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A REVIEW OF THE GENUS *LYGOSOMA* (SCINCIDAE: REPTILIA) AND ITS ALLIES.

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London.)

Since Boulenger wrote his Catalogue of Lizards in 1887, no comprehensive attempt has been made to deal with the large group of Scinks which he called *Lygosoma*. The elevation of his Subgenera, or rather Sections, to higher rank by later herpetologists has not helped the classification of the group, and in some cases has led to greater confusion. That some of the Sections, however, although they cannot be defined in clear generic terms, represent natural groups, has long been recognised. The combination of cephalic scalation, colour-pattern and form, which is to be found, for instance, in *Otosaurus* and in the well-developed species of *Lygosoma*, is quite distinct from that which obtains in *Riopa* or in *Emoia*. The well-developed members of each group appear to be a natural assemblage of species; they are capable of being defined as such, and are treated here as genera. On the other hand such groups as *Siaphos* and *Hemiergus*, which are merely assemblages, mainly of degenerate species, and not capable of being defined, have been abandoned. *Homolepida casuarinae*, the type of *Homolepida*, and three other species usually referred to *Lygosoma*, are placed in the genus *Tiliqua*. The status given to *Sphenomorphus*, *Lygosoma* (*sensu strictu*) and *Leiopisma*, will be dealt with under their respective headings.

The ancestor of the Scinks is not known, and there is no palæontological material to help us, but we may conceive it as a somewhat clumsily built, rather long-bodied and short-legged creature. It had a scaly lower eyelid, and an ear-opening without denticulations. The body was covered with more or less equal-sized scales and there was a full complement of head-shields including an occipital. The species of *Otosaurus*, *Dasia*, *Lygosoma* and *Emoia* that we know today, with their well-developed limbs, lacertiform bodies and symmetrically arranged head-shields, are certainly not primitive, although it may be from them that the degenerate ones have been derived.

In comparison with the tremendous changes that have taken place in the body and limbs, it is remarkable how little the head-shields have been affected. Many of the degenerate forms of *Lygosoma*, with their attenuated bodies, bud-like extremities, and closed ears, still retain all the head-shields that characterize the most highly developed members of that genus. These changes, as pointed out long ago by Günther and Boulenger, have no bearing on phylogeny.

The major structural changes that can occur are as follows:—

1. *Elongation of the body*.—Slight elongation of the body has occurred in many species, but marked elongation, with the assumption of a snake-like form, e.g., *Lygosoma verreauxi*, *Riopa*

(*E.*) *anchietae*, has occurred only in the genera *Lygosoma* and *Riopa*.

2. *Reduction in the size, and ultimate disappearance, of the limbs.*—Marked elongation of the body is invariably accompanied by degeneration of the limbs. In the terminal forms of *Rhodona* they have disappeared entirely. In *Lygosoma quadrapes*, in spite of their minute size and the distance which separates the anterior from the posterior pair, they are still perfectly formed and functionally useful.
3. *Changes in the tail.*—Elongation and thickening of the tail, particularly of the basal part. This change is usual in those species which have marked elongation of the body, but it may occur in species in which the body is not markedly elongate, e.g., *Lygosoma lesueri*, *L. monotropis*, *L. (E.) muelleri*. Compression of the tail has been described by Werner (*Lygosoma (Hinulia) compressicauda*, 1897, Australia) and by De Witte (*L. (Siaphos) compressicauda* 1933=*de wittei* Loveridge, Belgian Congo). The character, in a lesser degree, can be seen also in *Lygosoma delicatum*, *L. albertisii* and in several Ablepharids. It is best marked in the distal half of the tail, and is particularly noticeable when regeneration has occurred.
4. *Closure of the ear-opening, and degeneration of the auditory structures* has occurred in many Scinks that lead a more or less subterranean existence. The change is brought about by growth of the scales which surround the opening. The apparent punctiform opening can, by inserting a needle into it, be shewn often to be much larger than it appears at first sight. When the ear-opening is completely covered over, the tympanum and extra-columellar structures are lost; the columella auris remains and is attached by a rod or tube of tissue to the skin. Its position is usually indicated externally by a depression.
5. *Degeneration of the eye and its coverings* has occurred only in markedly degenerate species that have taken to a fossorial life, e.g., *Rhodona anguinoides*.
6. *Closure of the palatal notch* so that it lies farther back in the mouth. All the species that I have examined in which there is great elongation of the body shew this change.
7. *Increase in the size of the frontal shield and, in consequence, separation and reduction in the size of the prefrontals, which may ultimately be united with it.* The steps by which this change takes place can be studied best in *Lygosoma*, s. s. in its passage from *Sphenomorphus*.
8. *Enlargement of the body scales.*—The change has been brought about by (1) the union of two scales, or (2) apparent growth of one scale and suppression of the one adjacent to it. The change is best studied on the neck or at the base of the tail. Enlargement, usually in a transverse direction, of the dorsal scales, has taken place in many species. In those

which have marked reduction (18 to 22) in the number of scale-rows round the body, the scales are of uniform size throughout.

9. *Changes in the head shields.*—Fragmentation of the head-shields, as it has occurred in the Lacertidae has not taken place in the Scincidae. All the evidence that can be acquired from the degenerate forms indicates that the changes which have occurred have been in the opposite direction, namely in reduction in the number of shields by the union of two or more. I have assumed that such shields once lost, have not been regained.

The loss of the supranasals by union with the nasals and the union of the fronto-parietals and the interparietal into a single shield, has occurred again and again in species which in all other respects are highly developed.

10. *The successive steps by which the transparent "window" in the lower eyelid has been formed from the scaly lid* is already well known. It is best seen in the Leiolopismids, and as far as the Scincidae are concerned, culminates in *Ablepharus*, under which heading it is also discussed.

11. *Changes in the digits.*—The digital characters of the species, particularly of those which affect the hind foot, have received but little attention. Like the changes that have occurred in the other parts of the body they have no bearing on phylogeny, but are of interest from an ecological point of view. Four types of modification can be recognised.

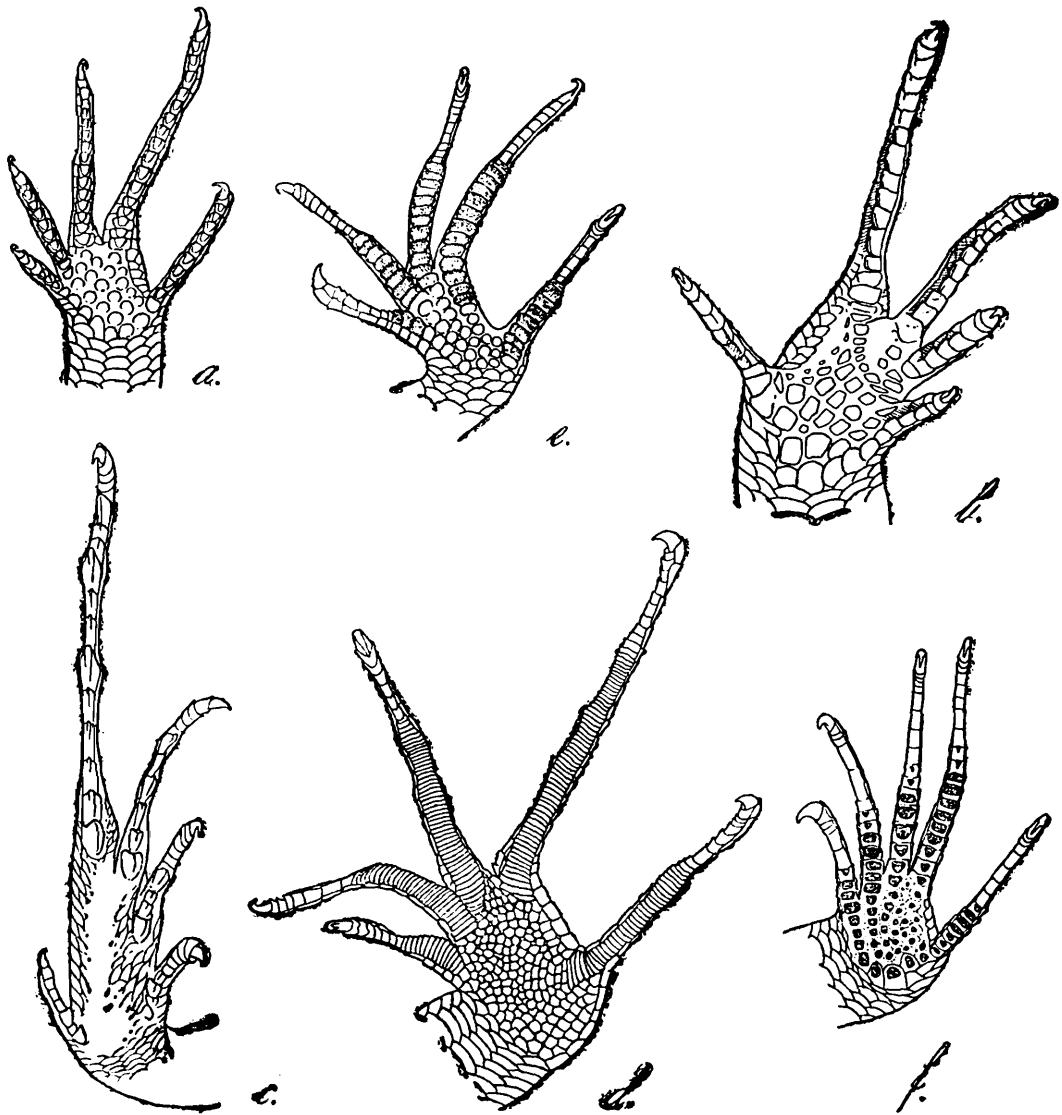
1. The simplest and least specialised form is shown in figure 1a (*Lygosoma indicum*), the subdigital lamellae being simply rounded or slightly keeled. It is the commonest form and occurs in the majority of species of *Lygosoma*, in *Riopa*, and with a few exceptions in all degenerate forms.

2. Figure 1b (*Otosaurus mimikanum*). The distinctive feature is a prominent ridge upon the lower aspect of the toes. It appears to have been formed by longitudinal division of the keeled lamellae and then increased growth of the inner portion; it is most marked upon the third and fourth toes. This type of modification occurs also in *Lygosoma melanopogon*, *L. (E.) muelleri*, *L. (E.) pratti* and others. A similar modification can be seen in the hind feet of many of the Agamidae and Lacertidae.

3. Figure 1c (*Otosaurus anomalopus*). The fourth toe is greatly elongated and the subdigital lamellae are very strongly keeled, those beneath the articulations being also much larger than the others. In *anomalopus* this type of foot reaches its greatest development; it can be seen also, though to a lesser degree, in *Otosaurus granulatum*, *O. sarasinorum*, *Lygosoma scotophilum*, *L. sanctum* and *L. maculatum*.

4. This type is characterized by enlargement of the subdigital lamellae upon the basal phalanges of the toe, and subsequently, as specialization proceeds, modification in the structure of those lamellae and differentiation of them from the lamellae upon the terminal phalanges (figure 1d *Emoia sanfordi*, figure 1e *Lygosoma anolis* and figure 1f

Dasia vittata). Many of the species which have these enlarged lamellae shew also that peculiar brown or black pigmentation upon the plates which can be seen in some species of Ground-Gecko (*i.e.*, *Gymnodactylus frenatus*, *Cnemaspis littoralis*), and which is associated with the proliferation of the epithelial cells and appears to be the forerunner of the hair-like processes that are characteristic of the true adhesive digit. In *Logosoma anolis* these hair-like structures have actually appeared.



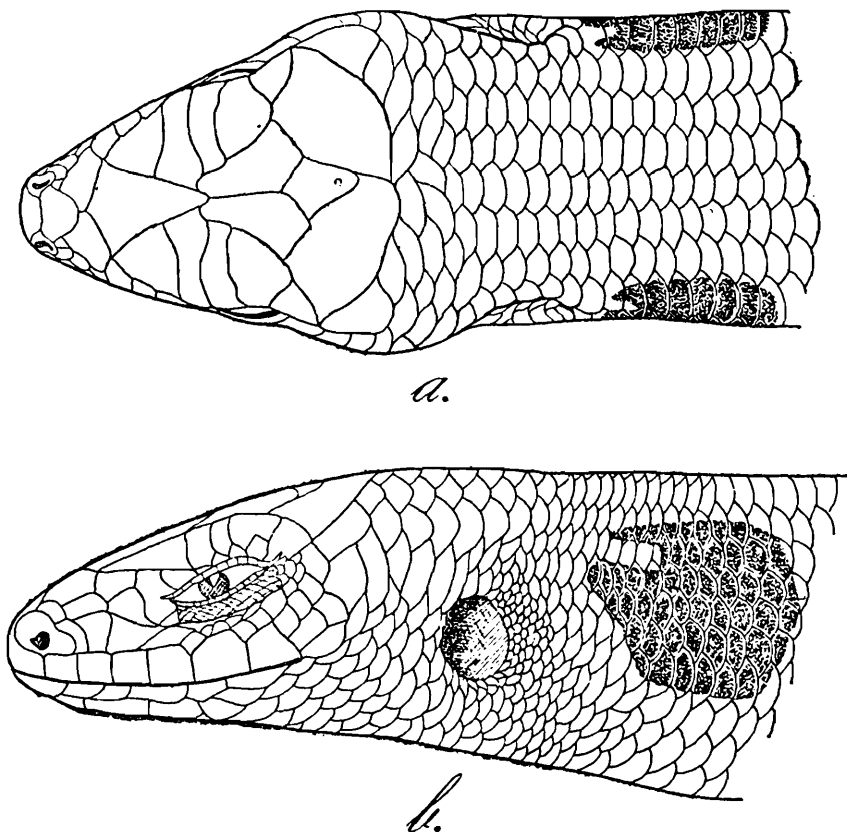
TEXT-FIG. 1.—Hind foot of a. *Lygosoma indicum*. b. *Otosaurus mimikanum*. c. *Otosaurus anomalopus*. d. *Emoia sanfordi*. e. *Lygosoma anolis*. f. *Dasia vittata*.

Our knowledge of the habits of the Scinks which have developed this type of foot is scanty, but many of them lead a more or less arboreal existence, an exception being *Emoia atrocostata* which lives on stones and rocks by the sea-shore. The modification is no doubt the earliest stage in the evolution of the adhesive digital disc which has attained so high a degree of development in the Geckonidae, and to a less extent in some Iguanids (*Anolis*). In the Scinks it is not yet sufficiently developed to enable them to make proper use of it as an adhesive structure. None of them appear to be able to climb a perfectly smooth surface as can most of the Geckoes and many of the Anoles.

Loss of the first finger has occurred in a large group of *Leiolopismids* (Section III). There are no species shewing the gradual disappearance of the digit; either it is there fully developed, or it has been lost, although dissection will usually show a vestige of the metacarpal remaining.

As already stated the purpose of this paper is to show generic relationships and to endeavour to trace the degenerate forms in each group as far as possible. In consequence the validity of species, except in a few instances, has not been questioned. The key characters under which the lists are arranged are intended primarily to indicate lines of descent rather than means of identification. Terms which apply to length of body and limb, size of ear, etc., can be approximate only, and may vary with the individual or in accordance with age.

Under *Otosaurus*, *Dasia*, *Emoia*, *Riopa* and *Rhodona* are listed all the species which appear to be valid for those genera. Those marked with an asterisk have not been seen by me. The species of *Lygosoma* are too numerous to be dealt with the same way, and only those in the British Museum collection have been mentioned.



TEXT-FIG. 2.—Upper (a) and side view (b) of head of *Otosaurus concinnatum* (B. M. 1932, 12.14.32-33).

The original manuscript of this article was destroyed by fire on the train in India. The carbon copy retained in London did not include all the final changes and these have been added from memory. It is hoped that the article as now presented is in the same form as the original one.

Genus **Otosaurus** Gray.*Otosaurus* Gray., *Cat. Liz. Brit. Mus.*, I, 1845, p. 93 (type *cumingi*).*Parotosaurus* Boulenger, *Trans. Zool. Soc. London*, XX, 1914, p. 257 (type *annectens*).

Supranasals present; fronto-parietals and interparietal distinct; ear-opening usually very large, without auricular lobules, tympanum not deeply sunk; lower eyelid scaly; limbs well developed, pentadactyle.

Range.—Malaysia to New Guinea; Celebes and the Philippines.

The separation of *Otosaurus* from *Lygosoma* rests entirely upon the presence or absence of supranasal shields. The distinction is slim, but it is a convenient means of separating from the main body of *Lygosoma* a group of species which have a number of characters in common and which are undoubtedly derived from the same stock. They are closely related to the *melanopogon-maculatum* group which, in the absence of supranasals, are placed under *Lygosoma*. In *O. concinnatum* the supranasals may be present or absent.

I. Supranasals large, in contact with one another; 6 or 7 supraoculars.

<i>cumingi</i> Gray	Philippines
<i>celebensis</i> Müll.	Celebes

II. Supranasals small, widely separated from one another.

A. 6 or 7 supraoculars.

<i>sarasinorum</i> Blgr.	Celebes
<i>annectens</i> Blgr.	New Guinea

B. 5 or 6 supraoculars.

<i>granulatum</i> Blgr.	New Guinea
<i>nigrilabre</i> Günth.	Celebes
<i>simum</i> Sauvage	New Guinea
<i>amblyplacodes</i> Vogt	New Guinea
<i>tropidonotus</i> Blgr.	Celebes
<i>variegatum</i> Peters	East Indies
<i>kinabaluense</i> Bartlett	Borneo
<i>llanosi</i> Taylor	Philippines
<i>mimikanum</i> Blgr.	New Guinea

C. 4 (5) supraoculars.

<i>jobiense</i> Meyer	Papuasias
<i>concinatum</i> Blgr. ¹	Solomon Is.
<i>curtirostris</i> Taylor	Philippines
<i>murudensis</i> M. A. Smith	Borneo
<i>anomalopus</i> Blgr. ²	Sumatra; ? Penang

¹ Supranasals present or absent.

² Originally described from Penang, the species has not since been obtained in the Malay Peninsula.

Genus **Lygosoma** Hardw. & Gray.(Section *Sphenomorphus*.)

Sphenomorphus Fitzinger, *Syst. Rept.*, 1843, p. 23 (type *melanopogon* Dum. & Bib.).

Eulamprus Fitzinger, *l.c.s.*, p. 22 (type *Lquoyi*).

Hinulia Gray., *Cat. Liz. Brit. Mus.*, 1845, p. 22 (type *Lyg. quoyi* Dum. & Bib.).

Lissonota (not of Gravenh. 1829), Blyth, *Journ. Asiat. Soc. Bengal*, XXII, 1853, p. 653 (type *maculata*).

(Section *Lygosoma*.)

Lygosoma Hardw. & Gray, *Zool. Journ.*, III, 1827, p. 228 (type *serpens* = *quadrupes*).

Siaphos Gray, in *Griff. Anim. King.*, IX, 1831, Syn. p. 72 (type *aequalis*).

Peromeles Wiegmann, *Herp. Mex.*, 1834, p. 11 (subst. name for *Siaphos*, same type).

Anomalopus Dumeril, *Cat. Meth. Rept.*, 1851, p. 185 (type *verreauxi*).

Coloscincus Peters, *Mon. Akad. Berlin*, 1876, p. 532 (type *truncatus*).

I am unable to find any character by which to separate generically the well-developed forms of *Lygosoma*, usually called *Sphenomorphus*, from the degenerate ones called *Lygosoma, sensu strictu*. Between the extremes in each Section the difference is enormous, but the gap can be bridged by connecting forms showing every stage of development. As arranged here they form a descending series in degeneration, and the two Sections are introduced merely to facilitate description and recognition. The *lesueuri-strauchi*, and the *monotropis-fasciolatum* groups, are divergents from the main line of descent, which continues on from *stellatum* through *undulatum*. Section *Leiolopisma* is dealt with separately.

Range.—The Western Pacific Islands, Australasia, Papuasias, the Oriental Region, Africa, N. America.

(Section *Sphenomorphus*.)

Supranasals absent; eyelids well developed, the lower scaly; prefrontals, fronto-parietals and interparietal distinct; limbs more or less well developed, pentadactyle; ear-opening present or absent; frontal not broader than the supraocular region.

I. The length of the leg exceeds the distance between the arm and the tip of the snout.

A. Ear-opening without lobules.*a.* Normally 5-7 supraoculars.

<i>melanopogon</i> Dum. & Bib.	Papuasias
<i>scotophilum</i> Blgr.	Malaysia
<i>aignanum</i> Blgr.	New Guinea
<i>lousiadense</i> Blgr.	Louisiade Archipelago
<i>striolatum</i> Weber	Flores Islands
<i>maindroni</i> Sauvage	New Guinea
<i>florense</i> Weber	Flores-Timor Islands
<i>dussumieri</i> Gray	Southern India
<i>maculatum</i> Blyth	Indo-China
<i>sanctum</i> Dum. & Bib.	Malaysia
<i>acutum</i> Peters	Philippines

b. 4 supraoculars.

<i>jagori</i> Peters	Philippines
<i>tersum</i> M. A. Smith	Siam
<i>indicum</i> Gray	Indo-China
<i>presigne</i> Blgr.	Malay Peninsula
<i>quoyi</i> Dum. & Bib.	Australia
<i>tenue</i> Gray	Eastern Australia
<i>stellatum</i> Blgr.	Malay Peninsula ; Annam

B. Ear-opening with very distinct lobules anteriorly ; nasals large, in contact with or just separated from one another ; tail long and thick at the base. Dorsal scales larger than laterals ; 4, sometimes 5, supraoculars.

<i>lesueuri</i> Dum. & Bib.	Western Australia
<i>dorsale</i> Blgr.	New Guinea
<i>leae</i> Blgr.	Central Australia
<i>taeniolatum</i> Shaw	Australia
<i>labillardieri</i> Gray	Western Australia
<i>fischeri</i> Blgr.	Australia
<i>ocelliferum</i> Blgr.	Western Australia
<i>strauchi</i> Blgr.	Queensland

II. The length of the leg equals the distance between the arm and the tip of snout.

A. Dorsal scales obtusely keeled, forming continuous lines.

<i>monotropis</i> Blgr.	Australia
<i>richardsoni</i> Gray	Western Australia
<i>fasciolatum</i> Günth.	Australia

B. Dorsal scales smooth or nearly so.

<i>undulatum</i> Ptrs. & Doria	Papuasias
<i>rufum</i> Blgr.	Aru Islands
<i>minutum</i> Meyer	New Guinea
<i>nigrolineatum</i> Blgr.	"
<i>pallidum</i> Günth.	Western Australia
<i>isolepis</i> Blgr.	Australia
<i>pardalis</i> Macleay	New Guinea ; North- ern Australia
<i>ornatum</i> Gray	New Zealand
<i>malayanum</i> Doria	Malaysia
<i>emigrans</i> Lidth de J.	Sumba—New Guinea
<i>modigliani</i> Blgr.	Mentawai Islands
<i>shelfordi</i> Blgr.	Borneo
<i>cameronicus</i> M. A. Smith	Malay Peninsula
<i>taprobanense</i> Kelaart	Ceylon
<i>striatopunctatum</i> Ahl.	"
<i>fallax</i> Peters	"
<i>decipiens</i> Blgr.	Philippines
<i>deplancki</i> Bavay	New Caledonia

III. The length of leg is less than distance between arm and the tip of the snout.

A. Ear-opening very distinct.

<i>temmincki</i> Dum. & Bib.	Sumatra—Celebes
<i>alfredi</i> Blgr.	North Borneo
<i>antoniorum</i> M. A. Smith	Timor
<i>forbesi</i> Blgr.	New Guinea
<i>courcyanum</i> Annand.	Assam
<i>helenae</i> Cochran	Siam
<i>textum</i> Müll.	Celebes
<i>brevipes</i> Bttgr.	"
<i>steeri</i> Stejneger	Philippines
<i>atrigrularis</i> Stejneger	"
<i>biparietalis</i> Taylor	"
<i>vigintiserium</i> Sjostedt	Fernando Po
<i>australe</i> Gray	Western Australia

B. Ear-opening punctiform or covered with scales.

<i>luzonense</i> Blgr.	Philippines
<i>scutirostrum</i> Peters	Eastern Australia
<i>cophias</i> Blgr.	Malay Peninsula

(Section *Lygosoma*.)

IV Body elongate, the distance between the tip of the snout and the arm being from 2 to 4 times in the distance between the axilla and groin. Limbs short or vestigial. Frontal usually broader than the supraocular region.

