the gametophyte is the development of the seed-habit. A first step towards this is the differentiation of the spores into micro- and mega-spores The latter with a greater food supply take on the responsibility of nutrition. The next stage is the development of a protective coat, the integument, as seen in the ovule and its attachment to the parent plant till the embryo is developed. A still more important stage in the emancipation of the land flora is the replacement of the ciliated sperms by two male nuclei, which are carried along a pollen-tube to the ova. Thus the most vital process in the life-cycle of the plant is protected.

The story of the development of the sporophyte does not form an altogether co-ordinated one, but, by comparison of living and fossil types, one can form an opinion as to the possible line of evolution. Between the mosses and the ferns, there is a big gap which possibly will never be filled. The sporophyte of *Riccia*, we may take as the simplest, the whole sporangium producing spores. Then that of *Marchantia* may be taken as an intermediate stage as some of the spore-mother-cells are sterilized to elaters. Then in *Pellia* a central sterile column starts to be formed and this reaches its highest development in the mosses. These latter first show signs of independence by the development of stomata and green tissue. The gap between these and the ferns has only recently been partly filled by the discovery of the Devonian floras—the *Rhynia* and *Asteroxylon* groups. These show a simple thalloid structure without roots, but with stomata. Leaves of the microphyllous type are found in *Asteroxylon*. The highly branched rhizomes probably represent the mode of origin of roots. It is a significant fact that in some of the *Lycopodiums*, exogenous roots are met with, contrary to the general rule that all branching of roots is endogenous. Further, the bulbous rhizomes of *Hornea*, remind one of the structures seen at the base of the stem of *Phylloglossum*, another of the Lycopodiaceae.

Thus, all the evidence seems to point to the development of the present land-flora from thalloid ancestors by the development of leaves, roots, and stomata, and of course, its final emancipation is in the development of true seeds.

The lecture was opened to the meeting for discussion. Prof. Ball and Mr. Burt contributed to the discussion, and the Chairman moved a hearty vote of thanks to the lecturer; this was carried with acclamation.

## One Hundred and Thirteenth General Meeting.

Minutes of the One Hundred and Thirteenth General Meeting of the Ceylon Natural History Society, held on Tuesday, December 13th, 1932, at 5.30 P.M., in the Lecture Hall of the Colombo Museum.

The President of the Society, Mr. G. M. Henry, took the Chair, and there were 65 present, of whom 15 members and 8 visitors signed the book.

The Minutes of the previous General Meeting were read and confirmed.

Mr. Henry said that instead of the usual lecture, a series of short papers and demonstrations had been arranged. Dr. Pearson, he said, was unable to give his paper on the Principles of Zoological Nomenclature, owing to illness, but he looked forward to hearing it at a future date.

Mr. Henry then called on Professor Ball to exhibit an abnormal coconut. Professor Ball exhibited an abnormal coconut, in which two horn-like out-growths were present at the base of the fruit. It was pointed out that similar abnormalities had previously been described, but that the nature of the out-growths was uncertain. He considered that the most probable explanation is that they represent members of the staminal whorl which are normally absent in the female flower, but which have become hypertrophied and have assumed the fibrous character of the husk.

Mr. Henry then called on Dr. Hill to exhibit three Veddah skulls. The skulls were two female and one male. He also showed some Sinhalese and Tamil skulls for comparison. He showed that all the Veddahs agreed in certain characters and that they differed from the Sinhalese and Tamil skulls. One young Sinhalese skull showed certain resemblances to the Veddahs. This was explained as due to the fact that the Sinhalese were not a pure race, but contained much Veddah blood, a fact that was substantiated on historical grounds, as well as anthropologically. The Tamil skulls conformed to the purer type usually known as 'Dravidian', *i.e.*, they had long narrow crania and long narrow faces (dolichocranial and lepto-prosopic).

The chief characters of the Veddah skulls were then enumerated The skull as a whole is small and the cranial cavity is less in them than in any other known race of normal living human beings The capacity of those shown was of the order 1000 1100 cc . whilst that of the Sinhalese was 1300 1400 The cranium was shown to be long and narrow, as in the Tamil, but the face, which was more characteristic, was indicated as chamaeprosopic The broad face was shown to be correlated with a broad nose, and a short upper jaw The orbits were pointed out as squarish as in the Australian skull, and also to be shallow and wide-mouthed—a detail in which they differ considerably from the other Ceylonese races. The floor of the nose was pointed out in one specimen as sloping off into the front of the jaw instead of being sharply marked off by a shelf of bone In this character, the Veddah skull resembled that of an Anthropoid Ape

In the discussion on Dr Hill's lecture, Mr Holsinger asked how Dr Hill knew that the skulls were genuine, and if he found them in the jungle was it not possible that they belonged to some other race?