A. Digits 5-5 ; ear-opening small or punctiform.

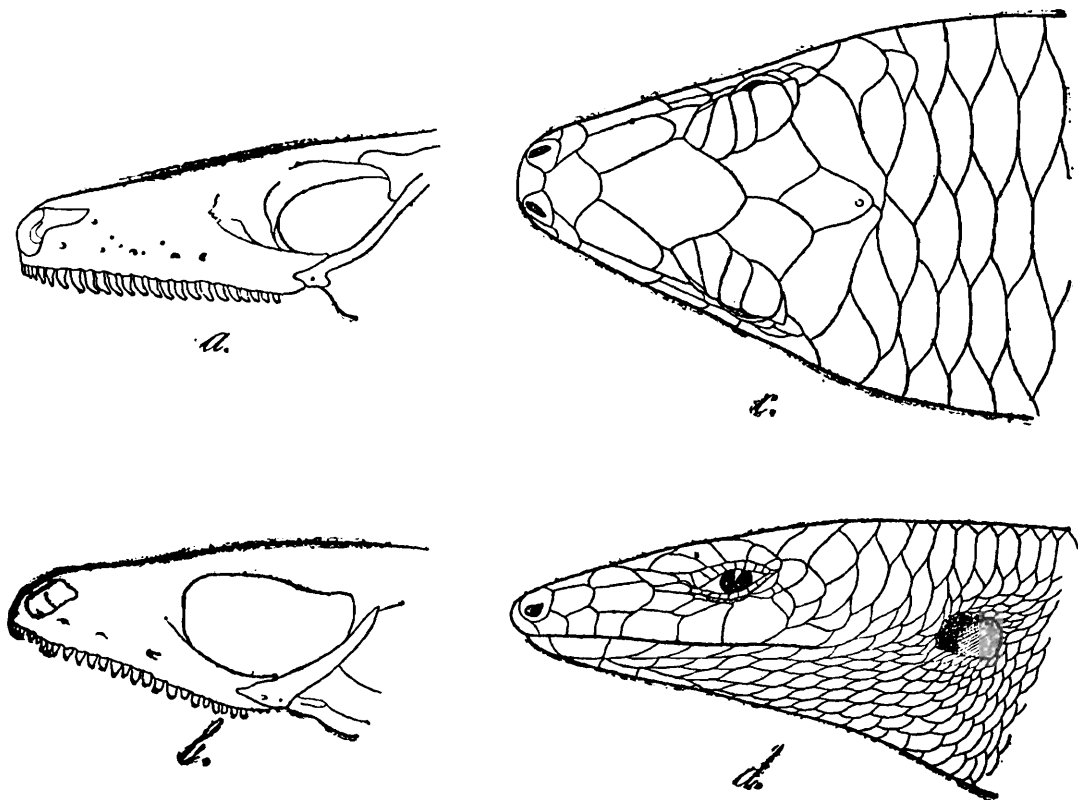
<i>pumilum</i> Blgr.	North Queensland
<i>punctulatum</i> Peters	Queensland
<i>mjobergi</i> Lonn.	North Queensland
<i>graueri</i> Sternfeld	East Africa
<i>quadrupes</i> Linn.	Indo-China ; Malaya

B. Digits reduced in number ; ear punctiform or covered with scales.

<i>aloysi-sabaudae</i> Peracca	East Africa
<i>meleagris</i> Blgr.	Tanganyika Territory
<i>clathrotis</i> Blgr.	Kenya
<i>aequale</i> Gray	Western Australia
<i>miodactylum</i> Blgr.	Malay Peninsula
<i>sumatrense</i> Blgr.	Sumatra
<i>reticulatum</i> Günth.	New South Wales
<i>larutense</i> Blgr.	Malay Peninsula
<i>verreauxi</i> Dum.	Eastern Australia
<i>truncatum</i> Peters	Queensland

Lygosoma (Ictiscincus).

Elania (not of Sundevall) Gray, *Cat. Liz. Brit. Mus.*, 1845, p. 80 (type *Scincus muelleri* Schleg.).
*Ictiscincus*¹ nom. nov. for *Elania* preocc.



TEXT-FIG. 3.—a. Teeth of *Lygosoma (Ictiscincus) muelleri*. b. Teeth of *Lygosoma indicum*.
c-d. Upper and side views of head of *Lygosoma (Ictiscincus) muelleri* (B. M. 1913, 10.10.173).

Teeth fang-like in the larger species. Frontal broader than the supraocular region, in contact with the enlarged first supraciliary. Body stout, somewhat elongate, limbs short, pentadactyle, tail thick. Ear-opening moderate, tympanum sunk.

Connects with *Lygosoma* through the *rufum-undulatum* group. With the exception of *crassicauda* and *woodfordi*, a group of closely related species.

<i>muelleri</i> Schleg.	New Guinea
<i>pratti</i> Blgr.	„
<i>woolastoni</i> Blgr.	„
<i>loriae</i> Blgr.	„
<i>oligolepis</i> Blgr.	„
<i>solomonis</i> Blgr.	New Guinea ; Solomon Islands
<i>crassicauda</i> Dum.	Papuasiasia ; Queensland
<i>woodfordi</i> Blgr.	Solomon Islands

¹ *Ictis*=a weasel.

(Section *Leiolopisma*.)

- Tridactylus* (not of Latreille 1802) Cuvier, *Regné Anim.*, 1829, p. 64 (type *decreasiensis*).
Tetradactylus (not of Merrem 1820) Cuvier, *l. c. s.*, p. 64 (type *decreasiensis*).
Peromelis Wagler, *Nat. Syst. Amphib.*, 1830, p. 160 (substitute name for *Tetradactylus* Cuvier).
Hemiergis Wagler, *l. c. s.*, p. 160 (substitute name for *Tridactylus* Cuvier); Boulenger, *Cat. Liz. Brit. Mus.*, III, 1887, p. 223.
Leiolopisma Dum. & Bib., *Erp. Gen.*, V, 1839, p. 742 (type *Scincus telfairii*).
Chelomeles Dum. & Bib., *l. c. s.*, p. 774 (type *C. quadrilineatus*).
Heteropus (not of Beauvois 1805) Dum. & Bib., *l. c. s.*, p. 742 (type *Lygosoma fuscum*).
Lampropholis Fitzinger, *Syst. Rept.*, 1843, p. 22 (type *Lyg. guichenoti*).
Eulepis Fitzinger, *l. c. s.*, p. 22 (type *Lyg. duperreyi*=*trilineatum*).
Lipinia Gray, *Cat. Diz., Brit. Mus.*, 1845, p. 84 (type *L. pulchella*).
Mococa Gray, *l. c. s.*, p. 80 (type *guichenoti*).
Oligosoma Girard, *Proc. Acad. Philad.*, 1857, p. 196 (type *Mococa zeylandica*=*moco*).
Hombronina Girard, *l. c. s.*, p. 196 (type *fasciolaris*).
Lygosomella Girard, *l. c. s.*, p. 196 (type *aestuosa*).
Cyclodina Girard, *l. c. s.*, p. 195 (type *aenea*).
Cophoscincus Peters, *Mon. Akad. Berlin*, 1867, p. 19 (type *quadrivittata*).
Anotis Bavay, *Mem. Soc. Linn., Normandie*, IV, 1869 (5), p. 29 (type *marei*).
Nannoscincus Günther, *Ann. Mag. Nat. Hist.*, (4) X, 1872, p. 421 (type *N. fuscus*=*marei*).
Lioscincus Bocage, *Journ. Acad. Sci. Lisbon*, XV, 1873, p. 328 (type *steindachneri*=*tricolor*).
Tropidoscincus Bocage, *l. c. s.*, p. 230 (type *aubrianus*).
Sauroscincus Peters, *Sitz. Ges. Nat. Fr. Berlin*, 1879, p. 149 (type *braconnieri*=*variabile*).
Lygisaurus de Vis, *Proc. Roy. Soc. Queensland*, I, 1884, p. 77 (type *foliorum*=*mundus*).
Myophila de Vis, *l. c. s.*, p. 77 (type *vivax*=? *blackmanni*).

Under *Leiolopisma* are included a number of species that cannot clearly be assigned to any genus. All agree in having an undivided, more or less transparent disc in the lower eyelid, a character that from a generic point of view is worthless, as it is in *Mabuya*, *Riopa*, *Scelotes*, *Sepsina* and others. The successive steps in the transformation of the scaly lid into one having a disc can be traced in numerous species. Usually there is no difficulty in deciding which character is present, but in some species, e.g., *L. ornatum*, *L. reevesi*, both conditions can be found.

The majority of the *Leiolopismids* have no doubt been derived from *Lygosoma* by the simple change in the eyelid, others from *Emoia* by loss of the supranasal shield through fusion with the nasal. The arrangement in the present list is based partly upon easily determined characters, partly upon geographical distribution.

I. Fronto-parietals paired (except in *novae-guineae*) ; interparietal large.

A. Subdigital lamellae not transversely enlarged.

a. Limbs well developed, pentadactyle ; ear-opening large or moderate.

<i>grande</i> Gray	New Zealand Archipelago
<i>lineo-ocellatum</i> Dum.	"
<i>suteri</i> Blgr.	"
<i>aeneum</i> Girard	"
<i>smithi</i> Gray	"
<i>homalonotum</i> Blgr.	"
<i>moco</i> Dum. & Bib.	"
<i>dendyi</i> Blgr.	"

<i>entrecasteauxi</i> Dum. & Bib.	Australia ; Tasmania
<i>mustelinum</i> O'Shaughn. ¹	"
<i>lichenigerum</i> O'Shaughn.	New South Wales
<i>infrapunctatum</i> Blgr.	Western Australia
<i>challengeri</i> Blgr.	Queensland
<i>nigrofasciolatum</i> Peters	New Caledonia
<i>nototaenia</i> Blgr.	New Guinea
<i>noctua</i> Less.	"
<i>himalayana</i> Günth.	Himalayas
<i>ladacense</i> Günth.	"
<i>sikkimense</i> Blyth	"
<i>doriae</i> Blgr.	Burma
<i>bilineatum</i> Gray	Southern India
<i>laterimaculatum</i> Blgr.	"
<i>vittigerum</i> Blgr.	Indo-China ; Malaya
<i>reevesi</i> Gray	China ; Indo-China
<i>unicolor</i> Harlan	U. S. A.
<i>rupicola</i> M. A. Smith	Siam
<i>telfairi</i> Desjard	Mauritius

- b. Body elongate, limbs short, not meeting when adpressed ; digits 5-5 or reduced in number ; ear punctiform or covered with scales.

<i>peroni</i> Fitz.	Australia
<i>maccoyi</i> Luc. & Frost	Eastern Australia
<i>woodwardi</i> Luc. & Frost	Western Australia
<i>quadrilineatum</i> Dum. & Bib.	"
<i>decresiense</i> Fitz.	Australia
<i>scharffi</i> Blgr.	Queensland
<i>gracile</i> Bavay	New Caledonia
<i>mariae</i> Bavay	"

B. Lamellae beneath the basal phalanges transversely enlarged and differentiated from those on the terminal phalanges (except in *pulchellum*).

- a. Snout subacuminate ; prefrontals separated from one another ; tail ? prehensile.

<i>elegans</i> Blgr.	New Guinea
<i>semoni</i> Oudemans	"
<i>flavipes</i> Parker	"
<i>parkeri</i> M. A. Smith	"

- b. Snout acuminate ; prefrontals in broad contact with one another.

<i>anolis</i> Blgr. ²	Solomon Islands
<i>longiceps</i> Blgr.	New Guinea
<i>pulchellum</i> Gray	Philippines

¹ *Lygosoma* (*Leiolopisma*) *pseudotropis* Werner 1903 (type in Natural History Museum, Brussels), is identical with this species.

² *Lygosoma virens* (Peters) from Papua with 34-36 scales round the body and 13-14 lamellae beneath the 4th toe, is a race of *L. anolis* which has 36-40 scales round the body and 15-17 lamellae beneath the toe.

II. Fronto-parietals united ; interparietal usually large ; limbs pentadactyle, usually well developed.

A. Ear-opening present.

<i>ocellata</i> Gray	Tasmania
<i>pretiosum</i> O'Shaughn.	"
<i>trilineatum</i> Gray	Australia ; Tasmania ; W Pacific Islands
<i>guichenoti</i> Gray	Australia
<i>metallicum</i> O'Shaughn.	W. Pacific Islands
<i>delicatum</i> Werner	Queensland
<i>variable</i> Bavay	New Caledonia
<i>steindachneri</i> Bocage	"
<i>tricolor</i> Bavay	"
<i>euryotis</i> Werner ¹	"
<i>novae-caledoniae</i> Parker	"
<i>austro-caledonicum</i> Bavay	"
<i>stanleyanum</i> Blgr.	New Guinea
<i>miotis</i> Blgr.	"
<i>morokanum</i> Parker	"
<i>pulchrum</i> Blgr.	"
<i>travancoricum</i> Bedd.	Southern India
<i>palnicum</i> Boettg.	"

B. Ear closed.

<i>initiale</i> Werner	Western Australia
<i>relictum</i> Vincig.	Sumatra
<i>infralineolatum</i> Günth.	Celebes ; Philippines
<i>quadrivittatum</i> Peters	Celebes ; Borneo
<i>surdum</i> Blgr.	Malaya

III. Frontoparietals united ; interparietal small or absent ; limbs usually well developed ; 4 fingers and 5 toes.

<i>nigrigulare</i> Blgr.	New Guinea
<i>fuscum</i> Dum. & Bib.	Papuasias
<i>becarrii</i> Peters & Doria	Kei Islands
<i>bicarinata</i> Macleay	New Guinea
<i>pectorale</i> de Vis	Queensland
<i>blackmanni</i> de Vis	"
<i>mundum</i> de Vis	"
<i>devisii</i> Blgr.	"
<i>mundivense</i> Browne	"
<i>tetradactylum</i> O'Shaughn.	Eastern Australia
<i>rhomboidale</i> Peters	Queensland
<i>maccooei</i> Ram. & Ogilby	New South Wales
<i>curtum</i> Blgr.	New Guinea
<i>novae-guinae</i> Meyer	"
<i>spinauris</i> M. A. Smith	Timor

¹ Doubtfully distinct from *tricolor*.

Genus **Dasia** Gray.

- Dasia* Gray, *Ann. Mag. Nat. Hist.*, II, 1839, p. 331 (type *olivacea*).
Lamprolepis Fitzinger, *Syst. Rept.*, 1843, p. 22 (type *Scincus smaragdinus* Lesson).
Liotropis Fitzinger, *l. c. s.*, p. 22 (type *Euprepes ernesti*=*olivacea*).
Keneuxia Gray, *Cat. Liz. Brit. Mus.*, 1845, p. 79 (type *smaragdinus*).
Apterygodon Ederling, *Nat. Tijds. Med. Ind.*, XXVI, 1863, p. 483 (type *vittata*).
Theconyx (not of Gray 1845) Annandale, *Spol. Zeyl.*, III, 1906, p. 191 (type *halianus*).

Supranasals present (except in *smaragdina* in which they are united anteriorly, or completely, with the nasal); prefrontals, frontoparietals and interparietal distinct; lower eyelid scaly; ear-opening small, tympanum sunk.

Limbs well developed, pentadactyle, the lamellae below the basal phalanges of the digits more or less expanded and differentiated from those below the terminal phalanges (fig. 1f).

Range.—From Southern India to the Western Pacific Islands.

As far as is known all the species are arboreal and subarboreal in their habits.

<i>smaragdina</i> Lesson	East Indies to W. Pacific Is.
<i>dahlia</i> Werner	Bismarck Archipelago
<i>olivacea</i> Gray	Indo-China; Malaysia; Philippines
<i>subcoerulea</i> Blgr.	South India
<i>vittata</i> Ederling	Borneo
<i>nieuwenhuisi</i> Lidth de J.	„
<i>vyneri</i> Shelford	„
<i>grisea</i> Gray	Malaysia; Philippines
<i>haliana</i> Haly & Nev.	Ceylon

Genus **Emoia** Gray.

- Eusoma* (not of Germar 1817) Fitzinger, *Syst. Rept.*, 1843, p. 22 (type *lessoni*=*cyanura*).
Emoia Gray, *Cat. Liz. Brit. Mus.*, 1845, p. 95 (type *Scincus atrocatus* Lesson).

Supranasals present, narrow, always separated from one another; lower eyelid with an undivided transparent disc; fronto-parietals united; interparietal small or absent; ear-opening never large, tympanum sunk. Limbs well developed, pentadactyle, digits long, the lamellae beneath the basal phalanges usually enlarged and differentiated from those on the terminal phalanges.

Range.—From Borneo and the Philippines to the Western Pacific Islands and North Australia.

I. Interparietal normally present.

<i>nigra</i> Hombr. & Jacq.	Papuasias; W. Pacific Is.
<i>adspersa</i> Steindach.	Fiji and Samoan Is.
<i>parietale</i> Peters ¹	Borneo; Christmas I.
<i>speiseri</i> Roux	New Hebrides

¹ *Lygosoma sinus* M. A. Smith is a race of this species.

<i>atrocostata</i> Lesson	Malaysia ; Papuasias ; W. Pacific Is.
<i>battersbyi</i> Procter	New Guinea
<i>sanfordi</i> Schmidt & Burt	W Pacific Is.
<i>cyanogaster</i> Lesson	Papuasia ; W. Pacific Is. ; Queensland
<i>samoensis</i> Dum.	W. Pacific Is.
<i>sorex</i> Boettger	Helmaheira I.
<i>ruficauda</i> Taylor	Philippines.
II. No interparietal.	
<i>cyanura</i> Lesson	Papuasia ; W Pacific Is.
<i>weneri</i> Vogt	"
<i>klossi</i> Blgr.	New Guinea
<i>tropidolepis</i> Blgr.	"
<i>baudini</i> Dum. & Bib.	Papuasia ; Celebes
<i>iridescent</i> Blgr.	"
<i>kukenthali</i> Boettger	Halmaheira I.
<i>mivarti</i> Blgr.	W. Pacific Is.
<i>tetrataenia</i> Blgr.	"
Species not seen by me.	
<i>acrocarinata</i> Kopstein .	New Guinea
<i>ahli</i> Vogt	"
<i>buergeri</i> Vogt	"
<i>callisticta</i> Peters	"
<i>cuniceps</i> de Vis	"
<i>pallidiceps</i> de Vis	"
<i>jakati</i> Kopstein	Solomon Is.
<i>flavigularis</i> Schmidt	"
<i>mehelyi</i> Werner	"
<i>murphyi</i> Burt	"
<i>whitenei</i> Burt	"
<i>similis</i> Dunn	Flores

Genus **Riopa** Gray.

- Riopa* Gray, *Ann. Mag. Nat. Hist.*, II, 1839, p. 332 (type *Lyg. punctata*).
Campsodactylus Dumeril, *C. R. Acad. Sci.*, IV, 1837, p. 16 (type *lamarrei*=*vosmaeri*).
Chiamela Gray, *Ann. Mag. Nat. Hist.*, 1839, p. 332 (type *C. lineatus*).
Hagria Gray, *l. c. s.*, p. 333 (type *Scincus vosmaeri*).
Liosoma (not of Brandt 1834) Fitzinger, *Syst. Rept.*, 1843, p. 22 (type *Eumeces microlepis* Dum. & Bib.).
Sphenosoma (not of Dejean 1834) Fitzinger, *l. c. s.*, p. 23 (type *Eumeces punctatus* Wiegmann).
Eugongylus Fitzinger, *l. c. s.*, p. 23 (type *Eumeces oppelii-rufescens*).
Mochlus Günther, *Proc. Zool. Soc. London* 1864, p. 308 (type *punctulata*).
Panaspis Cope, *Proc. Acad. Philad.*, 1868, p. 317 (type *aeneus*=*cabindae*).
Eumecia Bocage, *Journ. Acad. Sci. Lisbon* III, 1870, p. 67 (type *anchietae*).

The genus, as now tentatively reconstructed, consists of four groups or subgenera, each one containing a number of species closely related to each other, but not clearly related to the species in the other groups.

Riopa (Riopa).

Supranasals present, sometimes united anteriorly with the nasals; frontal broader than the supraocular region, broadly truncate anteriorly; prefrontals usually small and widely separated; lower eyelid scaly or with a disc; ear-opening distinct; tympanum sunk; body stout, more or less elongate; limbs short.

Range.—The Oriental Region; Africa.

The depressed, cuneiform snout, which characterizes the African *sundevalli-modestum* group and culminates in *vinciguerra* is foreshadowed in the Oriental *herberti*, *bowringi*, *punctata* and *koratense*. The resemblance of *R. guineense* from W. Africa to *R. herberti* from Siam is remarkable. When a good series of each is examined it is possible to separate the African form from the Siamese in having a slightly longer body and a few more scales, counted in longitudinal series, down the back. But individuals can be found which, if the locality of origin were not known, it would be difficult to give a name to. Such a case is probably explained by great consistency within the genus rather than by parallel evolution.

I. Supranasals large, in contact with one another.

A. Lower eyelid scaly.

a. Supranasals entire, or united anteriorly with the nasals.

<i>fernandi</i> Burton	West Africa
<i>mocquardi</i> Chaban.	Central Africa
<i>bampfyldei</i> Bartlett	Malaya
<i>opisthorhodum</i> Werner*	Sumatra
<i>corpulentum</i> M. A. Smith	Annam
<i>koratense</i> M. A. Smith	Siam
<i>albopunctatum</i> Gray	India
<i>bowringi</i> Günther	Indo-China; Philip- pines
<i>herberti</i> M. A. Smith	Peninsular Siam
<i>guineense</i> Peters	West Africa
<i>sundevalli</i> A. Smith	Africa
<i>modestum</i> Günther	East Africa

b. Supranasals completely united with the nasals.

<i>vinciguerra</i> Parker	Somaliland
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B. Lower eyelid with a disc.

<i>guentheri</i> Peters	India
<i>punctata</i> Gmelin	"
<i>lineolata</i> Stol.	Burma
<i>anguina</i> Theobald	"
<i>lineata</i> Gray	Bombay District
<i>vosmaeri</i> Gray	Bengal
<i>mabuiiformis</i> Loveridge	Kenya Colony
<i>tanae</i> Loveridge	"

II. Supranasals separated from one another; lower eyelid scaly.

<i>producta</i> Blgr.*	Somaliland
<i>isodactyla</i> Günther	Siam

Riopa (Eugongylus).

Supranasals present ; frontal not broader than the supraocular region ; lower eyelid scaly.

Range.—Papuasias ; Western Pacific Islands ; Northern Australia.

I. Supranasals in contact with one another.

<i>garnieri</i> Bavay	New Caledonia
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II. Supranasals separated from one another.

<i>albofasciolata</i> Günther	Solomon Islands ; Northern Australia
<i>microlepis</i> Dum. & Bib.*	Friendly Islands
<i>rufescens</i> Shaw	Papuasias ; Northern Australia
<i>mentovaria</i> Boettg.*	Halmaheira
<i>sulaense</i> Kopstein*	Sula Islands

Riopa (Panaspis).

Supranasals small, widely separated from one another, or absent (united with the nasals) ; frontal narrower than the supraocular region ; prefrontals, fronto-parietals and interparietal distinct ; lower eyelid with a disc ; limbs short, pentadactyle.

Range.—West Africa.

Parker has shown elsewhere (*Nov. Zool.* 1936, p. 139) that the species of the *breviceps-kitsoni* group are closely related to *reichenowei* and *africanum*, species which have lost the supranasal and are usually placed under *Leiolopisma*. This view is strengthened by the discovery that in some examples of *breviceps* (B. M. 1903. 11. 12. 10-14) union of the supranasal with the nasal has actually occurred. *Ablepharus cabindae* is placed in this group, with which, in cephalic scalation, it agrees. The disc of the lower eyelid in this species is very large but closure has not taken place. The palpebral fissure is still visible externally, the upper and lower eyelids being united only at the commissures.

I. Supranasals present, sometimes united with the nasals.

A. Disc of lower eyelid moderately large.

<i>breviceps</i> Peters	French Congo
<i>togoense</i> Werner	Ashanti
<i>kitsoni</i> Blgr.	Gold Coast

B. Disc of lower eyelid very large.

<i>cabindae</i> Bocage	Angola
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II. Supranasals always united with the nasal ; disc of lower eyelid very large.

<i>reichenowei</i> Peters	Cameroons
<i>africanum</i> Gray	Gulf of Guinea

Riopa (Eumecia).

Supranasals present or united with the nasal, in contact with one another ; prefrontals very large ; frontal long and narrow ; fronto-parietals and interparietal distinct ; lower eyelid with an undivided opaque disc. Body very elongate ; limbs vestigial.

Range.—East Africa.

anchietae Bocage
johnstoni Blgr.

British East Africa
Nyasaland

Genus **Rhodona** Gray.

Rhodona Gray, *Ann. Mag. Nat. Hist.*, 1839, p. 335 (type *punctata*=*lineopunctulata* Dum. & Bib.).

Soridia Gray, *l. c. s.*, p. 335 (type *lineata*).

Praepeditus Dum. & Bib., *Erp. Gen.* V, 1839, p. 787 (subst. name for *Soridia*).

Brachystopus Dum. & Bib., *l. c. s.*, p. 778 (type *lineopunctulatus*).

Ronia Gray, in Grey's *Trav. Austral.* II, 1842, p. 437 (type *catenulata*=*lineopunctulata* Dum. & Bib.).

Leptosoma (not of Nardo 1826) Fitzinger, *Syst. Rept.* 1843, p. 23 (type *bougainvillii*).

Pholeophilus Smith, *Ill. S. Africa*, 1849, p. 15 Append., (type *capensis*=*lineata*).

Ophioscincus Peters, *Mon. Akad. Berlin*, 1873, p. 747 (type *australis*).

Isopachys Lonnb., *Kunigl. Sv. Vet. Akad. Handl.* LV, 1916, 4 p. 10 (type *gyldenstolpei*).

Typhloseps Angel, *Bull. Mus. Hist. Nat. Paris*, 1920, p. 4 (type *roulei*).

Snout more or less depressed and cunieforn in shape, with projecting rostral; nasals and frontonasal very large; frontal broader than the supraocular region; prefrontals small and widely separated or absent. Ear-opening punctiform or absent. Lower eyelid with an undivided disc, except in *pumila* and *anguinoides*. Limbs very short, or vestigial or absent.

Range.—Australia; Siam. This apparently unusual distribution is paralleled by that of the agamid genus *Physignathus*.

A group of degenerate species derived perhaps from some *Riopa*-like stock. The African *Riopa vinciguerra* although possessing *Rhodona*-like characters is too obviously related to the *Riopa modesta* group to be included here. *Rhodona anguinoides*, *Rh. roulei* and *Rh. ophioscincus* which I originally placed under *Ophioscincus* (*Fauna Brit. Ind.* II, p. 333) are too intimately linked with other species of *Rhodona* to be separated from them.

I. Frontoparietals and interparietal distinct.

A. Limbs pentadactyle.

microtis Gray

Australia

pumila Blgr.

Queensland

bougainvillii Gray

Southern Australia

B. Digits reduced in number.

frosti Zeitz.

Australia

terdigitatum Parker

Australian Bight

walkeri Blgr.

Australia

gerrardi Gray

"

punctatovittata Günther

Australia; Tasmania

fragile Günther

"

planiventralis Luc. & Frost*

Western Australia

macropisthopus Werner*

Queensland

picturata Fry*

Western Australia

nichollsi Loveridge*

"

C. No anterior limbs; posterior vestigial.

wilkinsi Parker

Queensland

D. Neither anterior nor posterior limbs.

anguinoides Blgr.

Siam.

roulei Angel

"

australe Peters

Queensland

II. Frontoparietals and interparietal united ; no anterior limbs ; posterior vestigial.

A. Prefrontals present.

lineopunctulata Dum. & Bib.

Western Australia

B. No prefrontals.

bipes Fischer

Western Australia

miopus Günther

"

lineata Gray

"

Genus *Ateuchosaurus* Gray.

Ateuchosaurus Gray, *Cat. Liz. Brit. Mus.* 1845, p. 107 (type *chinensis*).

Lygosaurus Hallowell, *Proc. Acad. Philad.*, 1860, p. 496 (type *pellopleurus*);

Stejneger *Herp. Japan* 1907, p. 221.

Agrees with *Lygosoma* but no proper parietal shields, and the frontal very long and constricted, or divided, in the middle.

Range.—Tongking ; South China and the Riu Kiu Islands.

chinensis Gray

Southern

China ;

Tongking

pellopleurus Hallowell

Riu Kiu Islands

Genus *Cophoscincopus* Mertens.

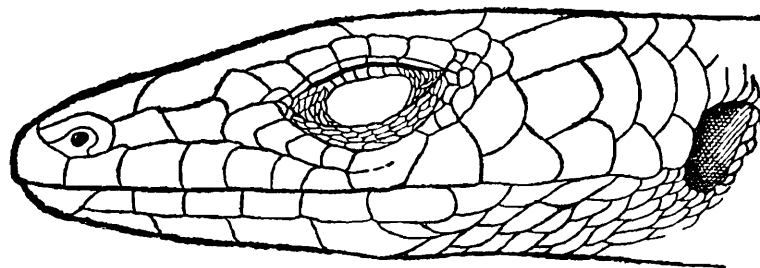
Cophoscincopus (not of Peters 1867) ; Vaillant, *Bull. Soc. Philom.* (7) VIII, 1884, p. 170 (type *C. simulans*=*Tiliqua dura* Cope).

Cophoscincopus Mertens, *Zool. Stuttgart*, XXXII, 1934, p. 190.

Ear-opening present, but covered, or almost entirely, with scales ; dorsal and lateral scales strongly keeled, those on the flanks arranged obliquely.

In general appearance, except for the character of the ear, like *Tropidophorus*.

A single species in West Africa.



TEXT-FIG. 4.—Side view of head of *Ablepharus spenceri*.

Genus *Ablepharus* Fitzinger.

I have recently advanced the view (*Fauna Brit. India*, II, 1935, p. 309) that *Ablepharus* is a genus of polyphyletic origin. It has been formed, not by the diversification of a single species, but by the independent evolution of a particular character, namely the covering of the eye

by the growth of the lower eyelid with its accompanying transparent disc, and the ultimate union of that lid with the upper, in a number of species in different parts of the world. The union of the two lids, however, is not so complete as is usually believed. A close examination of those structures will show that in several species, *A. boulengeri*, *A. egeriae*, *A. burnetti*, *A. pannonicus*, *A. tenuis*, the palpebral fissure still persists, but being small and hidden beneath the supercilium, or the vestige of the upper lid, has escaped observation.

A still earlier stage in the process of closure of the eye can be seen in the Australian *A. spenceri*, (fig. 4) a species in which the palpebral fissure is still visible externally, the union of the two lids having taken place only at the inner and outer commissures. *A. spenceri* was originally described as an *Emoia*, but its nearest relative is undoubtedly *A. lineo-ocellatus*. Closure of the eye in *spenceri* has not proceeded so far as in *lineo-ocellatus*, and the crescentic shield above the nasal which represents a combined supra- and post-nasal is different. In *A. lineo-ocellatus*, however, both supra- and post-nasal may be present (Loveridge, *Bull. Mem. Comp. Zool., Harvard*, LXXVII, 1934, p. 377) or both may be united with the nasal. In the character of the eye, in that closure is not yet complete, *Emoia spenceri* resembles *Ablepharus cabindae*. The latter, for reasons already given, is transferred to *Panaspis*, the former is now placed under *Ablepharus*, and the definition of that genus emended accordingly (Smith, *Fauna Brit. Ind.*, II, p. 309). That the condition of the eye as seen in these two species is but a further stage in the enlargement of the lower lid with its accompanying disc, such as obtains in *Lygosoma entrecasteauxi*, *L. trilineatum*, *L. himalayanum*, *L. albertisii*, *Riopa africanum*, to name but a few in which disc is particularly large, will not be disputed.

The origin of most of the Ablepharids cannot now be traced, the changes in cephalic scutellation having made this impossible. The majority appear to have been derived from *Lygosoma* through the Leiolopismids; *A. boutoni*, the most widely distributed species has all the characters of *Emoia*; *A. spenceri* and *A. lineo-ocellatus* possess supranasal shields but they do not appear to be related in any other way to the genera that have those shields.

Genus **Tiliqua** Gray.

Tiliqua Gray, *Ann. Phil.* (2) X, 1825, p. 201 (type *gigas*).

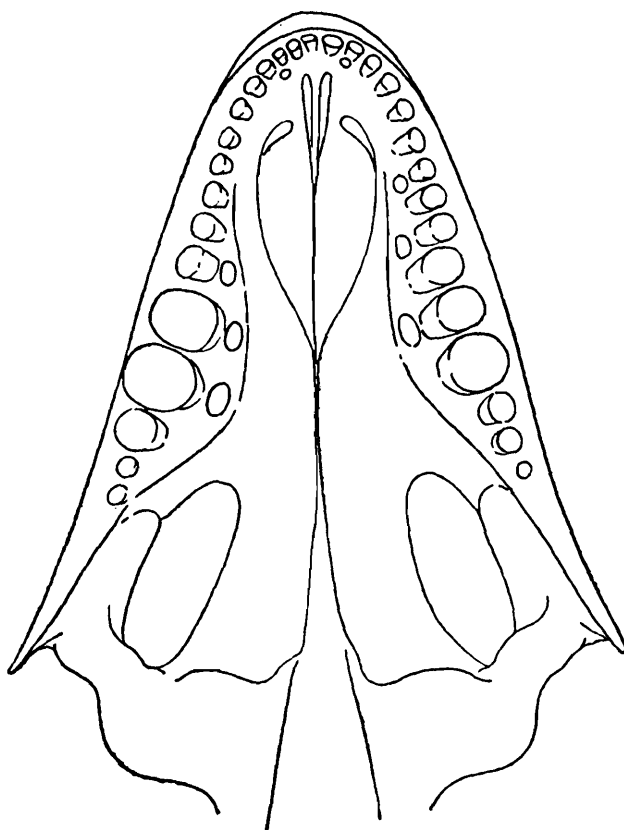
Cyclodus Wagler, *Desc. Icon. Amphib.* (1) 1828, tab. 6 and *Syst. Amphib.* 1830, p. 162 (type *flavicularis*=*gigas*).

Omolepida Gray, *Cat. Liz. Brit. Mus.*, 1845, p. 87 (type *Cyclodus casuarinae* Dum. & Bib.).

Cyclodomorphus Fitzinger, *Syst. Rept.*, 1843, p. 23 (type *Cyclodus casuarinae*).

Lateral teeth with spheroidal crowns increasing in size from before backwards, except the last two or three which are smaller. Eye-lids well developed, scaly; tympanum distinct, deeply sunk; nostril pierced in a single nasal, usually with a curved groove behind it; no supranasals; prefrontals, frontoparietals, and interparietal distinct, the last named

separating the parietals. Body more or less elongate, limbs short, pentadactyle.



TEXT-FIG. 5.—Upper jaw of *Tiliqua gigas*.

In the character of its teeth, and in having the parietals completely separated by the interparietal, *Cyclodus casuarinae* Dum. & Bib. agrees with *Tiliqua*, and its proper place is in that genus. Three other species, usually referred to *Lygosoma* or *Omolepida* are, for the same reason, placed there also. The genus with its additions, will now stand as follows :—

I. Length of tail not longer than the length of the body ; a complete series of scales between the orbit and the upper labials.

<i>gigas</i> Schneid.	Papuasia
<i>scincoides</i> White	Australia ; Tasmania
<i>nigrolutea</i> Gray	Australia
<i>occipitalis</i> Peters	Australia ; Tasmania
<i>adelaidensis</i> Peters	„

II. Length of tail longer than the length of the body ; no complete series of scales between the orbit and the upper labials.

<i>casuarinae</i> Dum. & Bib.	Australia ; Tasmania
<i>branchiale</i> Günth.	„
<i>wood-jonesi</i> Procter	„
<i>gastrostigma</i> Blgr.	„

Lygosoma parkeri, sp. nov.(Section *Leiolopisma*).

Type : Brit. Mus. 1913, 11.1.57.

Distance between the snout and the fore-limb once and a third times in the distance between the axilla and groin ; snout rounded ; rostral in good contact with the fronto-nasal, which is a little broader than long ; prefrontals large, just separated from one another and united with the anterior loreal ; posterior loreal longer than high ; frontal longer than the parietals and interparietal together, its lateral margins indented by the second supraocular ; four supraoculars, first largest, three in contact with the frontal ; parietals in contact with one another behind the interparietal ; a pair of nuchals ; eight or nine supraciliaries, all higher than long ; nine supralabials, the sixth largest and subocular ; two large superposed temporals. Ear-opening oval, nearly as large as the disc of the lower eyelid, no projecting lobules.

Body scales quite smooth, the dorsals a little larger than the laterals, 36 round the middle of the body ; a pair of enlarged preanals. Tail a little longer than the head and body, covered with sub-equal scales. Limbs rather short, just overlapping when adpressed ; subdigital lamellae beneath the basal phalanges transversely enlarged, and differentiated from those on the distal phalanges ; eight or nine lamellae beneath the basal phalanges of the fourth toe.

Light brown above indistinctly shaded with darker brown, and with dark brown sinuous alternating cross-bars extending from the vertebral line to the sides of the body ; tail with dark cross-bars above ; head-shields outlined with dark brown ; white below.

From snout to vent 53 m.m.

Described from a single specimen obtained by the Woolaston Expedition in 1913, on the Utakwa River, Dutch New Guinea.

L. parkeri is related to the species of the *elegans-flavipes* group ; it differs from them all in the character of the frontal and prefrontal, and in colour pattern.

CATFISHES OF THE GENUS *HELICOPHAGUS* BLEEKER.

By SUNDER LAL HORA, D.Sc., F.R.S.E., F.N.I., Assistant Superintendent, Zoological Survey of India, Calcutta.

It is generally recognised that the freshwater fish-fauna of India is very closely allied to that of south-eastern Asia, and, I¹ recently put forward the suggestion that it is in the main derived from that source. To elucidate the genetic affinities of some of the Indian forms it has, therefore, been necessary to study the morphological features of the related Far Eastern genera. For instance, in my work on the Siluroid fishes of India, Burma and Ceylon I found that though the accounts of the genus *Helicophagus* Bleeker clearly show its relationships to *Pangasius* Cuvier and Valenciennes, there are certain features in the anatomy of the latter by which it can be separated from the other Schilbeid fishes of south-eastern Asia and Africa; certain authorities² as a result regard it as a member of a separate, monotypic family Pangasiidae. The modern classification of Siluroid fishes is, in the main, based on Bridge and Haddon's³ critical morphological studies of these fishes, especially of their air-bladder and the associated skeletal structures. Unfortunately these authors were for want of material not able to deal with all the forms of the family, and in most cases it was not possible for them to study the changes undergone during growth in various species. *Helicophagus* was one of the genera, of which they had no specimen for study, but they reported upon 5 species of *Pangasius*. Through the kindness of Mr. Luang Choola, Officer-in-charge, Bureau of Fisheries, Bangkok, I was able to obtain on loan a fine example of *H. waandersi* Bleeker for study. I have availed myself of this opportunity to examine as much of its anatomy as possible without impairing the utility of the specimen for museum purposes. I am very grateful to Mr. Luang Choola and the Bureau of Fisheries, Bangkok, for the loan of the specimen.

According to Weber and de Beaufort,⁴ *Helicophagus* and *Pangasius* can be distinguished from each other with the help of the following key:—

- | | |
|--|----------------------|
| “ a. Posterior nostril between anterior one and eye ;
eye behind and totally above corner of mouth.
No palatine teeth | <i>Helicophagus.</i> |
| b. Posterior nostril at short distance from anterior
and above a line between anterior nostril and
eye. Eye partly below a horizontal through
the corner of mouth | <i>Pangasius.”</i> |

¹ Hora, S. L.—Geographical Distribution of Indian Freshwater Fishes and its bearing on the probable land connections between India and the adjacent Countries. *Carr. Sci.*, V, pp. 351-356 (1937).

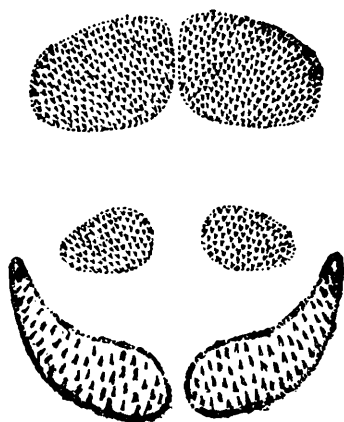
² Regan, C. Tate.—The classification of the teleostean fishes of the Order Ostariophysi. II. Siluroidea. *Ann. Mag. Nat. Hist.*, (8) VIII, pp. 553-557 (1911).

³ Bridge, T. W. & Haddon, A. C.—Contribution to the anatomy of Fishes.—II. The Air-bladder and Weberian Ossicles in the Siluroid Fishes. *Phil. Trans. Roy. Soc. London*, (B) CLXXXIV, pp. 214-221 (1893).

⁴ Weber, M. and de Beaufort, L. F.—*The Fishes of the Indo-Australian Archipelago*. II, p. 247 (Leiden, 1913).

In the above key no reference is made to the nature of the teeth in *Pangasius*, but in the description of the genus the authors state that the vomerine and the palatine teeth are "in 4 patches, or united into one, or only the vomerine patches united" I have examined the dentition of several species of *Pangasius* and find it to be very variable. In species like *P. hypophthalmus* (Sauvage), the dentition is feebly developed or altogether absent. In the development of *Pangasius pangasius* (Ham.) it has been found that the dentition of the species undergoes considerable changes. In the case of *Pangasius*, therefore, dentition is not a very safe diagnostic character. Presumably on the basis of dentition alone Sauvage¹ referred *P. hypophthalmus* to the genus *Helicophagus* and the same feature appears to have influenced Suvatti² in supporting Sauvage's view. It has, however, been shown by me³ that in this species the posterior nostril is situated only slightly behind the anterior and above the line joining the middle of the eye to the anterior nostril. According to this character there is no doubt regarding its position in the genus *Pangasius*. Its broad head and snout also point to the same conclusion, for in *Helicophagus* the head is conical with a prominent, bluntly-pointed snout. Moreover, a part of its eye is situated below a horizontal line passing through the corner of the mouth.

After the elimination of *P. hypophthalmus* from *Helicophagus* there only remain 2 species of this interesting genus: *H. typus* Bleeker, known from Palembang in Sumatra and *H. waandersi* Bleeker, known from Palembang, river Batang Hari and Djambi in Sumatra, Siam and Indo-China. Thus this genus has a somewhat restricted distribution, whereas *Pangasius* is found throughout south-eastern Asia (including India), except Southern China and Ceylon.



TEXT-FIG. 1.—Dentition of *Helicophagus waandersi* Bleeker. $\times 7$. Length of specimen 143 mm. without caudal.

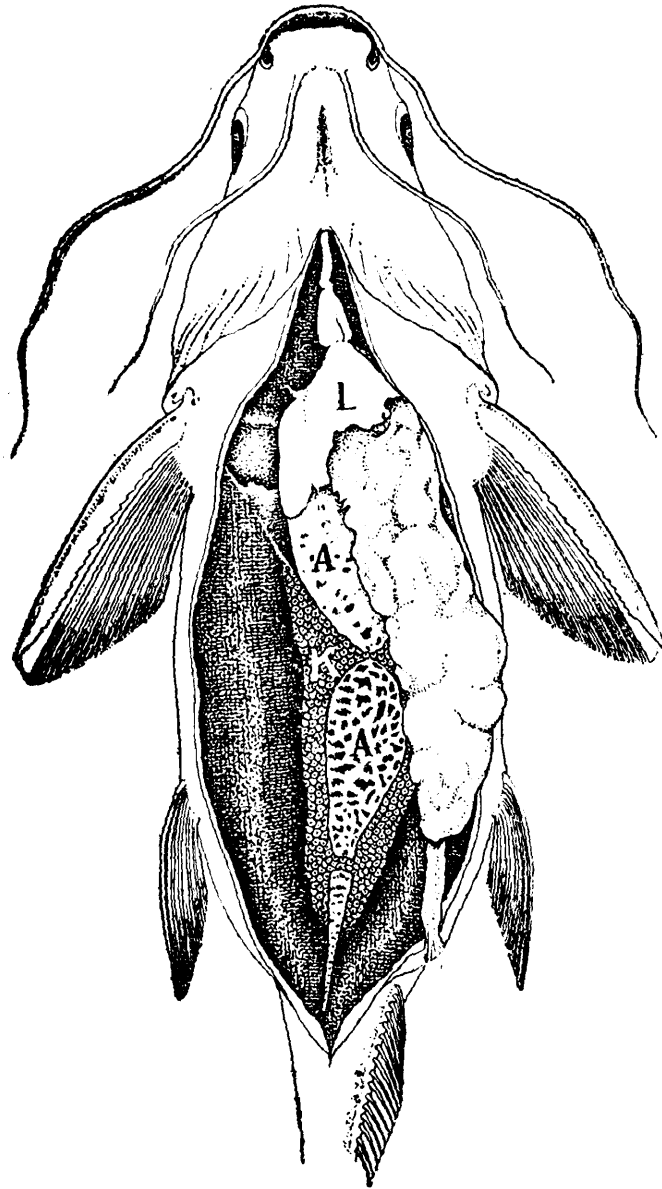
Comparing *Helicophagus waandersi* with several species of *Pangasius* that I have studied I find that the former possesses much longer barbels

¹ Sauvage, H. E.—Recherches sur la faune ichthyologique de l'Asie et description d' especes nouvelles de l'Indo-Chine. *Nouv. Arch. Mus. Hist. Nat. Paris*, (2), IV, p. 170 (1881).

² Suvatti, C.—*Index to Fishes of Siam*, p. 81 (Bangkok, 1936).

³ Hora, S. L.—On a collection of fish from Siam. *Journ. Nat. Hist. Soc. Siam*, VI, p. 166 (1923).

and a very peculiar type of dentition. The teeth (text-fig. 1) of the upper jaw form two almost quadratic patches and those of the vomer are disposed in two small patches widely separated from one another. In the lower jaw the teeth are somewhat larger and fewer in number ; they form two pear-shaped patches with the points directed outwards and backwards. In *H. typus*, however, the teeth in the jaws are stated to form broad, curved bands ; while those on the vomer are arranged in two distinct, narrow, curved bands. There would thus appear to be considerable variation in the dentition of this genus.



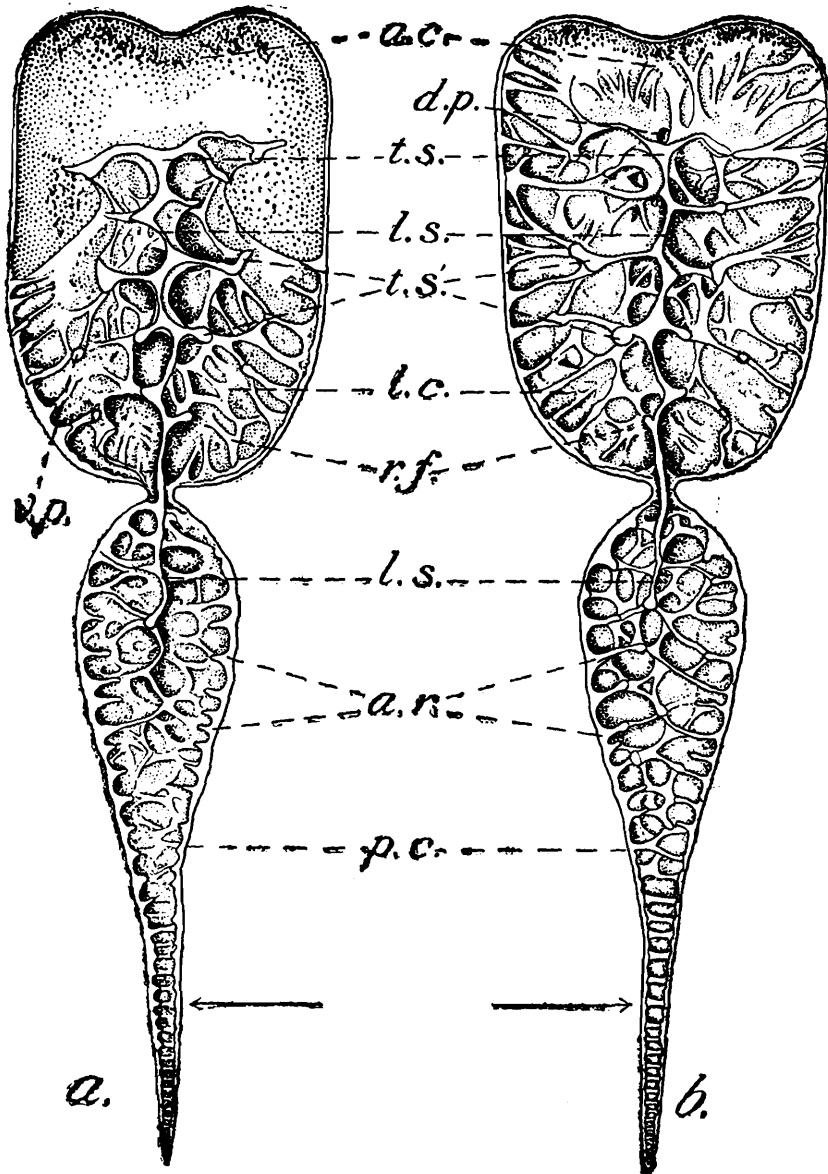
TEXT-FIG. 2.—Dissection of the visceral organs of a specimen of *Helicophagus waandersi* Bleeker. $\times 1\frac{1}{2}$.

A. Air-bladder ; K. Kidney ; L. Liver.

To examine the disposition of the visceral organs of *H. waandersi* (text-fig. 2) an incision was made along the mid-ventral line. The positions of the liver, the kidneys and the air-bladder respectively were almost similar to those of *Pangasius pangasius*.¹ The lateral lobes of the liver

¹ Hora, S. L.—Correlation between the disposition of the Liver and the Kidney and the form of the Air-bladder in Certain Siluroid Fishes of India. *Proc. Nat. Inst. Sci. India*, III, p. 34 (1937).

are lodged in small cul-de-sacs above the pectoral fins, so that the liver lies very close to the skin. The air-bladder is divided into two portions, a large anterior portion corresponding to the normal air-bladder and a posterior portion which is drawn out in the form of a caecum. A small portion of the caecum extends into the muscles of the tail on the right



TEXT-FIG. 3.—Air-bladder of a specimen of *Helicophagus waandersi* Bleeker, 143 mm. in length without the caudal, showing the internal structure. $\times 2\frac{3}{4}$.

a. Dorsal half; b. Ventral half.

a. c. Anterior chamber; a. r. Annular ridges; d. p. Pneumatic duct; l. c. Lateral chamber; l. s. Longitudinal septum; p. c. Posterior chamber or caecum; r. f. Root-like fibres; t. s. Primary transverse septum; t. s'. Secondary transverse septa; v. p. Vertical pillar.

The part of the air-bladder below the arrows is enclosed in the muscles of the tail region.

side. In several respects the bladder is similar to that of a specimen of *Pangasius pangasius* of the same size (143 mm. in length without caudal).

The internal structure of the air-bladder (text-fig. 3) is, in the main, similar to that of a specimen of *P. pangasius*¹ of the same size. The anterior portion of the bladder is divided internally by a primary transverse septum (*t. s.*) into a short and broad anterior chamber (*a. c.*) and a pair of lateral chambers (*l. c.*), separated from each other by a longitudinal septum (*l. s.*). The dorso-lateral walls of the anterior chamber bulge out dorsally so as to form pocket-like cavities which are lodged inside the recesses provided by the vertebral elements, one on either side of the vertebral column. The remaining portion of this chamber is invaded by fibrous growths of the primary transverse septum. The cavities of the lateral chambers are subdivided and broken up by the formation of numerous secondary transverse septa (*t. s'*), which grow out from the sides of the longitudinal septum; they do not, however, extend to the outer wall of the chambers. In the transverse cavities thus enclosed, the walls become greatly thickened and sacculated by the development of fibrous tissue (*r. f.*) so that the free space inside the bladder is greatly reduced. In addition to these fibrous growths, there are a few vertical pillars (*v. p.*) which make the air-bladder more compact.

The pneumatic duct (*d. p.*) opens into the bladder on its ventral wall in the middle line just in front of the transverse septum.

The posterior portion of the bladder (*p. c.*) communicates anteriorly with both the lateral chambers of the anterior portion, but terminates blindly behind. It is fairly broad anteriorly but from the middle of its length becomes very narrow and tube-like. The longitudinal septum noted above, extends into the caecum for a short distance. The walls of the caecum are greatly thickened throughout by the formation of annular ridges (*a. r.*).