Dr Hill replied that the evidence that the skulls were genuine Veddah skulls was decisive as he had obtained the skulls himself by digging them up The graves were indicated by Veddahs, who told him the names of the Veddahs whose skulls he got One, at least, of these Veddahs, is figured in Seligmann's book. The skulls were obtained in the Veddah country far from the nearest Sinhalese village, and it was unlikely that any Sinhalese would carry bodies so far into the jungle to bury them The evidence, he said, was conclusive

Mr Henry then called on Mr P Kirtisinghe to give an account of some Parasitic Copepoda of Ceylon

Mr Kirtisinghe said that Parasitic Copepoda exhibit every grade of transition between a free predatory habit of life and the most complete dependence upon a host Very little is known about the Copepoda parasitic on Ceylon fishes, for only about fifteen species have so far been recorded A consideration of this short list shows various degrees of modification associated with the parasitic habit, and it is possible to group them so as to indicate three distinct modes of attachment to the host —(1) Ectoparasitic forms such as the Fish lice *Artacolax* and *Gloiopotes*, (2) forms which partly bury themselves in the tissues of the host as *Pennella* and *Lernacenicus*, and (3) forms that are attached to the gills, as *Brachiella thynni*

Mr Henry then exhibited specimens of the Mantis, *Aethalochroa ashmoliana*, and *Phibalosoma hypharpax*, the largest Ceylonese Stick Insect The former were reared in the Museum from eggs laid on February 9th The Stick Insects had also been reared from eggs, the young being fed on Guava

Two Chamaeleons (*C calcaratus*) were then exhibited Mr Henry remarked on the peculiar distribution of the chamaeleons, the structural peculiarities such as the independent motion of the eyes, extensible tongue, and colour changing mechanism

A discussion followed the demonstrations and Mr Burt, Professor Hill, Professor Ellison, and Mr Holsinger took part in it; the main point discussed being the sight and independent movement of the eyes

Mr Burt proposed a vote of thanks to the lecturers, and said he hoped to arrange a similar meeting with short papers and demonstrations for February, when it was hoped Dr Pearson would give his talk on the naming of animals.

The vote of thanks was carried with acclamation and Mr. Henry replied on behalf of Professor Ball, Professor Hill, Mr. Kirtisinghe, and himself.

The Meeting then terminated.

## One Hundred and Fourteenth General Meeting

Minutes of the One Hundred and Fourteenth General Meeting of the Ceylon Natural History Society, held on January 17th, 1933, at 5.30 P.M., in the Lecture Hall of the Colombo Museum.

Professor F. O'B. Ellison, Vice-President, occupied the Chair in the absence of the President, and there were 14 members and 20 visitors present.

The Minutes of the previous General Meeting were read and confirmed.

The Chairman called on Professor W. C. O. Hill to exhibit a specimen of a Gibbon. Professor Hill called attention to the main anatomical features of this type of ape.

The Chairman called on Mr. E. C. T. Holsinger to give his lecture on the Green Seaweeds of Ceylon.

The lecturer began by referring briefly to the distinguishing characters of the Algae and their distribution in nature. He discussed the vertical distribution of Marine Algae in temperate and tropical seas, and enumerated the uses of Seaweeds. Coming to the Seaweeds of Ceylon, the lecturer gave a brief historical sketch of investigations concerning them. Next, he distinguished Ceylon genera which had a world-wide distribution from those which were mainly tropical. Dealing with the former group first, the lecturer exhibited, with the aid of the Epidiascope, pressed specimens of species of *Ulva*, *Enteromorpha*, *Chaetomorpha*, *Cladophora*, and *Bryopsis*, and briefly described their distribution, explaining the influence of the degree of salinity of the water on the thallus of Enteromorpha.

With regard to the Seaweeds which were mainly or strictly tropical, he said that the best represented and most interesting genus was *Caulerpa*. He compared the distribution of species of *Caulerpa* in Ceylon and West Indian waters and referred to the theories put forward to explain the similarity of the Algal flora of the tropical Atlantic, the Pacific, and Indian Oceans. He established a series of forms of *Caulerpa taxifolia* and described work done by him on the variability in the form of this species. Specimens of several forms of *Caulerpa* were next exhibited and their distribution in Ceylon waters was indicated. A brief reference was made to recent work on the problem of reproduction in the genus *Caulerpa*. The lecturer finally exhibited species of *Halimeda*, *Acetabularia* and *Valonia*, and described their distinguishing characters and distribution.

The Chairman declared the Meeting open for discussion and invited questions on the subject. Mr. Deraniyagala asked whether the differences in form of *Caulerpa* might not be due to mechanical influence such as friction caused by the sea currents, and Mr. Holsinger replied that the effect of friction was negligible as the Seaweeds were coated with slime. Questions were asked concerning the uses of Seaweeds as food, and Mr. Holsinger offered to obtain a recipe for making jam.

In proposing a vote of thanks, the Chairman referred to the uses of Seaweeds as food in Ireland, and also to Agar-Agar familiar to bacteriologists, which is obtained from Seaweed but which is indigestible. The vote of thanks was carried with acclamation.

The meeting then terminated.

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