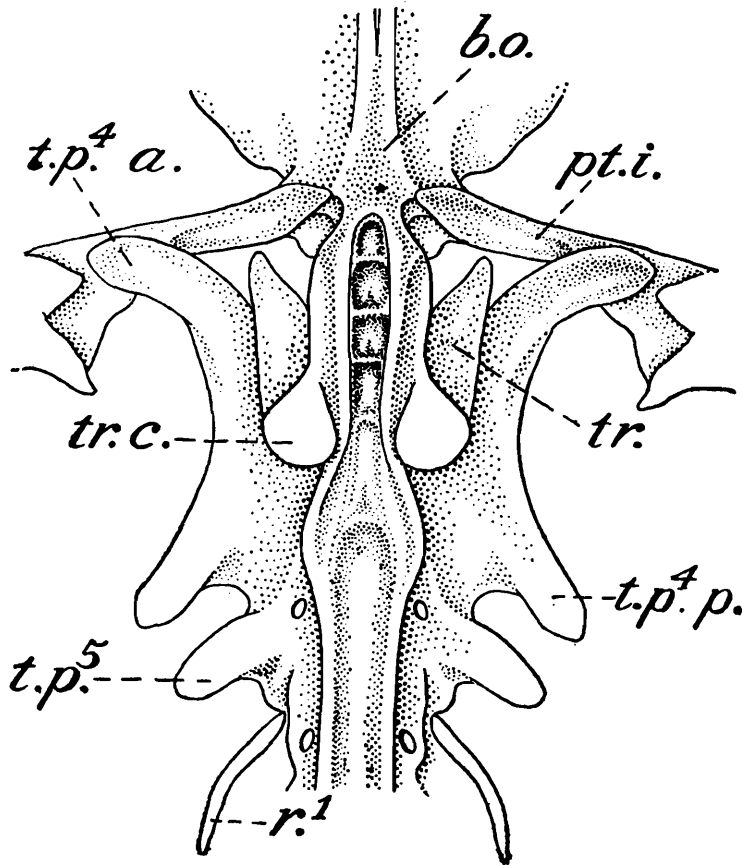
In the modification of the anterior vertebrae (text-fig. 4), *Helicophagus waandersi* differs from most of the species of *Pangasius*, but conforms to the normal condition in a great majority of the Siluroid fishes. Each of the transverse processes of the fourth vertebra has a broad flat root, which is prolonged distally into distinct anterior (*t. p⁴. a.*) and posterior (*t. p⁴. p.*) divisions, separated from each other by a broad, deep concavity. The anterior division is moderately thick and inflexible and does not possess any trace of the oval plate so characteristic of *Pangasius pangasius* and several other species of the genus. So in *Helicophagus* there is no "elastic-spring" mechanism; the distal portion of the process is applied to and firmly supports the outer extremity of the inferior limb of the post-temporal (*pt. i.*). The structures described above correspond with those of *P. micronema* Bleeker, the only species of *Pangasius* in which Bridge and Haddon (*op. cit.*) did not find an "elastic-spring" mechanism, and which would in the circumstances appear to form a connecting link between the genera *Helicophagus* and *Pangasius*.

In *P. pangasius*, Nair (*op. cit.*) has shown that with the development of the fish the space inside the air-bladder is gradually reduced and in

¹ Nair, K. K.—Changes in the Internal Structure of the Air-bladder of *Pangasius pangasius* (Ham.) during Growth. *Rec. Ind. Mus.*, XXXIX, pp. 117-124 (1937).

It may, however, be noted that the air-bladder of a specimen of *Pangasius pangasius*, 143 mm. in length, does not extend into the muscles of the tail region; the narrow portion of its caecum is devoid of annular ridges and the posterior portion is smaller than the anterior. The absence of an "elastic-spring" mechanism in *Helicophagus* is referred to later.

large specimens a fatty degeneration of its tissues, especially at the anterior end, takes place. So far as the hydrostatic function of the



TEXT-FIG. 4.—Ventral view of the anterior vertebrae and their processes in a specimen of *Helicophagus waandersi* Bleeker, showing the absence of any “elastic-spring” mechanism. $\times 4$.

b. o. Basioccipital; pt. i. Inferior process or limb of post-temporal; r^1 . First rib; $t.p^4$. a. Anterior division of the transverse process of the fourth vertebra; $t.p^4 p$. Posterior division of the transverse process of the fourth vertebra; $t.p^5$ Transverse process of the fifth vertebra; tr. Tripus; tr. c. Crescentic process of the tripus.

bladder is concerned it becomes less and less effective with growth. Owing to the competition for space inside the body cavity of forms with a long anal fin, the bladder is pushed from all sides and it seems to me that the modification of the anterior division of the transverse process of the fourth vertebra to form a plate is meant to check the forward growth of the bladder. It is because of this resistance at the anterior end that the bladder finds space for its extension in the muscles of the tail. The so-called “elastic-spring” apparatus is a primitive device, while the condition met with in *P. micronema*, *Helicophagus waandersi*, and in a majority of the other Siluroid fishes is of a more specialised nature.

From the foregoing considerations it would appear that *Helicophagus*, with long barbels, well-developed dentition, without an “elastic-spring” apparatus, etc., etc., is at a somewhat higher stage of evolution than *Pangasius*. There also seems no justification for separating *Pangasius* from the rest of the Schilbeidae only because of the presence of “elastic-spring” mechanism in a number of its species.

COMPARISON OF THE FISH-FAUNAS OF THE NORTHERN AND THE SOUTHERN FACES OF THE GREAT HIMALAYAN RANGE.

By SUNDER LAL HORA, D.Sc., F.R.S.E., F.N.I., *Assistant Superintendent, Zoological Survey of India, Calcutta.*

When Stewart¹ wrote a short article under the above title in the series of reports on a collection of aquatic animals made by him in Tibet during the year 1907, he was probably not aware that Day² had already compared in some detail the fish fauna of the highlands of Central Asia with that of the contiguous regions. In this connection Day made a survey of the fishes of Afghanistan, Western Turkestan, Eastern Turkestan, Yarkand, Tibet and Hindustan and concluded as follows (p. 25) :

"The conclusion, I think, we may fairly arrive at after examining the fishes of Yarkand and the adjoining countries, is that we find a peculiar group of Carps (*Schizothoracinae*) which has spread almost due east and west from the cold and elevated regions of Eastern Turkestan, but of which the southern progress has been barred by the Himalayas."

"If we look to the south, we see, as it were, that a wave of tropical forms of fishes has, at a prehistoric period, expanded over that portion of the globe where the Nicobars, Andamans, and the most southern portions of the continent of Asia and the islands of the Malay Archipelago now are, that this fish fauna has its northward progress arrested by some cause at or near where the Himalayas now exist and mark the division between the fish-fauna of India and that of Turkestan."

Stewart's data for the comparison of the two faunas were based on the records of distribution of the various Indian species in Day's volumes in the "Fauna of British India" series and on the species described by Regan³ and Lloyd⁴ from Eastern Tibet. He found that

"From the northern area seventeen species of fish are at present known, belonging to the families Siluridae and Cyprinidae. From the southern area thirty-six species of these two families are recorded in the *Fauna of British India*. These two groups have only two species in common (*Schizothorax esocinus* and *Diptychus maculatus*).⁵ (These two species are also the only forms from the Trans-Himalayan Indus which have not hitherto been found in the Trans-Himalayan Brahmaputra. Thus there are no species common to the latter and to the rivers of the south face of the Himalayas). Thus of these two families there are fifteen species confined to the northern regions, thirty-four to the southern, and two are found in both."

It may, however, be noted that while Day's conclusions are based on a study of the forms occurring to the north and the south of the western portion of the Himalayas, Stewart's remarks relate to the forms found in the eastern portion of that great range. Both these authorities are, however, in complete agreement that there is no similarity between the

¹ Stewart, F. H.—Comparison of the fish fauna of the north and the south faces of the great Himalayan range. *Rec. Ind. Mus.*, III, pp. 121-123 (1909).

² Day, F.—*Scientific Results of the Second Yarkand Mission*. Ichthyology, pp. 1-25 (Calcutta : 1878).

³ Regan, C. Tate.—Descriptions of five new Cyprinid fishes from Lhasa, Tibet. *Ann. Mag. Nat. Hist.*, (7) XV, p. 185 (1905); Descriptions of two new Cyprinid fishes from Tibet. *Ibid.* (7), XV, p. 300 (1905).

⁴ Lloyd, R. E.—Report on the fish collected in Tibet by Capt. F. H. Stewart, I.M.S., *Rec. Ind. Mus.*, II, pp. 341-346 (1908).

⁵ The known distributional records of *Schizothorax esocinus* Heckel and *Diptychus maculatus* Steind show that these species do not occur on the south face of the Himalayas and are typical members of the Central Asiatic fauna.

fish-fauna of the northern and the southern faces of the great Himalayan range. This conclusion appears to be based mainly on the distribution of the Schizothoracinae, and it is, therefore, of interest to examine the two faunas more closely.

FISH OF CENTRAL ASIA AND OF INDIA.

By "Central Asia" I mean the highlands bordered on the north by the Tien Shan Mountains and on the south by the north face of the Himalayas. To the west, where the Himalayan range does not extend, the Hindu Kush range forms the northern boundary while the southern and western boundaries are ill-defined. Towards the east of the headwaters of the Hwang Ho and the Yangtze Kiang form an undefined boundary. Within these limits are included the headwaters of the Jaxartes and the Oxus, the basins of the Hari Rud and the Helmund, the Trans-Himalayan portions of the Indus and the Brahmaputra, the Tarim Basin, the basin of Lake Balkash, the Mongolian Lake Basin and Tsaidam. The fauna of this vast territory, except near the fringes towards the east,¹ and the west,² is composed of the Schizothoracinae, of the catfishes of the genus *Glyptosternum* McClelland (Family : Sisoridae) and of the loaches of the genus *Nemachilus* van Hass. (Family : Cobitidae). Of these three types of fishes, the genus *Nemachilus* is the most widely distributed, as it is found not only throughout the Oriental Region, but its range extends to Africa as well. Though this genus is equally abundant in the northern and southern territories of the Himalayas, the species of the two regions are so different from one another that they can be readily distinguished.³ The Trans-Himalayan species usually grow to a fairly large size ; the body is greatly elongated and almost whip-like posteriorly. The skin is totally devoid of scales. The colour on the sides forms a mottled pattern. The species of the Indian region are usually small in size and possess short, stumpy bodies. Small scales, sometimes hidden in the skin, are usually present, while the body is invariably marked by a series of transverse bands. Several attempts have been made to subdivide the fishes of this genus, but from an intensive study of extensive material from the northern and the southern faces of the Himalayas I have not been able to discover any reliable characters for separating the groups recognised as genera by other workers. In spite of the great difference in the appearance of the

¹ In my account of the "Fish of Afghanistan" (*Journ. Bombay Nat. Hist. Soc.*, XXXVI, pp. 688-706, 1933) I gave a short review of the types of fishes found in Waziristan, Baluchistan, Seistan, Chitral ; the Pamirs and the Kashmir and in an addendum some further details are given on the information supplied by Prof. L. S. Berg. It will be seen how, with the exception of Chitral and the Pamirs, the Central Asiatic fauna becomes less marked as we move away from the central zone.

² In the lists of Chinese fishes given by Professor Tamezo Mori in his recent work entitled "Studies on the Geographical Distribution of Fresh water Fishes in Eastern Asia" (Chosen : 1936), we find that only one species of *Schizopygopsis* Steindachner is listed from Hoang-Ho, three species of *Schizothorax* Heckel, five species of *Oreinus* McClelland and two species of *Schizopygopsis* from the Yangtze Kiang and two species of *Schizothorax* and three species of *Oreinus* from Southern China. There is a considerable mixture of the Schizothoracine element with the typical Oriental forms in Szechuan, Yunnan and South China.

³ Hora, S. L.—On Fishes belonging to the family Cobitidae from high altitudes in Central Asia. *Rec. Ind. Mus.*, XXIV, pp. 63-83 (1922).

northern and the southern forms there can be no doubt regarding the genetic affinity of the two types.

The Central Asiatic group of species can be divided ecologically into two categories,¹ (i) those that live in shallow, rapid-running waters and (ii) those that live in lakes. The lake-forms possess a secondarily developed large air-bladder in addition to the original structure enclosed in two bony capsules. The free air-bladder referred to above is, in my opinion, a secondary acquisition developed as an adaptation to life in deeper waters. The form of the free air-bladder is so varied that it is difficult to resist the conclusion that the production of a secondary free air-bladder in certain species of *Nemachilus* has independently occurred again and again in different lakes of Central Asia—the presence of intermediate forms in shallow, sluggish waters lends support to this hypothesis. On the southern face of the Himalayas there are no large lakes and even the small ones that exist are probably not of any great antiquity, since they do not possess any endemic faunas. The lakes of northern Burma,² however, are of considerable age, as their fish faunas are characterised by several abberant and highly interesting indigenous forms. In this region we get certain species of *Nemachilus* which have developed a secondary air-bladder³ but their general build is similar to that of the forms found in India. It may be concluded from the above that the *Nemachili* of the north and the south faces of the Himalayan range, though genetically identical, represent totally different races.

There are only two species of the genus *Glyptosternum*, *G. reticulatum* McClelland and *G. maculatum* (Regan). The latter is known from Eastern Tibet, while the former is widely distributed in the upper reaches of the Indus, the Kabul, the Amu-Darya and the Syr-Darya Rivers. There is reason to believe that the two species have been produced as a result of isolation and segregation of a once widely distributed ancestral stock. A great variety of Glyptosternoid fishes is found in Siam, Yunnan, Burma and the Brahmaputra drainage of India⁴. Recently I⁵ have suggested the probable origin of the Glyptosternoid fishes from *Pseud-echeneis*-like ancestral forms, but whatever may be the origin of these interesting fishes there can be no doubt that the Trans-Himalayan *Glyptosternum* has its nearest allies in Siam, Yunnan, Burma and north-east India. Here again, though we find a close genetic similarity between the Himalayan and the Trans-Himalayan species, the diversity of form is so pronounced that the two faunas must be regarded as distinct.

The Schizothoracinae are small-scaled Barbels with their nearest allies in the so-called large-scaled or moderate-scaled Barbels of the

¹ Hora, S. L.—Report on Fishes of the Yale North India Expedition. Part I: Cobitidae. *Mem. Conn. Acad.*, X, pp. 299-305 (1936).

² Annandale, N.—Fish and Fisheries of the Inle Lake. *Rec. Ind. Mus.*, XIV, pp. 33-64 (1918); Prasad, B. and Mukerji, D. D. *Rec. Ind. Mus.*, XXXI, pp. 161-223 (1929).

³ Hora, S. L.—The Value of Field Observations in the Study of Organic Evolution. *Journ. Bombay Nat. Hist. Soc.*, XXXIV, pp. 377, 378, 382 (1930).

⁴ The distribution of the Glyptosternoid fishes is as follows: *Oreoglanis* Smith in Siam; *Glaridoglanis* Norman in Yunnan; *Euchiloglanis* Regan in Tonkin, China, Burma and the Brahmaputra drainage of India; *Exostoma* Blyth (used in its broadly accepted sense) in Burma and *Glyptosternum* McClelland in Kashmir, Turkestan and Tibet.

⁵ Hora, S. L.—On a New Genus of Chinese Catfishes allied to *Pseudecheneis* Blyth. (In press.)

Oriental and the Aethiopian regions. Both kinds of Barbels occur in diverse types of habitats—from strong currents to muddy pools—and have consequently become differentiated into a variety of closely related genera, which are often very difficult to distinguish from one another. The Schizothoracinae are distinguished from the Cyprininae by the possession of minute scales but in some cases the scales are entirely absent. A membranous sac or slit anterior to the anal fin, which is laterally bounded by a row of vertically placed scales, like eave-tiles, and which are continued along the base of the anal fin, is also characteristic of the Schizothoracinae. On the southern face of the Himalayas, this subfamily is represented by the genus *Oreinus* McClelland which is spread from Afghanistan along the whole Himalayan and contiguous ranges of hills to south-eastern China. So far as is known, these fishes appear to be strictly residents of rivers in the hilly regions, neither descending far into the plains nor occurring in the level plateaux on the summits of the mountains. Their mouth is armed with a special adhesive device which enables them to resist the rapid currents of the torrential streams. Though *Oreinus* is a well recognised morphological genus, there is every reason to believe that it represents only specialised members of the genus *Schizothorax* Heckel.¹ The two genera interbreed very freely and in several large collections intermediate forms between *Schizothorax* and *Oreinus* are not uncommon. Several Himalayan rivers have Trans-Himalayan sources and it is along these channels that *Oreinus*, a representative of the Schizothoracinae, has probably come down during floods, etc., to the Himalayan rivers. No other genus of this subfamily is found in the small torrential streams of the Himalayas. Tchang² has recently described two species of *Barbus* Cuvier from Yunnan, *B. regani* and *B. normani* in which the scales are minute and their general build is very much like the Schizothoracinae, except that they do not possess the tiled rows of scales in front of and at the sides of the anal fin. It thus seems likely that such species of *Barbus* were the progenitors of the Schizothoracinae. In the case of the Schizothoracinae, therefore, we have specially modified Oriental Barbels, but the differences between the two types of Barbels are sufficiently well marked for distinguishing the fish faunas of the northern and the southern faces of the Himalayas.

The great variety of other Catfishes and Carps that characterise the aquatic fauna of the southern face of the Himalayas is not at all represented on the northern face of the range.

PHYSICAL FACTORS AND THE CHARACTERISTIC FEATURES OF THE TWO FAUNAS.

In an account of the 'Ecology, Bionomics and Evolution of the Torrential Fauna'³ it was shown that the physical factors of an environment play a great part in the association of the fauna of a particular

¹ Hora, S. L.—The Fish of Chitral. *Rec. Ind. Mus.*, XXXVI, pp. 307-310 (1934).

² Tchang, T. L.—Two New Species of *Barbus* from Yunnan. *Bull. Fan Mem. Inst. Biology*, (Zool.), VI, pp. 60-63 (1935).

³ Hora, S. L.—Ecology, Bionomics and Evolution of the Torrential Fauna, with special reference to the organs of attachment. *Phil. Trans. Roy. Soc. London*, (B), CCXVIII, pp. 171-282 (1930).

habitat. Having shown that the fish faunas of the northern and the southern faces of the Himalayan range are almost totally different, though genetically closely related, we may enquire into the factors governing the habitats of the two faunas.

Stewart (*op. cit.*) gave the following four principal physical characteristics of the Central Asiatic region :—(i) its great elevation (usually over 10,000 ft.); (ii) its very low rainfall; (iii) sparse vegetation and (iv) the rapidity of flow of streams. From the point of view of the conditions that govern fish life, the first three factors are of little significance. For instance, the Schizothoracinae are not confined only to high altitudes but are also known from low elevations (for example Seistan, where *Schizothorax* and *Schizocypris* Regan occur, is situated in a deep depression less than 2,000 feet above sea level). It is also immaterial for fish life whether the water in a particular stream is derived from rainfall, glaciers or from springs, as fishes become gradually acclimatised to changes in temperature. Most of the hill-stream fishes feed on insect larvae or aquatic vegetation (mostly slimy algae adhering to rocks and stones), and it is no consequence whether the terrestrial vegetation of the area is sparse or thick. The nature of the river bed and the swiftness of the current are, however, important factors.

It is a general characteristic of the highlands of Central Asia that the rivers run with some rapidity in broad beds of boulders and often expand into marshes and lakelets. Further there are lakes of considerable magnitude dotted all over this area. For an understanding of the correlation between the type of habitat and the corresponding fauna reference may be made to my account of the fish of Chitral cited above. On the southern face of the Himalayas the streams are small and precipitous and there are no large lakes. The nature of the streams is so torrential that very few species of fish are found above an altitude of about 4,000 ft.; the greatly diversified fish-fauna of this region is mainly restricted to valleys. On the southern face of the Himalayas, therefore, fishes require mechanical devices to enable them to withstand the rapidity of the currents, such forms are *Garra* Hamilton, *Glyptothorax* Blyth, *Pseudecheneis* Blyth, etc., which do not grow to a large size, while some, like *Balitora* Gray, are greatly flattened. In the large rivers and lakes of the highlands of Central Asia the conditions of life are presumably not so rigorous and in consequence the rivers are stated by every observer to be teeming with fish life. The fish grow to a fairly large size and are trout-like in appearance, with the exception of *Glyptosternum* which is flattened and is found clinging to rocks, etc.

The most striking feature of the fishes of Central Asia, however, is the degenerate nature of their scales,¹ culminating in their total absence in some forms. As in the Salmonidae, the smallness of the scales in the Schizothoracinae is probably due to the necessity for a supple integument whether in fast-swimming fishes or in those that live in smooth, rapid-running waters, for it must be remembered that whether a fish moves through water swiftly or the water glides over it with great rapidity the physical factors involved are the same in both

¹ Annandale, N. and Hora, S. L.—The Fish of Seistan. *Rec. Ind. Mus.*, XVIII, p. 154 (1920).

cases. A remarkable feature of the Schizothoracinae is the anal sheath of scales. Besides these enlarged scales, there are usually somewhat larger scales in the scapular region, at the bases of the dorsal and ventral fins and along the lateral line. As the fish moves through the water, these are precisely the regions where, owing to protection afforded by the conical head, fins, and the stream-lined body of the fish, the tearing-away action of the current is least felt. In consequence, these scales do not undergo degeneration to the same extent as on the parts of the body more exposed to the currents. It seems logical, therefore, to assume that the whole of the fish-fauna of the highlands of Central Asia has been modelled to suit the peculiar conditions of the rivers of that region. *Schizothorax*, the perfectly scaled member of the Schizothoracinae, is found in lakes and in large rivers with backwaters,¹ while other genera of the subfamily with scales in varying degree of reduction live in swift waters of varying rapidity.

Along the southern face of the Himalayan range, on the other hand, though the streams are more torrential, we have forms with larger scales. In fact, the *Barbus tor* group, constituting the renowned 'Mahseers' of India, is well represented in the Himalayas and even in *Garra*, which possesses a true vacuum sucker, the body is provided with moderately large scales. The same is true of such mountain genera as *Balitora*, *Psilorhynchus* McClelland, *Crossochilus* van Hass., etc. Even the Siluroids, which live on the exposed surfaces of rocks, such as *Sisor* Hamilton, *Glyptothorax*, *Laguvia* Hora, *Erethistes* Müll. & Trosch., etc., have developed wart-like, hard projections on the skin. This may seem contradictory to what has been stated above regarding the reduction of scales in Central Asiatic fishes, but in reality it is not so. In dealing with the physics of the mechanism of attachment in hill-stream animals it was shown² that though at certain velocities the resistance of a body subjected to a current is greatly reduced by the rounding-off of its contours, at other velocities, in some bodies, such as spheres and cylinders, the resistance is actually reduced by the roughening of the surface. Those who have visited the Trans-Himalayan and the Cis-Himalayan areas of the great range will bear out very fully that the nature of the flow of water currents in the two areas differs very considerably. It is these differences in the nature of the currents that account for the different types of fish-fauna of the two regions.

ORIGIN OF THE TWO FAUNAS.

According to Day (*vide supra*, p. 241) at some very early age the Himalayas acted as a barrier between the northern and the southern forms and the resulting isolation kept the two faunas very distinct. This is true so far as it goes and certainly at the present day the Himalayan range is an effective barrier that does not permit the northern and the southern fish-faunas to intermingle. It has been shown above that

¹ Hora, S. L. and Mukerji, D. D.—Pisces in *Visser's Karakorum*, I, pp. 427, 428 (Leiden: 1935).

² Hora, S. L.—Ecology, Bionomics and Evolution of the Torrential Fauna, with special reference to the organs of attachment. *Phil. Trans. Roy. Soc. London* (B), CCXVIII, pp. 254-256 (1930).

the Central Asiatic *Glyptosternum* and *Schizothorax* have their close allies in Yunnan and the adjoining territories of south-eastern Asia. It seems reasonable, therefore, to infer that the fish-fauna of Central Asia was derived from an eastern stock, as I¹ have suggested in regard to the origin of the fish-fauna of India as a whole. The close genetic similarity between the two faunas is undoubtedly due to their common origin, and the dissimilarity between them is probably due to their differentiation in different geological ages, long isolation and the resulting segregation. Attention may here be directed to Regan's² hypothesis "that as a rule the first step in the origin of a new species is the formation of a community with a new and restricted environment, or with new habits; in other words, that some form of isolation, either localization or habitudinal segregation, is the condition of the development of a new species." What is true of the species is also applicable to faunas as a whole. The fish-fauna of Central Asia, at any rate, affords a remarkable instance in support of this hypothesis.

To compare the origin of the Trans-Himalayan and the Cis-Himalayan fish-faunas it seems worth while to give a very brief account of the geological history of the Himalaya, but unfortunately our knowledge of Trans-Himalayan geology is very meagre indeed.

"There is no evidence to show that the Himalaya, as a great mountain range, are older than the latter part of the Eocene period".³ Before that the Himalayan area formed the northern coast of Gondwanaland and a number of rivers flowed northward into the Tethys Sea of that period. The orogenic movement, which was strongly pronounced during the Oligocene, probably began in late Cretaceous times and continued throughout the Eocene and Middle Tertiary periods. There is considerable evidence to show that it was still active during the Pliocene and the later periods. The ossiferous beds of Ngari Khorsum and of the Karewas of Kashmir, however, indicate that during the Pleistocene period the Himalayas had already acquired the general features of their present-day form. The nature of the Siwalik deposits shows that the main drainage lines on the south face of the Himalayas date as far back as the Pliocene epoch and that "the rivers which brought down the sands and boulders from the mountains to build up the Siwaliks of the Duns and the Hundes were the direct ancestors of our modern Sutlej and Ganges."

From the generalised nature of the Trans-Himalayan fish-fauna it may be surmised that the eastern portion of the Tibetan plateau was the first area to be lifted and raised above the neighbouring Chinese territory. The drainage of this new land joined the then existing drainage of southern China and thus channels were established for the Chinese forms to colonise new lands. As the crustal movements gradually lifted the Tibetan region, better adapted hill-stream forms

¹ Hora, S. L.—Geographical Distribution of Indian Freshwater Fishes and its bearing on the Probable Land Connections between India and the Adjacent Countries. *Curr. Sci.*, V, pp. 351-356 (1937).

² Regan, C. Tate.—Mendelism and Evolution. *Nature*, CXIII, p. 569 (1924).

³ For geographical and geological facts about the history of the Himalayas I am indebted to Burrard and Hayden's "A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet" revised by Burrard and Heron (Delhi: 1933).

were able to invade the higher reaches of these streams. The association of the fish-fauna shows that these rivers had fairly broad valleys with deep beds of boulder and rapid-running currents. It has then to be presumed that at a certain period a localised disturbance caused this region to be lifted up so as to isolate the fauna of this area from the ancestral stock. The geographical distribution of the Schizothoracinae shows that the waters of Central Asia may have flowed at first towards the east, then towards the west and north before the present drainage pattern was established.

"On the basis of his geomorphological studies, Dr. de Terra has reconstructed the Tertiary drainage pattern of the western part of the Tibetan plateau. A number of rivers ran from west to east, one of them occupying the present valley of the Upper Indus. It is difficult to resist the conclusion that a similar pattern extended farther north, the Tarim basin draining into the Hwang-ho."¹ According to Burrard, Hayden and Heron², the evidence furnished by the feeders of the Trans-Himalayan Brahmaputra shows that the Tsangpo formerly flowed through Tibet from east to west, and that of the great rivers of the world, "the Brahmaputra furnishes the only instance of drainage flowing in a diametrically opposite direction to what it formerly did, though still occupying the same bed."

The Schizothoracinae are at present found in at least twelve major river systems and numerous closed basins adjoining the plateau of Central Asia. *Glyptosternum* is also found in the eastward and westward flowing rivers. Mukerji and I³ found the same species of *Nemachilus* in the headwaters of the Indus and the Karakash rivers. These facts concerning the geographical distribution of Central Asiatic fishes can only be explained reasonably on the assumption that after the establishment of the typical highland fish fauna local upheavals repeatedly led to changes in the drainage pattern of this region and thus made possible the wide dispersal of these forms.

So in the origin and distribution of the fish-fauna of Central Asia, the first step was the colonisation of the newly produced lands of Eastern Tibet, probably during the post-Eocene period, by the fauna of southern China, particularly of Yunnan. The second step was the lifting of this region, which resulted in the isolation of the fauna of the upper reaches by the reversal of the drainage system, and finally through localised orogenic movements in the region of the Tibetan trough the drainage pattern was made to oscillate from time to time resulting in the wide dispersal of the Central Asiatic forms within the limits of the trough defined above.

As indicated above, the fish of the southern face of the Himalayas are highly specialised and appear to have spread over this region from the east at a somewhat later date, possibly in the late Miocene or Pliocene periods. Of the hill-stream fishes of this region we have fossil records of *Bagarius* Bleeker, a widely distributed genus of the somewhat larger

¹ Hutchinson, G. E.—Yale North India Expedition. *Nature*, CXXXIV, p. 87 (1934).

² Burrard, S. G. and Hayden, H. H.—*A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet*. 2nd Edition, revised by Burrard, S. G. and Heron, A. M. (Delhi: 1933).

³ Hora, S. L. and Mukerji, D. D.—Pisces in *Visser's Karakorum I*, pp. 427-428 (1935).

rivers of India, Burma and the Malay Archipelago, from the Siwalik formations of Nahan and the Tertiary formations of Padang in Sumatra. All students of Oriental fishes are familiar with the great similarity between the south Himalayan fish fauna and that of Burma, Siam, the Malay Peninsula and the Archipelago and Indo-China. In another place I¹ discussed the probable origin of the fish fauna of India and showed that it was derived from the eastern countries. For the probable mode of dispersal of fishes from east to west reference may be made to Gregory² and Gregory and Gregory³ who have attempted to demonstrate that in south-eastern Asia the western rivers beheaded the rivers on the east; thus effecting the transference of eastern fauna towards the west. As the total Himalayan uplift was accomplished in three or more stages, every wave of orogenic movement may have affected the drainage pattern of that period, but, as evidenced by the distribution of freshwater fishes, it seems that every time the western rivers captured the waters of the eastern rivers. Changes in the drainage of the southern face of the Himalayas may also have resulted from localised disturbances. At any rate, it seems certain that when the South Chinese fauna began to spread along the southern face of the Himalayas, even the parental stock in China had probably already undergone considerable changes due to the torrential nature of the streams on the newly produced precipitous hill-sides.

It is thus seen that though the fauna of the northern and the southern faces of the Himalayas is derived from the same source, the Central Asiatic fauna, comprising comparatively less specialised forms, was probably differentiated at an earlier date when the parental stock was of a generalised nature; while that of the southern face of the Himalayas, comprising highly specialised forms, was produced at a later date when the original stock had already become fairly well adapted for life in torrential streams.

SUMMARY.

Attention is directed to the conclusions reached by Day and Stewart as a result of the comparison of the fauna on the northern and southern faces of the Himalayan range. From a critical examination of the fish of Central Asia and of India evidence is adduced in support of the earlier conclusions that the two fish faunas are very distinct from each other. The physical factors governing fish life in Central Asia and on the southern face of the Himalayas are discussed and it is shown that the fish of the two regions are adapted to suit the nature of their respective streams. The characteristic features of the two fish faunas are examined and their close correlation to environmental factors is indicated. The probable origin of the two faunas is described and it is shown that though the

¹ Hora, S. L.—Geographical Distribution of Indian Freshwater Fishes and its bearing on the Probable Land Connections between India and the Adjacent Countries. *Curr. Sci.*, V, pp. 351-356 (1937).

² Gregory, J. W.—The Evolution of the River System of South-Eastern Asia. *Scottish Geog. Mag.*, XLI, pp. 129-141 (1925).

³ Gregory, J. W. and Gregory C. J.—The Alps of Chinese Tibet and their Geographical Relations. *Geog. Journ.*, LXI, pp. 153-179 (1923).

Central Asiatic and the Indian faunas are derived from the same source in south-eastern Asia, especially Yunnan, the former probably became differentiated at an earlier age when the parental stock was of a generalised nature, whereas the fauna of the southern face of the Himalayas was derived from a younger and more vigorous stock which had already become specialised in south-eastern Asia for life in torrential streams.

DISTRIBUTION OF HIMALAYAN FISHES AND ITS BEARING ON CERTAIN PALAEOGEOGRAPHICAL PROBLEMS.

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The physical and biological factors that govern the life of a torrential fauna¹ are of a very special nature and tend to restrict the distribution of hill-stream animals. Of the various physical factors, two are of special significance, the rapidity of the current and the consequent high percentage of dissolved air in mountain brooks. In response to the former, the organisms have developed various types of adhesive devices to prevent being washed away by the strong currents and spend most of their life clinging to rocks and boulders, while the greatly flattened or torpedo-shaped body presents a stream-lined form to the rushing current. As an adaptation to the high percentage of oxygen in these waters, the respiratory organs are reduced, for in such habitats even a comparatively much smaller area is sufficient to absorb enough oxygen for the requirements of an organism. Hill-stream animals are, as a rule, not suited for existence in muddy, sluggish water, and under such conditions usually die through asphyxiation within a very short period. As an example of biological factors, attention may be directed to the fact that the majority of the hill-stream fishes feed by scraping off algal slime and insect larvae that encrust rocks and stones, and consequently their mouths and jaws are specially modified for this purpose. It is obvious that the same method of feeding cannot be employed on a muddy substratum.

The distribution of the highly specialised hill-stream fishes, therefore, cannot be affected by the ordinary methods of dispersal along water channels, because the nature of the substratum² and the rapidity of the current are very potent factors for the existence of these animals. Their distribution along a mountain range has to be explained in terms of river-captures, longitudinal river valleys or tilting of mountain blocks so that the courses of the streams may alter without impairing their torrential nature. The distribution of the southern Himalayan fishes shows that all the three processes have been responsible in varying degrees for the dispersal of the fish fauna in this region, and that the Himalayan uplifting movement, though it may have been fairly uniform in the beginning over large areas, certainly became localised towards the end. Through the influence of these unequal orogenic movements, extending from the middle Eocene to almost within, geologically speaking, recent times, the Himalayas became hydrographically divided into a number of units which can be roughly demarcated with the help of their fish faunas. It is the object of this article to elucidate the probable

¹ Hora, S. L.—Ecology, Bionomics and Evolution of the Torrential Fauna, with special reference to the organs of attachment. *Phil. Trans. Roy. Soc. London*, B, CCXVIII, pp. 171-282 (1930).

² Hora, S. L.—Nature of Substratum as an important factor in the ecology of Torrential Fauna. *Proc. Nat. Inst. Sci. India*, II, pp. 45-47 (1936).

boundaries of these hydrographical divisions of the Himalayas. Evidence is also adduced from the nature of the fish faunas of the north and south faces of the Himalayas to discuss whether the present-day drainage of the Himalayas is evolved from an ordinary "consequent drainage", i.e., the rivers flowed north or south of the crest, or is the result of an "antecedent drainage". Observations are also made regarding the existence of the so-called "Indobrahm" or the "Siwalik River" of the Tertiary period.

DISTRIBUTION OF FISHES ALONG THE SOUTHERN FACE OF THE HIMALAYAS.

Ecologically, the Himalayan fishes can be divided into several categories and in discussing their geographical distribution it is well to bear in mind their respective associations. For instance, several species of *Barbus* Cuvier and *Labeo* Cuvier occur all along the Himalayas, but essentially they are forms of the plains which live in pools or deeper portions of the streams of the Himalayan foot-hills; some of them maintain themselves in swift currents through sheer muscular efforts. *Oreinus* McClelland, on the other hand, represents the Central Asiatic element on the southern face of the Himalayas; it spreads from Afghanistan, along the whole of the Himalayas and the contiguous ranges of hills, to south-eastern China. So far as is known, the fishes of this genus appear to be strictly residents of rivers in hilly regions, neither descending far into the plains nor occurring on level plateaux on the summits of mountains. Unlike the other Schizothoracinae, their mouths are provided with an adhesive device which enables them to resist being washed away in mountain torrents. *Oreinus* is a trout-like muscular fish and seems to have evolved from stocks of *Schizothorax* Heckel that may have been washed down from the Trans-Himalayan sections of some of our modern rivers.

A group of genera,¹ comprising *Crossochilus* van Hass., *Semiplotus* Bleeker, *Chaca* Gray, *Sisor* Hamilton, *Leiocassis* Bleeker, *Gagata* Bleeker, *Nangra* Day, *Bagarius* Bleeker, etc., is found in the streams of the foot-hills in comparatively deeper and less rapid-flowing waters; while Loaches or Loach-like cat-fishes, such as *Nemachilus* van Hass., *Lepidocephalichthys* Bleeker, *Acanthopthalmus* van Hass., *Somileptes* Swainson, *Acanthopsis* van Hass., *Olyra* McClelland, *Amblyceps* Blyth, *Erethistes* Müll. and Trosch., *Parasilurus* Bleeker, etc., live among pebbles and stones at the bottom and escape the effect of the rushing current. Though *Garra* Hamilton and *Glyptothorax* Blyth are provided with adhesive devices they are found both in torrential streams and in streams with moderate currents. These are essentially rapid-water forms, but have taken secondarily to slow waters. The typical torrential genera are *Pseudecheneis* Blyth, *Exostoma* Blyth, *Euchiloglanis* Regan, *Balitora* Gray and certain species of *Psilorhynchus* McClelland; these are res-

¹ Attention may also be directed to the amphibious, marsh-loving fishes of the genus *Ophicephalus* which are sometimes found at the sides of mountain streams in burrows and are not affected by the strength of the current. These are found throughout the plains of south-eastern Asia and are capable of wriggling about on wet ground.

tricted in their distribution to very fast flowing waters, and are accordingly the most highly adapted forms for life in mountain brooks.

Before discussing the distribution of the genera enumerated above, it seems worth while to form some conception of the age and geographical divisions of the Himalayas. According to Burrard, Hayden and Heron (p. 86)¹,

“ Though the whole length of the great Himālaya range belongs to one geological age, yet the Punjab Himālaya are supposed to have arisen at a somewhat later date than the Nepāl Himālaya. The presence at elevations of 16,000 feet in the Punjab Himālaya of nummulites indicates that this portion of the range did not emerge from the sea till comparatively recently.”

It is further stated that

“ The rocks of the Siwalik range are stratified and date from the later half of the Tertiary period ; those of the outer Himālaya are stratified also but are very much older.”

For descriptive purposes the total length of the Himalayas from Namcha Barwa in the east to Nanga Parbat on the west, about 1,500 miles, is divided into four sections by three meridional lines, (i) The Tista, (ii) The Kali and (iii) The Sutlej. The easternmost section, about 450 miles, is known as the Assam Himalayas, the next section of about 500 miles is the Nepal Himalayas, then a length of about 200 miles is the Kumaon Himalayas and the last about 350 miles form the Punjab Himalayas.

“ Whilst in all the four parts the great range rises like a wall and the outer ranges tend to run parallel to it, no one portion of the Himālaya resembles another.”

“ In Nepāl we find numerous rivers cutting across the Great Himālaya range ; in the Punjab between the Sutlej and the Indus we do not find one. In Népal the great peaks stand in clusters and rows ; the great peak of the Punjab stands in solitude.”

In considering the distribution of fishes along the south face of the Himalayas, there is one fact which appears most striking at the very outset, *i.e.*, the great variety of forms towards the east as compared with the case of the west. For instance, in the Brahmaputra and the Tista drainage systems all the genera of fishes enumerated above are found ; while towards the west in the Gangetic drainage system we only find *Chaca*, *Amblyceps*, *Bagarius*, *Glyptothorax*, *Erethistes*, *Gagata*, *Nangra*, *Lepidocephalichthys*, *Nemachilus*, *Garra* and *Semiplotus*. Not one of these genera represents a highly specialised torrential form, and, with the exception of *Gagata*, *Nangra* and *Semiplotus*, all are widely distributed in the Oriental Region ; the range of *Nemachilus*, *Garra* and *Glyptothorax* extends for a considerable distance towards the west. There is one genus of large Catfishes—*Sisor* Hamilton—which was recorded by Day from both the Indus and the Ganges systems ; but it was found by Shaw and Shebbeare and Mukerji to occur also in the Tista river. In the Punjab Himalayas or the Indus drainage system *Chaca*, *Erethistes* and *Semiplotus* are absent. Unfortunately no systematic account of the Himalayan fishes has so far been published, and in the case of old records precise localities are not mentioned. In the case of *Semiplotus*, however, it may be noted that Day gave its distribution as “ Assam, and Chittagong Hill ranges, as well as Burma ”, but recently

¹ Burrard, S. G. and Hayden, H. H.—*A Sketch of the Geography and Geology of the Himalaya Mountains and Tibet*. 2nd Edition, revised by Burrard, S. G. and Heron, A. M. (Delhi : 1933).

I¹ recorded *S. semiplotus* (McClelland) from the portion of the Nepal Himalayas drained by the Gandak. Though our present-day knowledge of the distribution of the Himalayan fishes is very imperfect, it is doubtful whether the special forms of the Assam Himalayas, such as *Balitora*, *Psilorhynchus*, *Parasilurus*, *Olyra*, *Pseudecheneis*, etc., will ever be found in the western Himalayas. These very genera or some other closely allied forms are found in Burma, Southern China, Siam, the Malay Peninsula and the Archipelago and Indo-China on the one hand and in the hills of Peninsular India on the other. It seems remarkable that the distribution of these eastern forms, instead of being continued along the Himalayas, is deflected from the limits of the Tista drainage towards the south. This most striking feature in the distribution of Indian fishes is explained later (*vide infra*, p. 255).

The records of distribution of the Himalayan fishes, as given above, support the hypothesis that I² have suggested elsewhere regarding the eastern origin of the freshwater fish fauna of India. The above series of genera represents various phases of migration of the fauna. For instance, in the case of such widely distributed genera as *Barbus*, *Labeo*, *Garra*, *Nemachilus*, *Lepidocephalichthys*, *Bagarius*, *Amblyceps*, etc., one has to imagine a large, deep river in low hills fed by small, broad, rocky tributaries. The wide distribution of these genera along the entire length of the Himalayan foot-hills shows further that such a river must have had a longitudinal course, like that of the Trans-Himalayan sections of the Brahmaputra and the Indus. It was, no doubt, during this type of drainage of the Himalayas that the large river fishes of India, such as *Catla* (represented in Siam and Indo-China by *Carpio-catla* Boulenger), *Cirrhina*, large-scaled Barbels, *Wallago* Bleeker, *Silonia* Swainson (replaced in Siam and Indo-China by *Pangasianodon* Chevey), *Pangasius pangasius* (Ham.), etc., could spread almost all over India. The presence in the Ganges, Brahmaputra and Indus of identical species of freshwater dolphins and turtles also shows the course and nature of this mighty river. Thus the distribution of the freshwater fish fauna of northern India lends a strong support to the existence of a river of the type of the Indobrahm, envisaged by Pascoe³ and Pilgrim⁴. From the geological evidence it is concluded by these authors that such a river existed even in the Eocene period. Its lower course is evident from the distribution of the boulder conglomerates, but the position of its headwaters is a matter of mere conjecture. It is stated that the headwaters of the Indobrahm consisted of the Assam portion of the present-day Brahmaputra. Dr. C. S. Fox of the Geological Survey of India has pointed out to me in a note that this cannot be the case as

“ A marine gulf in Burma and Upper Assam in Cretaceous times became an estuary in the Eocene and the mouth of a very important river in the Miocene. I do not see how

¹ Hora, S. L.—Notes on Fishes in the Indian Museum, XXIX. On a Collection of Fish from Nepal. *Rec. Ind. Mus.*, XXIX, pp. 45, 46 (1937).

² Hora, S. L.—Geographical Distribution of Indian Freshwater Fishes and its bearing on the probable land connections between India and the adjacent countries. *Curr. Sci.*, V, pp. 351-356 (1937).

³ Pascoe, E. H.—Early History of the Indus, Brahmaputra and Ganges. *Quart. Journ. Geol. Soc.*, LXXV, p. 136 (1919).

⁴ Pilgrim, G. E.—Suggestions Concerning the History of the Drainage of Northern India. *Journ. As. Soc. Bengal* (N. S.), XV, p. 81 (1919).

the debouchure of a river into a delta can become the source of a river that is to go to sea all the way round the Himalayan foothills to the Indus."

In the same note he stated that

"It is probable that as the old geosyncline of the Himalayan belt was folded up into a mountain chain a depression was established parallel to it to the south. In the swampy country the rivers from the rising hills discharged, and their silt was spread out laterally into great alluvial fans. It is these Siwalik deposits of freshwater fluvial deposition that have been joined up lengthways, along the axis of the depression, and thus have supplied material for the belief in a Siwalik river."

This view is, however, disputed by Wadia¹ who has drawn attention to the remarkable homogeneity and uniformity of the Siwalik deposits all along this strike, from Assam to the Punjab. This strike continuity is inconsistent with the fan theory of deposition at the mouths of isolated transverse streams and is best explained by deposition in a continuous longitudinal basin of a wide east-west flowing river.

Without going into the geological merits of the case, it seems clear that the distribution of freshwater fishes, as indicated above, postulates the existence of a mighty river of the nature of the Indobrahm.² This river at an early stage of its existence certainly did not have its headwaters in the Assam portion of the present-day Brahmaputra, but it must have crossed the broad isthmus that joined India with the main Asiatic continent and had its headwaters further east. The distribution of the large freshwater river fishes of the Oriental Region (*vide supra*, p. 254) can only be explained on this assumption. Even the occurrence of precisely the same river fishes, especially of the giant forms as *Catla catla* (Ham.), *Labeo rohita* (Ham.), *Cirrhina mrigala* (Ham.), *Wallago attu* (Bloch), *Pangasias pangasias* (Ham.), *Silonia silondia* (Ham.), and others in Burma, Assam, Bengal, the United Provinces, the Central Provinces, Orissa and the Punjab postulates the existence of a large, longitudinal river and its subsequent divisions into several independent watersheds. As the Himalayas rose to a great height in the region of this isthmus (mostly the western part of the Assam Himalayas and eastern part of the Nepal Himalayas) all the evidence concerning the north-eastward extension of the Indobrahm seems to have been obliterated. The uplift movement was probably most active in this region as we find practically all the highest peaks of the Himalayas clustered round this area. This differential movement, which probably occurred late in the Miocene period, must have obliterated all traces of the eastward extension of the Indobrahm and also acted as a barrier between the eastern and the western Himalayan fishes. The new stocks of specialised hill-stream fishes from the east, not finding means to cross this barrier, were deflected towards south-west along the Satpura Trend which probably at this period stretched across India as a pronounced

¹ Wadia, D. N.—The Tertiary Geosyncline of North-West Punjab and the History of Quaternary Earth-movements and Drainage of the Gangetic Trough. *Q. J. Geol. Min. Met. Soc. India*, IV, pp. 69-96 (1932).

² Evidence of the existence of the Indobrahm is also furnished by "the tendency of the tributaries of the supposed Indobrahm to flow in a direction opposite to that of the modern trunk river. If but one feeder has been observed to take a course contrary to that of the main stream, it might have been attributed to some local accident of topography, but when all the principal affluents of a long section of the river do so, it is indicated that the Indobrahm flowed from east to west, when the tributaries were developed, and that its direction of flow has been reversed." (Burrard, Hayden and Heron, *op. cit.*, p. 349.)

range from Gujarat to the Assam Himalayas. From Gujarat the hill-stream fauna migrated towards the south along the Western Ghats and spread to the hills of the Peninsula in the extreme south. It may here be noted that the Indobrahm fauna of moderate, deep currents does not extend to the south below the Kistna river, while the torrential fauna of the Eastern Himalayas is represented in the hills of the extreme south of the Peninsula by forms such as *Silurus* Linn., *Bhavana* Hora, *Parapsilorhynchus* Hora, *Thynnichthys* Bleeker, etc.; it is not found in Ceylon, for the island had by then become separated from the mainland. Further, it has no representative in Africa, because the main land bridge between Peninsular India and Africa had already disappeared during the Eocene period, though a mass of land in the region of the Gulf of Oman probably existed till Pliocene or possibly even Pleistocene times.¹ This course of events, in my opinion, explains the anomalous distribution of the various hill-stream fishes of India, and suggests a reason for the closer similarity of the South Indian fish fauna with that of the Malay Peninsula and the Archipelago.

To the west of this supposed barrier in the Eastern Himalayas the hill-stream fauna is composed of ordinary rapid water fishes; most of the genera are more or less uniformly distributed all along the range. In the Nepal Himalayas, however, the eastern element, *Semiplotus*, *Chaca* and *Erethistes*, is more pronounced. The last two genera extend up the Ganges system and are absent from the Punjab Himalayas. The Punjab Himalayas, being furthest from the source of distribution, has the least number of hill-stream forms in its fauna. It may, therefore, be presumed that at the end of the Kumaon Himalayas or somewhere in that region there is probably another barrier, which isolated the fauna of the Punjab at a fairly early age. This conclusion is justified by the detailed studies recently carried out by Mukerji² and Hora³ on the specific position of some of the Himalayan fishes. The isolation of the Punjab Himalayan forms may have resulted through the differential earth-movements which elevated the Potwar basin into a plateau and led to further dismemberment of the Indobrahm into the Indus and the Ganges systems of the present-day drainage of the Himalayas. In any case, this barrier must have been formed at a later date and is not contemporaneous with the Eastern Himalayan barrier. This presumption is based on the fact that after the formation of the Eastern Himalayan barrier there was for some time no river of the nature of the Ganges flowing into the Bay of Bengal to divide the Peninsula from the Extra-Peninsula: such a river, if it had existed, would in itself have acted as a barrier and have inhibited the dispersal of Himalayan fishes to the hills of the Peninsula. It is thus seen that the Indobrahm must have continued to flow towards the Arabian Sea even after the severance of its

¹ Wiseman, J. D. H. and Sewell, R. B. S.—The floor of the Arabian Sea. *Geol. Mag.*, LXXIV, pp. 219-230 (1937).

² Mukerji, D. D.—Report on Burmese Fishes collected by Lt.-Col. R. W. Burton from the tributary streams of the Mali Hka river of the Myitkyina District (Upper Burma). *Journ. Bombay Nat. Hist. Soc.*, XXXVII, pp. 49-59 (1934).

³ Hora, S. L.—On a further Collection of Fish from the Naga Hills. *Rec. Ind. Mus.*, XXXVIII, pp. 320-324 (1936).

connection with the Far East ; its dismemberment seems to have occurred in several stages. After the formation of the Eastern Himalayan barrier its headwaters may have been in the Nepal Himalayas. A later upheaval probably divided it into a westerly flowing Indus and an easterly flowing Ganges. The formation of this drainage pattern has a counterpart on the northern face of the Himalayas also, namely, the reversal of the direction of flow of the Tsangpo towards the east and the westerly flowing Indus.

From the distribution of the fish fauna along the southern face of the Himalayas it is thus possible to recognise three well marked divisions—the Eastern Section up to and including the drainage basin of the Tista river, the Middle Section up to the Sutlej river and then the Western Section comprising the entire drainage basin of the Indus. The precise boundaries of these sections can only be demarcated when our knowledge of the various Himalayan species and their races becomes more exact. It may be indicated that the Jumna river was a tributary of the Sutlej not very long ago, though it now joins the Ganges. The oscillation of the Jumna makes it still more difficult to define the various sections without a proper survey of the fish fauna of the Himalayas.

HIMALAYAN FISHES AND THEIR BEARING ON THE EVOLUTION OF THE PRESENT-DAY DRAINAGE SYSTEM OF THE HIMALAYAS.

With the exception of *Oreinus* and *Nemachilus*, none of the genera enumerated above are found on the northern face of the Himalayas, the fish fauna of which comprises the Schizothoracinae, *Glyptosternum* McClelland and *Nemachilus*. In another place I¹ have shown that the Nemachili of the northern and the southern faces of the Himalayas are very distinct from each other and that *Glyptosternum* is very different from the other Glyptosternoid fishes found in Siam, S. China, Burma and the Eastern Himalayas. *Oreinus* is a mountain form of *Schizothorax* Heckel and is only found along the slopes of the Central Asiatic plateau, but not on the tableland. In fact, it may definitely be stated that there is no similarity between the fish faunas of the northern and the southern faces of the Himalayas. To account for this I have suggested that the two faunas were probably evolved from the same stock at different geological ages and owing to the barrier provided by the rising Himalayas had little chance to intermingle. The deep gorges and rapids in the course of certain Himalayan rivers with trans-Himalayan courses still isolate the two fish faunas from each other.

With regard to the evolution of the present-day Himalayan drainage pattern two alternative theories have been advanced.

“ One of the theories postulates that at an early age the Himalaya had ordinary consequent drainage, the rivers flowing north and south from the crest. This simple drainage pattern is considered to have been modified to its present form by some of the south-flowing rivers cutting back through the range and capturing rivers on the Tibetan side. The much greater precipitation on the south side of the range and the much steeper fall and therefore greater erosive power are put forward as possible reasons for the unusual behaviour of the south-flowing rivers. The alternative theory postulates that the Arun and similar rivers always had their present courses which, when they were inaugurated, were the easiest routes down an irregular surface sloping towards the

¹ Hora, S. L.—Comparison of the Fish-Fauna of the northern and the southern faces of the great Himalayan range. *Rec. Ind. Mus.*, XXXIX, pp. 241-250 (1937).

Gangetic plain. Subsequently the Himalayan range is considered to have risen up across the rivers, but so slowly that by vigorous erosion they were able to keep open their original channels."¹

The distinctness of the northern and the southern fish faunas of the Himalayas definitely favours the former view. If the rise of the Himalayas had been so slow as to enable the rivers to keep open their channels by vigorous erosion there should have been little or no difference in the fish faunas of the cis- and trans-Himalayan portions of such rivers as the Brahmaputra, the Arun, the Sutlej, the Indus, etc. On the other hand, there is every reason to believe that the rise of the Himalayas was in sharp orogenic movements so that the fishes of the southern face of the range were unable to adapt themselves to very turbulent waters and have, even to this day, remained confined to low valleys and are rarely found above an elevation of four to five thousand feet. In this connection it may also be remembered that the so-called Indian monsoon conditions—south-west for four months and north-east for three or four months—had begun before the Himalayas started to rise, as in the late Cretaceous period open seas of great extent existed to the south of India and some land had been formed to the north. The rise of the Himalayas had a great influence on the distribution of rainfall, for most of the moisture is now precipitated on its southern face; and there is practically no rainfall on the northern face of the Himalayas. Consequently, the rivers along the southern face are very turbulent while those on the northern face are placid, broad-valleyed and deep. Very different sets of ecological conditions were thus produced on the northern and southern faces of the Himalayas and these became accentuated as the mountains rose higher and higher.

When the south-flowing rivers, through erosion captured the rivers on the Tibetan side it was natural that some of the fishes on the Tibetan side should have been washed down on the southern side, but they had to pass through such precipitous channels before reaching congenial conditions that with the exception of one genus of the Schizothoracinae—*Oreinus*, a specialised member of the subfamily fully adapted for life in rapid, mountain streams—no other member of the Central Asiatic fauna has been able to colonise the southern slopes of the Himalayas.

The migration of torrential fishes along the southern face of the Himalayas and from the Eastern Himalayas to the hills of the Peninsula shows that the process of river-capture was a fairly common phenomenon in this territory and also in the region of the contiguous hill-ranges to the east. The distribution of specialised hill-stream fishes strongly suggests that in south-eastern Asia, as a rule, the rivers on the west beheaded the rivers on the east² and thus effected the transference of the fish fauna from the east to the west.

SUMMARY.

The physical and biological factors that govern the life of a torrential fauna are examined and it is indicated that the distribution of highly

¹ Wager, L. R.—The Arun River Drainage Pattern and the rise of the Himalayas. *Geog. Journ.*, LXXXIX, pp. 239-250 (1937).

² Gregory, J. W.—The Evolution of the River System of South-Eastern Asia. *Scottish Geog. Mag.*, XLI, pp. 129-141 (1925).

specialised hill-stream fishes cannot be effected by the ordinary methods of dispersal ; it has to be explained in terms of longitudinal valleys, river-captures and tilting of mountain blocks.

The distribution of the fish-genera along the southern face of the Himalayas is discussed in terms of the ecological associations of the different types, and it is indicated that at a very early period of the rise of the Himalayas a mighty longitudinal river must have existed along its base. This river probably corresponded with the ' Indobrahm ' of Pascoe and Pilgrim, but the distribution of fishes shows that it must have extended towards the Far East. From the distribution of various fishes the probable phases of dismemberment of this river are indicated, and it is explained how the Himalayas became divided hydrographically into three main divisions—the Brahmaputra, the Ganges and the Indus drainage systems.

The almost total dissimilarity between the northern and the southern Himalayan fishes is indicated, and it is concluded therefrom that the present-day drainage pattern of the Himalayas cannot have resulted from an antecedent drainage, according to which the Himalayan range is considered to have risen up across the rivers which kept their original channels open by vigorous erosion, but is the result of consequent drainage, of which the southern rivers captured the rivers of the north secondarily.

SCIENTIFIC RESULTS OF THE YALE NORTH INDIA EXPEDITION.

Biological Report No. 21.

AQUATIC AND AMPHIBIOUS MOLLUSCS.

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INTRODUCTION.

Mr. G. E. Hutchinson, the biologist attached to the Yale North India Expedition, entrusted to me for report the collection of freshwater molluscs, including amphibious molluscs of the family Succineidae. The collection was made mainly in the Kashmir Valley and Western Tibet and comprises representatives of the families Valvatidae, Amnicolidae, Lymnaeidae, Planorbidae, Succineidae, and Corbiculidae. As was to be expected, the fauna of this area is entirely Palaearctic; almost all the species represented are truly Palaearctic forms, but in a few cases special local races of some of the species have evolved in the area under consideration.

In all 17 species are represented in the collection and in the case of two species of the genus *Lymnaea* a number of distinct forms were found in the collection.

The main interest of the collection is a new species of the genus *Sphaerium* which I describe below as *Sphaerium kashmirensis*. Another species is represented by two young shells, but with the limited material available I have not considered it right to describe it as new.

In the case of all species, as complete references as possible to the literature dealing with molluscs of the area under consideration are given. References to monographic works in which detailed accounts of the different species are already available, are also included.

In addition to the collections made in the Kashmir Valley and Western Tibet, Mr. Hutchinson collected a few molluscs at Calcutta, some places in the Punjab and in the Nilgiri Hills. These are dealt with in the Appendix at the end of the paper.

My sincere thanks are due to Mr. G. E. Hutchinson for affording me the opportunity of studying this interesting collection. I have also to offer my apologies for the delay in the preparation of the report, but this has been inevitable owing to pressure of official work.

GASTROPODA.

Subclass PROSOBRANCHIA.

Family VALVATIDAE.

Thiele¹ in his monograph included *Andrusovia* Brusina² from the Caspian Sea with *Valvata* O. F. Müller as a second genus of the family

¹ Thiele, J. *Handb. Syst. Weichtierk.* I, p. 121 (1929).

² Brusina in Westerlund, C. A. *Rad. Jugoslav. Akad. CLI*, p. 133 (1903). I have not seen this work.

Valvatidae. In the same work he has suggested dividing the genus *Valvata*, as generally accepted by most workers, into a number of sections. I, however, am not adopting this division, as the differences between the various sections do not seem to be sufficiently marked for assigning the species to these sections.

Genus *Valvata* O. F. Müller.

1774. *Valvata*, Müller, *Verm. Terr. Fluv. Hist.* II, p. 198.
 1926. *Valvata*, Kennard & Woodward, *Synonymy Brit. Non-Marine Moll.* p. 27.
 1927. *Valvata*, Pilsbry & Bequaert, *Bull. Amer. Mus. Nat. Hist.* LIII, p. 243.

For the synonymy of the genus reference may be made to Kennard and Woodward, while the characteristics of the animal and shell are described in detail by Pilsbry and Bequaert.

In the collection before me the genus is represented by *V. piscinalis* (Müller), which is widely distributed in Europe, Asia Minor, Northern Asia and Kashmir.

Valvata piscinalis (O. F. Müller).

1774. *Nerita piscinalis*, Müller, *Verm. Terr. Fluv. Hist.* II, p. 172.
 1878. *Valvata piscinalis*, Nevill, *Sci. Res. Second Yarkand Mission, Mollusca*, p. 12.
 1882. *Valvata piscinalis* var. *ambigua*, von Martens, *Mem. Acad. Imp. Sci. St. Petersbourg* (7) XXX (No. 11), p. 48.
 1910. *Valvata piscinalis*, Weber, *Zool. Jahrb. Syst.* XXIX, p. 307.
 1926. *Valvata piscinalis*, Kennard & Woodward, *Synonymy British Non-Marine Moll.* p. 27.
 1935. *Valvata piscinalis*, Mozley, *Trans. Roy. Soc. Edinburgh*, LVIII, p. 612, pl. ii, fig. 7.

Valvata piscinalis is represented in the collection from the following localities :—

K 5(2)	Bren Spur, Lokut Dal Lake, Kashmir ; alt. ca. 5,200 ft. (Bren terrace exposure).	8 complete and a broken shell.
—	Same locality	3 large well preserved but weathered shells.
K 10(2)	Exposure along bank of Jhelum River below Pampur, Kashmir ; alt. ca. 5,200 ft. Lower Shell-Bed. 25.iii.32.	2 complete shells embedded in dried mud, with a fragmentary shell of <i>Lymnaea</i> sp.
K 24 .	Nishat Bagh, Kashmir ; alt. ca. 5,200 ft. In a pond. 7.iv.32.	4 fresh shells.
K 42(a) . .	Wular Lake, Kashmir : alt. ca. 5,180 ft. Littoral at Kiuhnus. 17.iv.32.	1 fresh shell.
K 42(b)	Also dredged in 1.5-2 metres of water. 18. iv. 32.	15 fresh specimens.
—	Top Shell-Bed between Man and Spangmik near Panggong Tso, W. Tibet. 1. vii. 32.	5 bleached shells.

The specimens from the pond at Nishat Bagh—St. K. 24, those collected from the littoral zone of the Wular Lake (K 42a) and those dredged in the same Lake from a depth of 1.5-2 metres, are of a greenish colour with the surface rather dull and rough. They agree in all respects with European specimens and shells from the Pankong Lake, Yarkand, recorded by Nevill.

The specimens from Bren Spur, Lokut Dal Lake—St. K 5(2)—are all weathered shells, mostly well preserved, which were dug out of dried earth. These specimens resemble the ones from Nishat Bagh, but are somewhat larger in size.

The five shells from the Top Shell-Bed between Man and Spangmik near Panggong Tso, W. Tibet, are all bleached and partly weathered.

Family AMNICOLIDAE.

I have followed Pilsbry and Bequaert¹ in adopting the family name Amnicolidae for Hydrobiidae and Paludestrinidae of older authors. This very large family is found almost all over the world, more particularly in the temperate and tropical zones.

In the collections before me it is represented by two subgenera of *Bulimus* Scopoli, *Bulimus* s. s. and *Alcinma* Annandale & Prashad. The genus *Bulimus* is a representative of the subfamily Buliminae, members of which are distinguished by the possession of a solid, mainly calcareous, and largely concentric operculum which is too large for retraction into the peristome, and is, therefore, lodged at its edge.

Genus **Bulimus** Scopoli.

1777. *Bulimus*, Scopoli, *Introd. Hist. Nat.* p. 392.

1927. *Bulimus*, Pilsbry & Bequaert, *Bull. Amer. Mus. Nat. Hist.* LIII.

1928. *Bulimus*, Rao, *Rec. Ind. Mus.* XXX, p. 427.

1929. *Bithynia*, Rao, *Rec. Ind. Mus.* XXXI, p. 283.

Pilsbry and Bequaert gave detailed reasons for adopting *Bulimus* Scopoli in preference to *Bithynia* Leach, and selected *Helix tentaculata* Linn. as its genus type. Kennard & Woodward² had a few years earlier, after reviewing the opinions of other workers, suggested that “*Bulimus* was an obvious mistranscription for *Bulinus*; it must be treated as such, and discarded in future literature” In view of this Rao reverted to *Bithynia* in place of *Bulimus* in his second paper cited above. The matter was referred to the International Commission on Zoological literature, by Dr. H. A. Pilsbry, and in accordance with its decision, Opinion 116, *Bulimus* Scopoli with its genotype *Helix tentaculata* as selected by Pilsbry & Bequaert must replace *Bithynia* Leach 1818 with the same genotype.

Bulimus tentaculatus (Linn.).

var. **kashmiriensis** Nevill.

1885. *Bithynia tentaculata* var. *kashmiriensis*, Nevill, *Hand-List Moll. Ind. Mus.* II, p. 39.

1925. *Bithynia tentaculata* var. *kashmiriensis*, Prashad, *Rec. Geol. Surv. Ind.* LVI, p. 358, pl. XXIX, figs. 2-5.

A detailed synonymy of the typical form is published by Kennard & Woodward³, and a good description with figures is to be found in

¹ Pilsbry, H. A. & Bequaert, J. *Bull. Amer. Mus. Nat. Hist.* LIII, p. 212 (1927).

² Kennard, A. S. & Woodward, B. B. *Proc. Malacol. Soc. London*, XVI, pp. 125, 126 (1927).

³ Kennard, A. S. & Woodward, B. B. *Synonymy Brit. Non-Marine Mollusca*, pp. 14-16 (1926).

Moquin-Tandon¹. Mozley² in recording the species from Northern Asia gives the geographical range of the species as "Europe; Northern Asia, Kashmir, Punjab east of the River Indus, Annandale & Rao (1923); parts of North America, both living and in Pleistocene deposits, Baker (1928)". Other important references to the species are given in my part cited above.

As was stated in my paper cited above, Nevill gave the new name *kashmiriensis*, with measurements of a specimen, to a variety of *Bithynia tentaculata* which he recorded from Kashmir and Srinagar. In the above paper I also published the diagnostic characters and photographs of Nevill's variety from Kashmir.

The species is represented in the collection from the following localities :—

K 42	.	Wular Lake, Kashmir; alt. ca. 5,180 ft.	3 specimens.
		Littoral at Kihnus. 17.iv.32.	
K 46	.	Bakh Hajan, Kashmir; alt. ca. 5,170 ft.	13 specimens.
		Jhil. 19.iv.32.	

The fresh shells from both the localities are of a dull brownish green colour, with the growth lines rather feebly marked, but regular; the suture is more deeply impressed than in the typical form, and the whorls are more tumid. The umbilical chink, though minute, is also more marked than in the typical form.

Nevill gives the measurements of his specimen as "Length 7, diam. $4\frac{1}{2}$ mil." The measurements of the largest specimen from the Wular Lake are 5.4 mm. $\times$ 3.8 mm. and of one from Bakh Hajan Jhil 6.3 mm. $\times$ 4.2 mm.

Subclass PULMONATA.

Family LYMNAEIDAE.

Genus *Lymnaea* Lam.

1799. *Lymnaea*, Lamarck, *Prœdr. Nouv. Clas. Coq.* p. 75.
 1911. *Lymnaea*, Baker, *Chicago Acad. Sci.*, Sp. Publ. III, p. 134.
 1925. *Limnaea*, Annandale & Rao, *Rec. Ind. Mus.* XXVII, p. 146.

The synonymy and diagnostic characters of the genus *Lymnae* are discussed at length in the works of Baker and Annandale & Rao, and it is not necessary, therefore, to deal with them here.

In the collections of the Yale North India Expedition the genus is represented by the subgenera or groups :—

- Lymnaea* s. s.—genotype *L. stagnalis* (Linn.);
Radix Montfort—genotype *L. auricularia* (Linn.); and
Galba Schrank—genotype *L. truncatula* (Müll.).

¹ Moquin-Tandon, A. *Hist. Moll. France*, II, pp. 528, 529, pl. xxxix, figs. 23-44 (1856).

² Mozley, A. *Trans. Roy. Soc. Edinburgh*, LVIII, pp. 608, 609 (1935).

Subgenus **Lymnaea** s. s.

Lymnaea stagnalis (Linn.).

1758. *Helix stagnalis*, Linné, *Syst. Nat.* (Ed. X), p. 774.
1882. *Limnaea stagnalis*, von Martens, *Mem. Acad. Imp. Sci. St. Petersburg*,
(7) XXX, No. 11, p. 32.
1911. *Limnaea stagnalis*, Baker, *Chicago Acad. Sci.*, Sp. Publ. III, p. 136.
1913. *Limnaea stagnalis*, Weber, *Abhandl. Königl. Bay. Akad. Wiss. (Math.-
phys. kl.)* XXVI, p. 20.
1915. *Limnaea stagnalis*, Preston, *Faun. Brit. Ind. Freshw. Moll.* p. 106.
1925. *Limnaea stagnalis*, Annandale & Rao, *Rec. Ind. Mus.* XXVII, p. 147.
1935. *Limnaea stagnalis*, Mozley, *Trans. Roy. Soc. Edinburgh*, LVIII, p. 615.

Mozley has recently resummarised the geographical range of the species as "the whole of Europe, except Iceland; North Africa; Northern Asia as well as Afghanistan and Kashmir; and the greater part of North America to the north of 40°" Other references to the occurrence of the species in Central Asia and particularly in the Kashmir area are summarised in my notes incorporated in Annandale and Rao's paper cited above. In the collections of the Yale North India Expedition the species is represented by the forms *kashmiriensis* Prashad and *minor* Kobelt.

Form **kashmiriensis** Prashad.

1925. *Limnaea stagnalis* race *kashmiriensis*, Prashad in Annandale & Rao, *Rec. Ind. Mus.* XXVII, p. 148, figs. V, 9, 10.

The race *kashmiriensis* was described by me in the paper cited above, and its anatomy was dealt with by Annandale and Rao in the same paper.

This race was found to be widely distributed in the lakes of Kashmir, and in the collection under report it is represented from the following stations :—

- K 19 Gargibal, Kashmir; alt. ca. 5,190 ft. 13 specimens in spirit.
Closed swamp. 31.iii.32.
- K 15 Same locality . . . 2 dried shells.

These specimens resemble in all respects the earlier collections from Kashmir. The measurements of the largest specimen are :—Length 40 mm. ; breadth 22 mm. ; length of aperture 24 mm. ; breadth of aperture 12·5 mm. A number of very young specimens in the collection seems to indicate that the animals must have been breeding about the time (March) they were collected.

Form **minor** Kobelt.

1925. *Limnaea stagnalis* form *minor*, Prashad in Annandale & Rao, *Rec. Ind. Mus.* XXVII, p. 150, fig. V, 8.

For synonymy and description of this race reference may be made to my notes in the publication cited above. In the Indian Museum it is represented from a pool at Srinagar, Kashmir, and from Shandur Lake, Shandur Pass between Chitral and Gilgit, at an elevation of 12,300 ft.

The Yale North India Expedition collected specimens of this race from the following station :—

- K 46 Bakh Hajan, Kashmir ; alt. ca. 5, 170 ft. 3 specimens in spirit.
Jhil.

Subgenus **Radix** Montfort.

1910. *Radix*, Montfort, *Conch. Syst.* II, p. 266.
 1911. *Radix*, Baker, *Chicago Acad. Sci.*, Sp. Publ. III, p. 178.
 1915. *Gulnaria*, Preston, *Faun. Brit. Ind. Freshw. Moll.* p. 110.
 1925. *Radix*, Annandale & Rao, *Rec. Ind. Mus.* XXVII, p. 150.

For detailed characters of this subgenus reference may be made to Baker's work cited above. The type of the subgenus is the widely distributed Palaearctic species *L. auricularia* (Linn.).

Annandale & Rao recorded from India the following four species of the subgenus :—*L. auricularia* (Linn.), *L. lagotis* (Schränk), *L. persica* Issel and *L. brevicauda* Sowerby. In the collections made by the Yale North India Expedition there are representatives of all these species except *L. persica*.

Lymnaea auricularia (Linn.).

1758. *Helix auricularia*, Linné, *Syst. Nat.* (Ed. X), p. 774.
 1877. *Limnaea auricularia* var. *ventricosa*, Kobelt in *Rossmässler Icon. Land Süßw. Moll.* V, p. 40, pl. cxxix, fig. 1244.
 1878. *Limnaea auricularia* var., Nevill, *Sci. Res. Second Yarkand Mission, Mollusca*, p. 6.
 1882. *Limnaea auricularia* var. *ventricosa*, von Martens, *Mem. Acad. Imp. Sci. St. Petersbourg*, (7) XXX, No. 11, p. 33, pl. iv, figs. 3, 4.
 1910. *Limnaea* (*Gulnaria*) *auricularia* var. *ventricosa*, Weber, *Zool. Jahrb. Syst.* XXIX, p. 501.
 1913. *Limnaea auricularia* var. *ventricosa*, Weber, *Abhandl. König. Bay. Akad. Wiss. (Math.-phys. kl.)*, XXVI, p. 23.
 1925. *Limnaea auricularia*, Annandale & Rao, *Rec. Ind. Mus.* XXVII, p. 158, figs. 1, 2, 4.
 1935. *Lymnaea* (*Radix*) *auricularia*, Mozley, *Trans. Roy. Soc. Edinburgh*, LVIII, p. 620.

Mozley summarised the known distribution of this species as "Europe, as far south as Spain and Italy; Northern Asia; Afghanistan; Kashmir" Annandale & Rao recorded it from the Kashmir Valley.

In the collections made by the Yale North India Expedition there are a series of specimens from the following two localities :—

- K 5(2) Bren Spur, Lokut Dal Lake, Kashmir; 2 broken, bleached shells.
 alt. ca. 5,200 ft. Exposure Shell-Bed.
 31. iii. 32.
 L 58 Kyam; Western Tibet; alt. 15,630 ft. Many specimens in spirit.
 Hot Spring.

The two broken shells from the "Exposure Shell-Bed" at Bren Spur can be assigned only doubtfully to this species, but the form of the spire, the suture and the remains of the body-whorl have led me to this identification.

The series of specimens from the hot spring at Kyam are all of a small size not exceeding 23 mm. in total length, and the shells of most specimens have a fairly thick, closely adhering encrustation of a brownish colour.

The shell is globose, thin, light brownish with the surface rather smooth and shining; the last or body-whorl appears in some shells to be finely ribbed. Whorls about $3\frac{1}{2}$ -4, convex, all well rounded, the last well expanded especially along the superior margin; spire very small, acutely pointed; suture deeply impressed, almost channeled; aperture large, ovate, columella gently curved, becoming greatly twisted over the umbilical chink.

At first I had some doubt about assigning the Kyam specimens to *L. auricularia*, but after carefully comparing them with specimens from various localities in the collections of the Indian Museum I have come to the conclusion that they represent a dwarfed form of the species, probably produced as a result of the peculiar biological conditions prevailing in the hot spring.

Lymnaea lagotis (Schrank).

1803. *Buccinum lagotis*, Schrank, *Fauna Boica*, III, p. 290.
 1874. *Limnaea lagotis*, von Martens in *Fedtschenko's Reise in Turkestan*, *Mollusca*, p. 26, pl. ii, fig. 22.
 1878. *Limnaea lagotis* (in part), Nevill, *Sci. Res. Second Mission, Mollusca*, p. 7.
 1882. *Limnaea lagotis*, von Martens, *Mem. Acad. Imp. Sci. St. Petersbourg*, (7) XXX, No. 11, p. 34.
 1904. *Limnaea (Radix) lagotis*, Kobelt in *Rossmässler Icon. Land Süßw. Moll. (N. F.)* XI, p. 239.
 1911. *Limnaea (Gulnaria) lagotis*, Andreae in *Futterer Durch Asien*, III, p. 75.
 1913. *Limnaea lagotis*, Weber, *Abhandl. König. Bay. Akad. Wiss. (Math.-phys. kl.)*, XXVI, p. 24.
 1925. *Limnaea lagotis*, Annandale & Rao, *Rec. Ind. Mus.* XXVII, p. 151.

Annandale & Rao in their paper cited above have discussed at length the differences between the shells of *L. auricularia* and *L. lagotis* and described the five forms of the latter species which occur within Indian limits. Four of these, viz., *striata* Andreae, *costulata* von Martens, *solidissima* Kobelt and *defilippii* Issel are represented in the collections of the Yale North India Expedition.

Form *striata* Andreae.

1911. *Limnaea (Gulnaria) lagotis* var. *striata*, Andreae in *Futterer Durch Asien*, III, p. 75, fig.
 1913. *Limnaea lagotis* var. *striata* Weber, *Abhandl. König. Bay. Akad. Wiss. (Math.-phys. kl.)*, XXVI, p. 24, pl. i, figs. 10a-d, f. h.
 1925. *Limnaea lagotis* form *striata*, Annandale & Rao, *Rec. Ind. Mus.* XXVII, p. 153, fig. I, 1.

Andreae remarked that his new var. *striata* from Sulai-ho in the Gobi Desert appears to be identical with the form recorded as *L. plicatula* Bens. var. *fasciolata* by von Martens¹ from Kuko-Nur. He, however, considered his form to be a variety of *L. lagotis*, and this was confirmed by Weber and Annandale & Rao.

In young shells of this form, as is clearly shown by Andreae's figures, there is fairly prominent spire, but in older shells (see figure in Annandale & Rao) the spire is very short as compared to the total length of the shell. The mouth is ovoid in the young stages, but becomes semicircular to auriculate in the adult. The shell bears fine vertical striae.

In the collections of the Yale North India Expedition it is represented from the following localities :—

- | | | |
|------|--|--------------|
| K 21 | Dal Lake, Kashmir ; alt. ca. 5,190 ft.,
in about 1·25 metres of water. 11.
iv. 32. | 3 specimens. |
| K 46 | Bakh Hajan, Kashmir ; alt. ca. 5,170 ft.
<i>Jhil.</i> 19. iv. 32. | 4 specimens. |
| L 16 | Spitok, Kashmir ; alt. ca. 10,730 ft.
Deepest pond. 9. vi. 32. | 5 shells. |

¹ von Martens, E.—*Mem. Acad. Imp. Sci. St. Petersbourg*, (7) XXX, No. 11, p. 38, pl. iv, fig. 10.(1882).

From **costulata** von Martens.

1874. *Limnaea lagotis* var. *costulata*, von Martens, *Fedtschenko's Reise in Turkestan, Mollusca*, p. 26, pl. ii, fig. 24.
 1878. *Limnaea lagotis* var. *costulata*, Nevill, *Sci. Res. Second Mission, Mollusca*, p. 8.
 1882. *Limnaea lagotis* var. *costulata*, von Martens, *Mem. Acad. Imp. Sci. St. Petersbourg*, (7) XXX, No. 11, p. 50.
 1925. *Limnaea lagotis* var. *costulata*, Annandale & Rao, *Rec. Ind. Mus.* XXVII, p. 153, fig. I, 7.

This form was described by von Martens as a variety of *L. lagotis* from shells collected in "Saissan-Sea," and was later recorded by Nevill from Leh. Nevill further remarked that the form figured by von Martens (fig. 22) as *L. lagotis* also belonged to this form; in the specimens from Leh he found specimens which formed "every conceivable connecting link," though the columella "graduates from even a more rounded shape than figure 22 B to the straight (or slightly bent-back) form of figure 24 A." Weber¹ considered both the varieties *costulata* and *subdisjuncta* of von Martens to be only variations of *striata* Andreae. Annandale & Rao, with whose conclusions I agree, however, considered this form to differ from *striata* Andreae in its longer spire and having the mouth less expanded and less variable in shape. The columellar fold is, further, a little broader than in the var. *striata*.

In the collections of the Yale North India Expedition this form is represented from the following localities:—

- | | | |
|----------|---|----------------|
| K 15, 19 | Gagribal, Kashmir; alt. ca. 5,190 ft. | 7 specimens. |
| | Closed swamp. 31. iii. 32. | |
| L 14 | Spitok, Kashmir; alt. ca. 10,730 ft. | 4. 1 specimen. |
| | vii. 32. | |
| L 38 | 3 miles west of Mugleb, W. Tibet; alt. ca. 13,700 ft. | 15 specimens. |
| | Drying pool with <i>Potamogeton</i> . 27. vi. 32. | |
| L 73 | Chushol, W. Tibet; alt. ca. 13,700 ft. | 3 specimens. |
| | 2nd pond below village. 9. viii. 32. | |

Form **solidissima** Kobelt.

1872. *Limnaea lagotis* var. *solidissima*, Kobelt, *Malakozool, Blätt.* XIX, p. 77, pl. ii, figs. 17, 18.
 1877. *Limnaea lagotis* var. *solidissima*, Kobelt in *Rossmässler Icon. Land Süssw. Moll.* V, p. 38, pl. cxviii, fig. 1242.
 1878. *Limnaea lagotis* (in part), Nevill, *Sci. Res. Second Yarkand Mission, Mollusca*, p. 7.
 1925. *Limnaea lagotis* var. *solidissima*, Annandale & Rao, *Rec. Ind. Mus.* XXVII, p. 154, figs. I, 3, 5.

Kobelt in describing the var. *solidissima* from a shell from the Himalayas remarked "Ueber das vorkommen dieser Form habe ich genaueres leider in Erfahrung bringen können; wahrscheinlich sind die Verhältnisse denen ähnlich, unter welchen *L. obliquata* vorkommt, und mit Sicherheit glaube ich ihre Heimath in einem See suchen zu müssen." Nevill surmised that Kobelt's type-specimen of the var. *solidissima* probably came from Lake Pankong. He apparently considered *solidissima* to be a variety of *L. lagotis*, but from this account it is not clear

¹ Weber, A.—*Abhandl. Königl. Bay. Akad. Wiss. (Math. phys. kl.)*, XXVI, p. 25, (1913).

as to whether he is dealing with the typical form of *L. lagotis* or the var. *solidissima*. Annandale & Rao remarked on the great variability of this thick-shelled form and added that "it probably lives in water of abnormal chemical composition." The figures of Kobelt represent a young shell, while very good figures of two adult shells showing the major variations in the form of the spire and the mouth aperture are published in Annandale & Rao's paper.

This form is represented in the collections of the Yale North India Expedition from the following localities :—

L 39	Tsar Tso, W. Tibet ; alt. 13,950 ft. 28. vi. 32.	3 specimens.
L 40	Panggong Tso, W. Tibet ; alt. 13,915 ft. "Upper Shell-Bed under Moraine," 28.vi.32.	17 shells (mostly bleached).
	Top Shell-Bed between Man-Spangmik, W. Tibet ; bottom shore about 1 mile from western bare end. 1.vii.32.	21 shells.
	Top Shell-Bed at Man, W. Tibet. 5.vii. 32.	12 shells.
L 72	Chushol, W. Tibet ; alt. 14,228 ft. Large pond. 1.viii.32.	1 specimen.
	Near L 72. 14.vii.32	2 specimens.

Form *defilippii* Issel.

1865. *Limnaea defilippii*, Issel, *Mem. Real. Accad. Sci. Torino*, (2) XXIII, p. 45, pl. iii, figs. 62, 63.

1925. *Limnaea lagotis* var. *defilippii*, Annandale & Rao, *Rec. Ind. Mus.* XXVII, p. 156, fig. 1, 9.

Issel in describing his species from Lake Goktscha (alt. 5,500 ft.) in Armenia remarked that it appears to be intermediate between *L. stagnalis* and *L. auricularia*, while von Martens in the *Zoological Record* for 1865 (p. 279) added "almost too closely allied to *L. stagnalis* L." Nevill¹ in describing a new variety, *sirikulensis*, remarked "This is perhaps the most remarkable of the Yarkand species of *Limnaea* and the further removed from the typical forms of *L. auricularia* and *L. lagotis*, even more so than typical *L. defilippii*. As justly pointed out by Issel, it is intermediate between the above group and that of *L. stagnalis*." Annandale & Rao rightly considered Issel's species to be a form of *L. lagotis*, and after remarking on its general resemblance to the form *subdisjuncta* Nevill² stated that it is distinguished by its larger and more fragile shell and an additional whorl in the spire.

The specimens, which I assign to this form, have an elongate, scalariform spire distinctly marked off from the moderately tumid body-whorl ; in some specimens the spire is more elongate than others, while in others with a more channeled suture it is somewhat sunk into the body-whorl. The suture is generally moderately impressed and greatly slanting towards the posterior end of the mouth. The surface of the shells bears vertical costae almost as strong as in the form *costulata* von Martens, and in addition is decussately malleated, particularly in the region of

¹ Nevill, G.—*Sci. Res. Second Yarkand Mission, Mollusca*, p. 7 (1878).

² Nevill, G.—*op. cit.* p. 9 (1878).

the body-whorl. The aperture is more or less ovate with its outer margin almost regularly arched. I give below the measurements (in millimetres) of three specimens from an irrigation trench at Rampur (St. K 1):—

Total length	19	18.6	18
Maximum breadth	14.4	14.7	14.5
Length of aperture	12.8	14	14
Breadth of aperture	10.2	10.5	11
Length of spire (dorsal)	5.8	4.5	4.8
Breadth of base of spire	6	5.8	5.5

This form is represented in the collections of the Yale North India Expedition from :—

- K 1 Rampur, Kashmir ; alt. ca. 4,000 ft. In 13 specimens in spirit.
irrigation trench and fields. 18.iii.
32.
- K 34 Phashakuri near Pampur, Kashmir ; alt. 3 dry shells.
ca. 5,200 ft. 7. v. 32.

***Lymnaea brevicauda* Sowerby.**

1873. *Limnaea brevicauda*, Reeve, *Conch. Icon.* XVIII, pl. xv, sp. 105.
1876. *Limnaea brevicauda*, Hanley & Theobald, *Conch. Ind.* p. 64, pl. clvii,
fig. 7.
1915. *Limnaea (Gulnaria) brevicauda*, Preston, *Faun. Brit. Ind. Freshw. Moll.*
p. 111.
1925. *Limnaea brevicauda*, Annandale & Rao, *Rec. Ind. Mus.* XXVII, p. 156,
fig. I, 6.

As pointed out by Annandale & Rao “ this is one of the commonest molluscs in the lakes of the Kashmir Valley, to which the species is perhaps confined.” The type-specimen was stated by Sowerby to be from Australia, but the error was corrected by Hanley & Theobald. The anatomy and relationships of the species are discussed in detail by Annandale & Rao.

In the collections of the Yale North India Expedition the species is represented from :—

- K 3 Lokut Dal Lake, Kashmir ; alt. 5,190 ft. 5 specimens in spirit.
- K 42 Wular Lake, Kashmir ; alt. 5,160 ft. 21 specimens (13 in spirit,
8 dry shells).

Subgenus *Galba* Schrank.

1803. *Galba*, Schrank, *Fauna Boica*, III, pt. 2, pp. 262, 285.
1911. *Galba* (in part), Baker, *Chicago Acad. Sci.*, Sp. Publ. III, p. 199.
1925. *Galba*, Annandale & Rao, *Rec. Ind. Mus.* XXVII, p. 161.
1926. *Galba*, Kennard & Woodward, *Synonymy Brit. Non-Marine Moll.* p. 42.

The synonymy of the subgenus *Galba* is dealt with at length by Kennard & Woodward. I follow Annandale & Rao in restricting this subgenus to forms which can be distinguished by the great development of the columellar fold of the shell.

In the collection under report the subgenus is represented by the type-species *L. truncatula* (Mull.).

Lymnaea truncatula (Müll.).

1774. *Buccinum truncatulum*, Müller, *Verm. Terr. Fluv. Hist.* II, p. 130.
 1862. *Limnaeus truncatulus*, Küster in *Martini Chemnitz Conch. Cab.* I, Ab. 17b, *Limnaeus* etc., p. 17, pl. iii, figs. 24-27.
 1878. *Limnaea truncatula* (in part) Nevill, *Sci. Res. Second Yarkand Mission*, Mollusca, p. 10.
 1882. *Limnaea truncatula*, von Martens, *Mem. Acad. Imp. Sci. St. Petersbourg*, (7) XXX, No. 11, p. 41.
 1911. *Limnaea* (*Limnophysa*) *truncatula*, Andreae in *Futterer Durch Asien*, III, p. 77.
 1925. *Limnaea truncatula*, Annandale & Rao, *Rec. Ind. Mus.* XXVII, p. 161, fig. V, 3, 4, 5.
 1926. *Limnaea* (*Galba*) *truncatula*, Kennard & Woodward, *Synonymy Brit. Non-Marine Moll.* p. 59.
 1935. *Lymnaea* (*Galba*) *truncatula*, Mozley, *Trans. Roy. Soc. Edinburgh*, LVIII, p. 630.

Mozley sums up the geographical range of the species as "Europe including Iceland, Northern Africa; Northern Asia, Afghanistan, Kashmir; Alaska, Aleutin Islands, Yukon." Annandale & Rao recorded it from Leh in Little Tibet and from Chitral.

In the collections of the Yale North India Expedition the species is represented from the following localities:—

K 77	Dras, Kashmir; alt. 10,144 ft. In a stream. 22. v. 32.	7 specimens.
L 3	Kangral, Kashmir; alt. ca. 11,100 ft. 27 v. 32.	6 specimens.
L 14	Spitok, Kashmir; alt. 10,730 ft. 4. vi. 32.	17 specimens.
L 18	Gulam Bagh, Chushod, Kashmir; alt. ca. 10,600 ft. In a pond. 10. vi. 32.	5 specimens.
L 19	2 miles east of L 18; alt. ca. 10,600 ft. 10. vi. 32.	4 specimens.

All the above collecting stations are situated in Kashmir in the area adjoining Western Tibet.

Family PLANORBIDAE.

Genus **Planorbis** Geoffroy.

1767. *Planorbis*, Geoffroy, *Traité Coq.* p. 12.
 1774. *Planorbis*, Müller, *Verm. Terr. Fluv. Hist.* II, p. 152.
 1905. *Planorbis*, Dall, *Harriman Alaska Exped.* XIII, p. 80.
 1921. *Planorbis*, Germain, *Rec. Ind. Mus.* XXI, p. 1.
 1922. *Planorbis*, Annandale, *Rec. Ind. Mus.* XXIV, p. 360.
 1924. *Planorbis*, Kennard & Woodward, *Proc. Malacol. Soc. London*, XVI, p. 9.
 1925. *Planorbis*, Kennard & Woodward, *Synonymy Brit. Non-Marine Moll.* p. 66.
 1931. *Planorbis*, Baker, *Proc. Zool. Soc. London*, p. 583.

As is clear from the publications cited above, there has been a great deal of difference of opinion regarding the genotype of *Planorbis* and the author to whom this genus should be assigned. Kennard & Woodward consider Geoffroy (1767) as the author of the genus with *Planorbis planorbis* (Linn.) as its genotype, while Dall, Germain and recently Baker, who has discussed the question at length, all assign the genus *Planorbis* to Müller and regard *Planorbis corneus* (Linn.) as its genotype. I follow Kennard & Woodward in the following notes.

Planorbis planorbis (Linn.).Var. **tangitarenis** Germain.

1878. *Planorbis* (*Anisus*) *subangulatus* (?) var. (? n. species), Nevill, *Hand-List Moll. Ind. Mus.* 1k p. 243.
 1878. *Planorbis* (*Tropidiscus*) *subangulatus* var., Nevill, *Sci. Res. Second Yarkand Mission, Mollusca*, p. 11.
 1918. *Planorbis* (*Tropidiscus*) *planorbis* var. *tangitarenis*, Germain, *Bull. Mus. Hist. Nat. Paris*, XXIV, p. 276.
 1921. *Planorbis* (*Tropidiscus*) *planorbis* var. *tangitarenis*, Germain, *Rec. Ind. Mus.* XXI, p. 77, pl. iv, figs. 3, 4, 8.

Germain's account may be consulted for a detailed description of this interesting variety. It was described from specimens collected by the Second Yarkand Expedition at North Tangitar.

The Yale North India Expedition collected 18 specimens at St. K 24—Nishat Bagh, Kashmir; alt. ca. 5,200 ft.; in a pond. These specimens agree in all respects with the types of the variety from North Tangitar.

I also assign, with some doubt, 3 incomplete casts of shells collected from St. K 10(2)—Pampur, Kashmir; alt. ca. 5,200 ft. Exposure along the Jhelum River opposite Island north of Pampur; 4. iii. 32.

Genus **Gyraulus** Charpentier.

1837. *Gyraulus*, Agassiz *Ms.* in De Charpentier, *Denkschr. Schweiz. Gesell. Nat. Neuchatel*, I, p. 21.
 1922. *Gyraulus*, Germain, *Rec. Ind. Mus.* XXI, p. 98.
 1922. *Gyraulus*, Annandale, *Rec. Ind. Mus.* XXIV, p. 361.

Germain regards *Gyraulus* Agassiz as a subgenus of *Planorbis* Mull., but I follow Annandale in classing it as distinct genus.

Gyraulus pankongensis (Nevill) von Martens.

1878. *Planorbis* (*Gyraulus*) *albus* (in part), Nevill, *Hand-List Moll. Ind. Mus.* I, p. 245.
 1878. *Planorbis* (*Gyraulus*) *albus* var. Nevill, *Sci. Res. Second Yarkand Mission, Mollusca*, p. 10.
 1882. *Planorbis Pankongensis*, von Martens, *Mem. Acad. Imp. Sci. St. Petersburg*, (7) XXX, No. 11, p. 45, pl. iv, figs. 14a-c.
 1890. *Planorbis* (*Gyraulus*) *pankongensis*, Westerlund, *Faun. Paläarct. Region Bimenconch*, Suppl. 1, p. 149.
 1910. *Planoris* (*Gyraulus*) *pankongensis*, Weber, *Zool. Jahrb. (Syst.)* XXIX, p. 306.
 1918. *Planorbis* (*Gyraulus*) *pankongensis*, Germain, *Bull. Mus. Hist. Nat. Paris*, XXIV, p. 280.
 1922. *Planorbis* (*Gyraulus*) *pankongensis*, Germain, *Rec. Ind. Mus.* XXI, p. 110.
 1925. *Gyraulus pankongensis*, Prashad, *Rec. Geol. Surv. Ind.* LVI, p. 359.

Nevill, though he recorded the specimens from the Lake Pankong as *P. (G.) albus* var., had given them the manuscript name *pankongensis*, and it was under this name that the species was described by von Martens from material sent to him by Nevill. Weber recorded some specimens collected by Zugmayer from the same Lake as *P. (G.) pankongensis*, but considered it to be only a local form of *P. glaber* Jeffr. and not of *P. albus* Müll., as the specimens did not show any spiral sculpture. Germain discussed the species at great length and was of opinion that von Martens was not justified in comparing this species with the South American *P. andecolus* d'Orbigny or the African *P. choanomphalus* von Martens. He considered it to be allied to *G. ladacensis* Nevill, but suggested that

“ par sa forme générale et son enroulement, plus étroitement apparenté aux *Gyraulus* de la fauna européenne.”

The Yale North India Expedition collected specimens of the species from the following localities :—

- | | |
|------|--|
| K 10 | Pampur, Kashmir; alt. ca. 5,200 ft. 7 complete, bleached shells.
Exposure along Jhelum river. 25.
iii. 32. |
| K 34 | Phashakuri, Kashmir; alt. ca. 5,200 ft. 9 specimens.
7. v. 32. |
| K 46 | Bakh Hajan, Kashmir; alt. ca. 5,170 ft. 2 specimens.
Jhil. 19. iv. 32. |
| L 14 | Spitok, Kashmir; alt. ca. 10,600 ft. 6 specimens.
Marsh. 4. vi. 32. |
| L 18 | Chushod, Kashmir; alt. ca. 16,600 ft. 4 specimens.
Gulam Bagh. 10. vi. 32. |
| L 19 | 2 miles east of L 18 3 specimens. |
| L 36 | Between Durbuk and Tangtse, W. Tibet; 8 specimens.
alt. ca. 13,000 ft. In a pond. |
| L 38 | Between Tangtse and Mugleb, W. Tibet; 12 specimens.
alt. ca. 13,700 ft. 27. vi. 32. |
| L 40 | Panggong Tso, W. Tibet; alt. 13,915 ft. 51 shells, mostly bleached.
Upper Shell-Bed under moraine. 25.
vi. 32. |

I have assigned the specimens from Stations K 10, K 34 and K 46 to this species with some doubt; they may represent a distinct species, but the material at my disposal is not sufficient for deciding this point.

***Gyraulus ladacensis* Nevill.**

1878. *Planorbis (Gyraulus) laevis* var. *ladacensis*, Nevill, *Sci. Res. Second Yarkand Mission, Mollusca*, p. 10.
 1882. *Planorbis Nevilli*, von Martens, *Mem. Acad. Imp. Sci. St. Petersbourg*, (7) XXX, No. 11, p. 35.
 1890. *Planorbis (Gyraulus) Nevilli*, Westerlund, *Faun. Paläarct. Region Biménconch*, Suppl. I, p. 149.
 1918. *Planorbis (Gyraulus) ladacensis*, Germain, *Bull. Mus. Hist. Paris*, XXIV, p. 278.
 1921. *Planorbis (Gyraulus) ladacensis*, Germain, *Rec. Ind. Mus.* XXI, p. 112.

I have nothing to add to the detailed account of this species by Germain.

The Yale North India Expedition collected this species from the following localities :—

- | | |
|------|--|
| | Between Man-Spangmik, W. Tibet; alt. 10 bleached shells.
ca. 14,000 ft. Top Shell-Bed. 1. vii.
32. |
| L 47 | Lung-Yun, W. Tibet; alt. 16,331 ft. 38 specimens.
Chagra Warm Spring. 8. vii. 32. |

Family SUCCINEIDAE.

Genus ***Succinea*** Draparnaud.

1801. *Succinea*, Draparnaud, *Tabl. Moll. Terr. Fluv. France*, p. 55.
 1914. *Succinea*, Gude, *Faun. Brit. Ind. Mollusca II (Trochomorphidae-Janelidae)*, p. 445.
 1924. *Succinea*, Rao, *Rec. Ind. Mus.* XXVI, p. 377.

In the following notes on the specimens of the genus *Succinea* collected by the Yale North India Expedition, I have followed the excellent monograph of Rao cited above. All the specimens in the collection belong to the amphibious species, *Succinea indica* Pfeiffer.

***Succinea indica* Pfeiffer.**

1849. *Succinea indica*, Pfeiffer, *Proc. Zool. Soc. London*, p. 133.
 1914. *Succinea indica*, Gude, *Faun. Brit. Ind. Mollusca* II (Trochomorphidae-Janellidae), p. 447.
 1924. *Succinea indica*, Rao, *Rec. Ind. Mus.* XXVI, p. 378, pl. xxviii, figs. 4-9.

Gude and Rao may be consulted for detailed information regarding the form of the shell and anatomy of this variable species.

The Yale North India Expedition collected shells of the species from the following localities :—

- | | | |
|----------|---|--------------|
| K 15, 19 | Gagribal, Kashmir; alt. ca. 5,190 ft. | 6 specimens. |
| | Closed swamp. 31. iii. 32. | |
| K 34 | Phashakuri, Kashmir; alt. ca. 5,200 ft. | 3 specimens. |
| | 7. v. 32. | |
| K 46 | Bakh Hajan, Kashmir; alt. ca. 5,170 ft. | 1 specimen. |
| | Jhil. 19. iv. 32. | |
| K 51 | Bod Dal. Kashmir. 2. v. 32 | 5 specimens. |

PELECYPODA.

Order *EULAMELLIBRANCHIATA*.

Family CORBICULIDÆ.

In view of the fact that the generic name *Cyrena* Lam., as generally understood by most authors, is an absolute synonym of *Corbicula* Megerle,¹ Thiele² has suggested the family name Corbiculidae for Cyrenidae.

Genus ***Corbicula*** Megerle von Müblfeldt.

1928. *Corbicula*, Prashad, *Mem. Ind. Mus.* IX, p. 14.

For the synonymy and distribution of the Asiatic species reference may be made to my paper cited above. In the collection before me the genus is represented by a single species—*C. cashmiriensis* Deshayes.

***Corbicula cashmiriensis* Deshayes.**

1854. *Corbicula cashmiriensis*, Deshayes, *Proc. Zool. Soc. London*, p. 344.
 1910. *Corbicula fluminalis* var. *oxiana*, Weber, *Zool. Jahrb. Syst.* XXIX, p. 308.
 1928. *Corbicula cashmiriensis*, Prashad, *Mem. Ind. Mus.* IX, p. 20, pl. iii, figs. 14-18.

In my paper cited above I dealt with *C. cashmiriensis* in detail and pointed out the characters in which it differs from *C. fluminalis* (Müll.). The species, as pointed out in the paper cited above, is confined to Kashmir where it occurs in River Jhelum and the waters connected

¹ See Prashad B.—Lamellibranchia of the Siboga Expedition. Systematic Part II, Pelecypoda exclusive of the Pectinidae. *Siboga Expeditie*, LIIIC, p. 174 (1932).

² Thiele, J.—*Handb. Syst. Weichtierkunde*, II, p. 850 (1935).

with. Weber recorded specimens of the species from Wular Lake as *C. fluminalis* var. *oxiana*,

The Yale North India Expedition collected a single specimen of the species from St. K 1—Rampur, Kashmir ; alt. ca. 4,000 ft.; in an irrigation trench ; 18. iii. 32.

Genus **Pisidium** Pfeiffer.

1821. *Pisidium*, Pfeiffer, *Naturg. Deutsch. Moll.* I, pp. 17, 123.

1925. *Pisidium*, Prashad, *Rec. Ind. Mus.* XXVII, p. 407.

1933. *Pisidium*, Prashad, *Rec. Ind. Mus.* XXXV, pp. 1-8, pl. i.

The Indian and Tibetan species of the genus *Pisidium* are dealt with in detail in my papers cited above. The Yale North India Expedition collected the following species from Kashmir and Western Tibet :—*P. hydaspicola* Theobald, *P. zugmayeri* Weber, and *P. stoliczkanum* Prashad.

Pisidium hydaspicola Theobald.

1878. *Pisidium hydaspicola*, Theobald, *Journ. As. Soc. Bengal*, XLVII, p. 147.

1925. *Pisidium hydaspicola*, Prashad, *Rec. Ind. Mus.* XXVII, p. 414, pl. vii, figs. 5-7, pl. viii, fig. 5.

This species, which belongs to the subgenus *Eupisidium* Odhner, is confined to the Kashmir Valley. For detailed descriptions of the shell, animal and its distribution reference may be made to my paper cited above.

The Yale North India Expedition collected specimens of the species from the following localities :—

K 10 One mile north of Pampur, Kashmir ; 3 shells in dried mud.
alt. ca. 5,200 ft. Exposure along
bank of Jhelum River. 25. iii. 32.

K 24 . Nishat Bagh, Kashmir ; alt. ca. 5,200 ft. Pond. 7. iv. 32. 20 specimens.

In addition there is a badly damaged shell from St. K 76—1 mile west of Dras, alt. ca. 10,000 ft., which probably also belongs to this species.

Pisidium stoliczkanum Prashad.

1933. *Pisidium stoliczkanum*, Prashad, *Rec. Ind. Mus.* XXXV, p. 5, pl. i, figs. 7, 8.

A detailed description of this interesting species from Yarkand was published in my paper cited above.

The Yale North India Expedition collected 5 valves from the Top Shell-Bed between Man-Spangmik, Western Tibet ; alt. ca. 14,000 ft. ; 1. vii. 37.

Pisidium zugmayeri Weber.

1910. *Pisidium* (*Fossarina*) *zugmayeri*, Weber, *Zool. Jahrb. Syst.* XXIX, p. 310.

1935. *Pisidium zugmayeri*, Prashad, *Rec. Ind. Mus.* XXXV, pl. i, figs. 1, 2.

This species was described from the Pankong Lake (Panggong Tso of Yale North India Expedition), Western Tibet, by Weber, while figures of the shell and hinge are published in my paper cited above.

The Yale North India Expedition collected with an Eckman Grab 2 complete shells and a right valve from St. L 78 —Yaye Tso, Western Tibet, alt. 15,373 ft. ; 19.viii.32.

Genus **Sphaerium** Scopoli.

1777. *Sphaerium*, Scopoli, *Introd. Hist. Nat.* p. 397.

1921. *Sphaerium*, Prashad, *Rec. Ind. Mus.* XXII, p. 614.

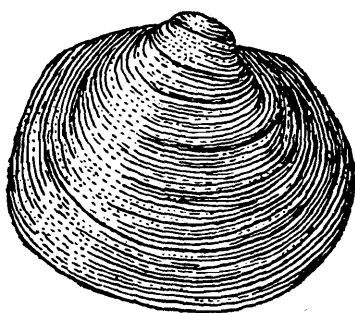
1925. *Sphaerium*, Kennard & Woodward, *Synonymy Brit. Non-Marine Moll.* p. 300.

1927. *Sphaerium*, Pilsbry & Bequaert, *Bull. Amer. Mus. Nat. Hist.* LIII, p. 347.

Pilsbry & Bequaert are certainly wrong in stating that the genus *Sphaerium* is restricted mainly "to the Holarctic Region and is not known from the Oriental and Australian Regions." In the paper cited above I listed three species from India, *S. montanum* T. Canefri¹ from Burma, while *S. borneense* (Sowerby) and *S. cecilae* Prashad² are known from Borneo and Sumatra. The Yale North India Expedition collected a new species from the Wular Lake, Kashmir, which I describe below as *S. kashmirensis*.

***Sphaerium kashmirensis*, sp. nov.**

Shell subquadrate, moderately swollen, sub-equilateral, moderately thick, anterior half of upper margin short, nearly straight, posterior part somewhat longer, markedly sloping ; anterior margin evenly curving down to the very slightly arched lower margin ; posterior margin slightly arched in the upper region, then sharply truncate. Umbones very prominent, very tumid, incurved, almost touching in the middle line. Epidermis of a light olive colour in the major part of the shell, of a yellowish colour along the margin, shining, with well marked, closely situated concentric striae, those in the regions of growth much better developed. Hinge apparently as in other species.



Type shell of *Sphaerium kashmirensis*, sp. nov. ×6.

Measurements (in millimetres).

	Holotype.	Single valve.
Length	6	5.8
Breadth	5.3	4.9
Thickness	3	..

¹ See Prashad, B.—*Rec. Ind. Mus.* XXII, p. 630, figs. 36, 37, (1921).

² Prashad, B.—*Rec. Ind. Mus.* XXII, p. 505, fig. 17, (1921).

Locality.—A complete shell, the holotype, and a left valve with a broken right valve were collected by the Yale North India Expedition at St. K 42—Wular Lake, Kashmir, alt. ca. 5,180 ft. ; Kiuhnus, dredged in 0.5-10 metres of water, on 18.iv.32.

S. kashmirensis appears to be allied to *S. montanum* T. Canefri from Burma, but is relatively shorter, with its anterior and posterior margins straighter and its sculpture more strongly developed.

Sphaerium sp.

A young complete shell and a broken valve of a species were collected on 4.vii.32 by the Yale North India Expedition from a swamp at St. L 14—Spitok, Kashmir, alt. 10,730 ft.

The shells differ from *S. kashmirensis* in their being less quadrate, and they probably represent another species. With the very limited material available, I, however, do not propose describing it as a new species.

APPENDIX.

GASTROPODA.

Family AMNICOLIDAE.

Bulimus (Alocinma) stenothyroides (Dohrn).

1857. *Bithynia stenothyroides*, Dohrn, *Proc. Zool. Soc. London*, p. 123.
 1870. *Bythinia stenothyroides*, Hanley & Theobald, *Conch. Ind.* p. 18.
 1884. *Bythinia stenothyroides*, Nevill, *Hand-List Moll. Ind. Mus. II*, p. 37.
 1915. *Bithynia stenothyroides*, Preston, *Faun. Brit. Ind., Freshw. Moll.* p. 77.
 1920. *Amnicola (Alocinma) stenothyroides*, Annandale, *Rec. Ind. Mus. XIX*, p. 43.

Dohrn's *Bithynia stenothyroides* was assigned by Annandale to the subgenus *Alocinma* Annandale & Prashad¹ of the genus *Amnicola* Gould, but as Pilsbry & Bequaert² have shown, *Alocinma* is not related to *Amnicola*, but belongs to the subfamily Buliminae, and should be treated as a subgenus of *Bulimus* Scopoli.

This species is, as was remarked by Nevill, extremely variable in the form of the spire and whorls. Extreme forms are easily distinguished but intermediate types are hard to separate from the allied species.

In the collections made by the Yale North India Expedition the species is represented by two typical shells collected at St. N 6—a pool near milestone 4 on Marimund—Connamara Rd., alt. ca. 7,500 ft., Nilgiri Hills, Peninsular India.

The species, which was described from Ceylon, has a wide range in Peninsular India, having been recorded from Madras, Trichinopoly, South Arcot, the Nilgiris, and Poona.

¹ Annandale, N. & Prashad, B.—*Rec. Ind. Mus.* XVIII, p. 23 (1919).

² Pilsbry, H. A. & Bequaert, J.—*Bull. Amer. Mus. Nat. Hist.* LIII, p. 213 (1927).

Family LYMNAEIDAE.

Genus **Lymnaea** Lam.Subgenus **Pseudosuccinea** Baker.1911. *Pseudosuccinea*, Baker, *Chicago Acad. Sci.*, Sp. Publ. III, p. 162.1925. *Pseudosuccinea*, Annandale & Rao, *Rec. Ind. Mus.* XXVII, p. 171.

Specimens of two species of this subgenus, viz., *L. acuminata* Lam. and *L. luteola* Lam. were collected by the Yale North India Expedition in the Punjab and the Nilgiri Hills.

Lymnaea acuminata Lam.1822. *Lymnaea acuminata*, Lamarck, *Hist. Nat. Anim. sans Verteb.* VI (2), p. 160.1858. *Lymnaea acuminata*, Lamarck, *Hist. Nat. Anim. sans Verteb.* (Ed. II), VIII, p. 411.1922. *Lymnaea acuminata*, Annandale & Prashad, *Rec. Ind. Mus.* XXII, p. 568, pl. vii, figs. 1-3, text-fig. 12.1925. *Lymnaea acuminata*, Annandale & Rao, *Rec. Ind. Mus.* XXVII, p. 177, fig. III.

The great variability in the form of the shell of this Indian species and its varieties is fully discussed by Annandale and Prashad and Annandale and Rao in the papers cited above.

In the collections of the Yale North India Expedition the species is represented by the forms :—*typica* Lam. and *hians* Sowerby.¹

The exact localities for the two forms are as follows :—

Form **typica** Lam.

P 2 Sohawa, Rawalpindi Dist., Punjab. 22 specimens.
4.iii.32.

Form **hians** Sowerby.

N 5 Ootacamund, Nilgiri Hills, South India ; 3 specimens.
north margin of Lake. 8.xi.32.

Lymnaea luteola Lamarck.1822. *Lymnaea luteola*, Lamarck, *Hist. Nat. Anim. sans Verteb.* VI (2), p. 160.1858. *Lymnaea luteola*, Lamarck, *Hist. Nat. Anim. sans Verteb.* (Ed. II), VIII, p. 411.1925. *Lymnaea luteola*, Annandale & Rao, *Rec. Ind. Mus.* XXVII, pp. 106, 183, fig. IV.

This interesting species is discussed in detail by Annandale and Rao in the papers referred to above. It is widely distributed in India, Burma and Ceylon.

In the collections of the Yale North India Expedition it is represented by the form *ovalis* Gray² from the following localities :—

Ootacamund, Nilgiri Hills ; alt. ca. 23 specimens.
7,400 ft. Pond beyond cemetery.
N 16 Avalancho, Nilgiri Hills, S. India ; alt. 9 specimens.
6,500 ft. 14.xi.32.

¹ For full details regarding these species reference may be made to the paper by Annandale & Rao cited above, pp. 180 and 182 respectively.

² For reference to this form see Annandale & Rao, *loc. cit.*, p. 184 (1925).

Family PLANORBIDAE.

Genus **Indoplanorbis** Annandale & Prashad

1921. *Indoplanorbis*, Annandale & Prashad, *Rec. Ind. Mus.* XXII, p. 578.
 1923. *Indoplanorbis*, Rao, *Rec. Ind. Mus.* XXV, pp. 199-219, figs. 1-14.
 1931. *Indoplanorbis*, Baker, *Proc. Zool. Soc. London*, p. 587.
 1933. *Indoplanorbis*, Baker, *Journ. Morphol.* LV, pp. 1-9, pls. i, ii.

This genus was established by Annandale and the present author for the common large Planorbid of India, *Indoplanorbis exustus* (Deshayes), and the work of Rao and Baker on the anatomy of the species has fully upheld the separation of this species from the genus *Planorbis* Geoffroy.

Indoplanorbis exustus (Deshayes).

1834. *Planorbis exustus*, Deshayes, *Voyage Belanger Indes-Orient. Zool.*, p. 417, pl. i, figs. 11-13.
 1921. *Planorbis exustus*, Prashad, *Rec. Ind. Mus.* XXII, p. 472.
 1921. *Indoplanorbis exustus*, Annandale & Prashad, *id.*, p. 580.
 1921. *Planorbis* (*Planorbis*) *exustus*, Germain, *Rec. Ind. Mus.* XXI, p. 26, pl. i, figs. 4-9; pl. iv, figs. 11, 17, 18, text-figs. 1-11, 13-16.

The great variation in the form of the shell of this highly variable species is discussed at length by Germain and Annandale and Prashad, while the anatomy has been described by Annandale and Prashad, Rao and Baker.

The Yale North India Expedition collected a single young shell of this species from St. P 2—Sohawa, Rawalpindi Dist. Punjab; alt. 1,734 ft.; 4.iii.32.

Genus **Gyraulus** Charpentier.**Gyraulus convexiusculus** (Hutton).

1850. *Planorbis convexiusculus*, Hutton, *Journ. As. Soc. Bengal*, (2) XVIII, p. 657.
 1919. *Gyraulus convexiusculus*, Annandale & Prashad, *Rec. Ind. Mus.* XVII, p. 52, fig. 7B.
 1921. *Planorbis* (*Gyraulus*) *convexiusculus* and *P. (G.) saigonensis*, Germain, *Rec. Ind. Mus.* XXI, pp. 118, 119.

For detailed synonymy and description of the species reference may be made to the publications cited above. *G. convexiusculus* has a very wide range from "Lower Mesopotamia through Eastern Persia, Afghanistan and Northern India to Upper Burma, French Indo-China, China, Japan and the Malay Archipelago."

The Yale North India Expedition collected specimens of *G. convexiusculus* from the following localities:—

	Calcutta, Bengal; from an artificial fountain in Dalhousie Square.	1 specimen.
	30.x.32.	
P 2	Sohawa, Punjab; alt. 1,734 ft.	4.iii.32 9 specimens.
P 9	Khabakki Kabar, Punjab; alt. 2,481 ft.	12.iii.32 1 specimen.

Gyraulus sp.

A young specimen of *Gyraulus* from St. N 15—Ootacamund, Nilgiri Hills, cannot be identified specifically.

PELECYPODA.

Genus **Pisidium** Pfeiffer.**Pisidium clarkeanum** G. & H. Nevill.

1871. *Pisidium clarkeanum*, G. & H. Nevill, *Journ. As. Soc. Bengal*, XL, pl. ii, p. 9; pl. i, figs. 4, 4a-d.

1925. *Pisidium clarckeanum* (*sic*), Prashad, *Rec. Ind. Mus.* XXVII, p. 408, text-figs. 1-3, pl. vii, figs. 1, 2; pl. viii, figs. 1, 2.

For a detailed description of this species reference may be made to my paper cited above. *P. clarkeanum* is widely distributed in India and Burma.

The Yale North India Expedition collected 2 specimens of this species from St. N 2—Ootacamund, Nilgiri Hills; alt. 7,400 ft.; in a pond, on 10.xi.32.

STUDIES ON INDIAN ITONIDIDAE (CECIDOMYIDAE : DIPTERA)¹.

IV.—EIGHT NEW MIDGES.

By M. S. MANI, M.A., Gallery Assistant, Zoological Survey of India,
Indian Museum, Calcutta.

The new species of midges described in this paper were mostly caught by Mons. Vitale Menasché's Entoray machine, which was recently tried in Calcutta. The catches contain several well known genera not previously recorded from India. I have also included the descriptions of two other species, one found swarming in the laboratories of the Imperial Agricultural Research Institute, New Delhi, and the other bred from the univalve galls of *Eagle marmelos*.

Lestremia calcuttaensis, sp. nov.

Female.—Length 1.75 mm. Orange. Palpus moderately setose; not counting the palpiger segments four; first segment rather stout, of a length about twice its diameter; second segment nearly equal in length to the first but more slender; third and fourth segments more slender, probably equal to each other and about twice the length of the second segment, differing in these respects from *L. indica* Kieff.² in which fourth palpal segment is twice the length of third. Length of terminal antennal segment about four times its diameter, with a more or less distinct constriction at basal fourth. Mesonotum dark brown. Anterior metatarsus about as long as the next three tarsal segments combined. Posterior tibia one and one fourth times the combined length of the first two tarsal segments. Claws simple, slender, slightly curved. Empodium very short. Terminal lamellae of ovipositor subquadrate, broadly rounded apically, length about one and one fourth the breadth, densely setose.

Holotype.—One female dissected on a slide in the collections of the Zoological Survey of India, Indian Museum, Calcutta, No. 1311/H6. Trapped by 'Entoray', Portland Park, Calcutta, 13-vii-1936.

This new species differs from the two other Indian species *L. indica* Kieff. and *L. ceylonica* Kieff.³ mainly in the length of palpal segments, short, subquadrate terminal lamellae of ovipositor and much longer terminal antennal segment.

Micromyia indica, sp. nov.

Male.—Length about 1.5 mm. Palpus triarticulate; first segment much stouter and shorter than the rest, its thickness nearly equal to length; second more slender, twice the length of first, stouter apically

¹ Part III of this series was published in *Rec. Ind. Mus.*, XXXVIII, pp. 193-197, (1936).

² Kieffer, *Rec. Ind. Mus.*, III, p. 29, (1909).

³ Kieffer, *Spol. Zeyl.*, VIII, p. 29, (1912).

than basally; terminal segment nearly one and one third times the first, subfusiform and somewhat stout apically. Antennae somewhat less than one fifth the length of body, reduced apically; segments 10; third and fourth segments globose; fifth pyriform; sixth, seventh and eighth subcylindrical and with a distinct stem, about half the enlargement; ninth and tenth segments fused together. Mesonotum dark brownish to black. Scutellum brown, post scutellum lighter. Abdomen grey above and paler below and at the sides. Claws slender, long, sickle-shaped. Basal clasp segment of genitalia stout, short. Terminal clasp segment subfusiform, about one third the basal segment, apically armed with a short, slightly curved, sharp spine. Dorsal plate somewhat longer than basal clasp segment, apically bilobed and emarginate.

Holotype.—One male dissected on a slide No. 1312/H6.

Paratypes.—Several examples in spirit No. 1323/H6. Genitalia of one example is mounted on a slide.

Holotype in the collections of the Zoological Survey of India, Indian Museum, Calcutta and paratypes in the collections of the Zoological Survey and the Imperial Agricultural Research Institute, New Delhi.

Received from the Imperial Entomologist, New Delhi, with the label: 'Found swarming in laboratory compound, Coll. H. L. Bhatia, 28-ii-1937, I. A. R. I., New Delhi.'

***Neolasioptera variipalpis*, sp. nov.**

Female.—Length of body varies between 1-2 mm. Bright reddish brown in colour. Palpus densely scaled, quadriarticulate; first segment short; second about twice longer and somewhat stouter; third more slender, either equal to or one and a half times the second, intermediate proportions are met with in a larger series of individuals; fourth either about twice the third or almost equal to (sometimes slightly longer than) the third; usually, however, the third and fourth are nearly equal and each about one and a half times the second. Occasionally the second, third and fourth are all equal. Antenna about half the length of body, segments 19, moderately hairy; fifth segment about three fourths the fourth, which latter is equal to third; terminal segment subglobose and slightly longer than the penultimate segment. Mesonotum dark reddish brown. Scutellum lighter than mesonotum. Wings about two and a half times as long as broad; third vein reaching costa at about basal two thirds. Claws long, slender, unidentate; tooth long, evenly curved; empodium much shorter than claws. Abdomen reddish brown. Ovipositor longer than body.

Holotype.—One female in spirit in the collections of the Zoological Survey of India, Indian Museum, Calcutta, No. 1313/H6.

Paratypes.—Several examples mounted in canada balsam in the collections of the Zoological Survey of India, Indian Museum, Calcutta, Nos. 1314-H/6.

Trapped by 'Entoray', Portland Park, Sahapur Yard, Gun Foundry, Cossipur and Sonarpur, Calcutta, 19-vi-1931 to July 1936.

This species resembles *N. crataevae* Mani¹ in colour of body, in the absence of scaly spots and markings on abdomen and costa, but differs in the fewer antennal segments and more slender claws. From *N. cephalandrae* Mani², which it resembles in the number of palpal segments, it is readily distinguished by the unspotted abdomen and wings, fewer antennal segments and relatively longer third vein, which unites with costa well beyond the basal half of wing. There is a considerable variation in the relative proportions of the third and fourth palpal segments, size of body and wings.

***Asphondylia menaschéi*, sp. nov.³**

Male.—Length about 2 mm. Reddish brown, Palpi triarticulate ; first segment short, subquadrate ; second segment of a length about two and a half times its diameter ; third segment twice the second, with moderately dense, long and slender setae. Antennae reddish brown ; third segment of a length about four to five times its diameter ; fourth segment somewhat longer than third ; fifth segment of a length about three and a half times its diameter. Mesonotum dark reddish brown. Genitalia moderately setose, dark brown ; basal clasp segment stout ; apical clasp segment very short, basally swollen very much and bidentate apically ; the teeth short, black and greatly diverging. Claws as long as empodium.

Female.—Length about 2.5 mm. Reddish brown. Palpi triarticulate ; first segment short, stout ; second segment longer, somewhat stouter apically than basally, with long straight, stiff setae ; third segment about twice the length of second, more slender, also with long stiff setae. Fifth segment of antennae of a length about five times its diameter and also about five sixths that of fourth. Mesonotum dark brown. Dorsal basal pouches of ovipositor moderately large. Claws as long as empodium.

Holotype.—One male dissected on a slide No. 1315/H6.

Allotype.—One female dissected on a slide No. 1316/H6.

Paratype.—One male dissected on a slide No. 1317/H6. In the collections of the Zoological Survey of India, Indian Museum, Calcutta. Trapped by 'Entoray', Portland Park, Calcutta, 13—17-vii-1936.

This species runs with *A. pongamiae* Felt in my key⁴ to the Indian species of *Asphondylia*, agreeing with it in the terminal clasp segment of male genitalia but differing in the following characters : second palpal segment of a length slightly greater than twice its diameter ; third palpal segment just twice the second, without stout but slender, moderately dense setae ; fifth antennal segment of a length about four and half times its diameter.

¹ Mani, *Rec. Ind. Mus.*, XXXVI, p. 399, (1934).

² Mani, *Ibid.*, p. 397.

³ I have great pleasure in associating with this species the name of Mons. Vitale Menasché, the inventor of the Entoray, which trapped many gall midges.

⁴ Mani, *Rec. Ind. Mus.*, XXXVI, pp. 408-409, (1934).

Hormomyia calcuttaensis, sp. nov.

Female.—Length 2.5 mm. Reddish brown. Palpi short, segments (including palpiger) three, the terminal segment somewhat longer than the rest and broadly rounded apically, the other segments are equal. Antennae about half the length of body; segments 14; third segment with a subcylindrical enlargement having a length about six times its diameter, stem about one sixth the length of the enlargement; fifth segment with a stem about four fifths the length of the segment, the enlargement of a length about four times its diameter; terminal segment sharply constricted in its apical third, forming a small oval part about half the length of the rest of the segment. Circumfili in two irregular whorls, the basal whorl is usually more irregular than the apical. Mesonotum dark reddish brown. Halteres long, the club much longer than the pedicel. Legs dark reddish brown. Claws simple, long, moderately stout, about three fourths the length of empodium. Abdomen reddish brown. Ovipositor long, terminal lamellae of a length about two and a half times its breadth, narrowly rounded apically.

Holotype.—One female dissected on a slide No. 1318/H6.

Paratypes.—Three females dissected on slides Nos. 1319/H6. One claw of one of the paratypes is abnormal, being forked to a short length.

In the collections of the Zoological Survey of India, Indian Museum, Calcutta. Trapped by 'Entoray', Portland Park, Calcutta, 4—9-vii-1936.

This species differs from the two other Indian species, *H. ischaemi* Felt¹ and *H. subaptera* Felt² in the antennal segments of female having only two instead of three whorls of circumfili, agreeing, however, in the number of antennal segments. The species is also further distinguished from *H. subaptera* by the wings being long and narrow as is usual in the genus *Hormomyia*.

Trishormomyia indica, sp. nov.

Female.—4 mm. long. Reddish. Palpi triarticulate (including the palpiger); second segment nearly equal to the basal but more slender; third segment slender and about twice the second. Antennae reddish brown; segments 15 (?); third segment distinctly constricted a little below the basal half, with a stem about one-fifth the subcylindrical enlargement, circumfili in two whorls; fourth segment about three fourths the length of third, its stem equal to that of third; fifth segment equal to fourth, with apparently only two whorls of circumfili, the basal whorl situated between the basal one fourth to basal half and the apical whorl near the tip of enlargement; sixth segment somewhat shorter than the fifth, its stem equal to that of the fifth. Mesonotum dark reddish brown. Scutellum lighter than mesonotum. Legs dark reddish brown. Claws stout, evenly curved, simple, somewhat shorter than or equal to the narrow, long empodium. Abdomen long,

¹ Felt, *Pusa Bull.*, No. 89, p. 46, (1920).

² Felt, *Mem. Dept. Agri. Ind. Ent. Ser.*, IX, p. 224, (1926).

deep reddish orange. Ovipositor long, terminal lobes moderately broad, short and oval.

Holotype.—One female dissected on a slide in the collections of the Zoological Survey of India, Indian Museum, Calcutta, No. 1320/H6. Trapped by 'Entoray', Portland Park, Calcutta, 14-vii-1936.

***Orseoliella bengalensis*, sp. nov.**

Male.—Length about 2.75-3 mm. General colour dark brown. First palpal segment short, stout, subglobose; second segment more slender than others, about twice the length of first; third segment about one and one fourth the length of second; fourth nearly equal to third and broadly rounded apically; all segments moderately clothed with long setae. Antennal segments 14; fifth segment with a basal globose and an apical subcylindrical enlargement, the latter of a length about twice its diameter, more or less distinctly constricted in the middle; stems about one and a half to twice their diameters; apical subcylindrical enlargement of seventh and the following segments often constricted in the middle so that these segments appear trinodose. Mesonotum dark brown or dark reddish brown. Legs densely hairy. Claws moderately stout, evenly curved, much longer than the empodium. Abdomen yellowish to brownish, densely hairy. Genitalia densely hairy; dorsal plate heavily chitinated, deeply bilobed, lobes with rounded apical angles; ventral plate longer than dorsal plate, broadly rounded apically and somewhat narrowly emarginate at sides and subapically; basal clasp segment about twice as long as the ventral plate, with a large, obtuse, basal inner lobe; terminal clasp segment about half to three fourths the length of the basal clasp segment, moderately stout, slightly reduced and curved apically; style as long as or longer than ventral plate.

Holotype.—One male dissected on a slide in the collections of the Zoological Survey of India, Indian Museum, Calcutta, No. 1321/H6. Trapped by 'Entoray', Portland Park, Calcutta, 20-vi-1936.

Paratypes.—Two examples on slides, Nos. 1324-25/H6.

This species has a general resemblance to *O. aphudae* Felt¹ but is readily distinguished by the smaller size and free dorsal and ventral plates.

***Cecidomyia dattai*, sp. nov.²**

Female.—Length 1.75-2 mm. General colour of body reddish brown. Palpi long, quadriarticulate, moderately setose; first segment short, quadrate; second segment over twice the length of first, somewhat stout; third segment nearly equal to second; fourth segment about one and a half times the length of third, somewhat slender. Antennae about half the length of body, with 14 cylindrical segments; third and

¹ Felt, *Mem. Dept. Agric. Ind.*, Ent. Ser., VII, p. 8, (1920).

² *Cecidomyia* is employed here as a group name and not in the sense of *Itonida* Meig. Vide Felt, *Bull. N. Y. St. Mus.*, No. 257, p. 15, (1925); *Mem. Dept. Agric. Ind. Ent.*, Ser., VII, pp. 11, 27, (1920-1); X, pp. 2-3, (1927); Mani, *Rec. Ind. Mus.*, XXXVIII, p. 196, (1936). I associate with this species the name of my friend and colleague Mr. M. N. Datta, who reared the midge from its galls.

fourth segments fused together ; fifth segment of a length about twice its diameter, stem about one fifth the length of segment ; sixth to twelfth segments nearly equal ; thirteenth segment somewhat shorter than twelfth, its stem nearly equal ; terminal segment somewhat longer than thirteenth, with an apical prolongation about two seventh the total length. Mesonotum black, submedian lines scarlet, thickly haired. Wings hyaline, neither narrow nor broad, with three longitudinal veins, third vein uniting with costa beyond apex, fourth vein obsolete, fifth vein faint apically. Legs pale brown, densely hairy. Claws simple on all legs, not strongly curved, slightly shorter than empodium. Abdomen reddish brown. Ovipositor exserted, long ; terminal lamellae ovate.

Holotype.—One female dissected on a slide in the collections of the Zoological Survey of India, Indian Museum, Calcutta. No. 1322/H6. Coll. M. S. Mani and M. N. Datta, Pulta Pumping Station, near Barrackpore, Calcutta, 5-vi-1936.

Notes.—This species produces the univalve galls on the leaflets of *Eagle marmelos* Corr. described in an earlier paper¹. When mature, the larvae escape from the gall through the slit-like opening, wander about and drop to the ground. They enter the soil and pupate in cocoons at depths varying from half to two inches from the surface. The adults emerge from the ground in five to seven days. Before they burrow into the soil, the larvae are subject to attacks of enemies, the most common one being the Indian house sparrow. It picks off the larvae from the ground and thus destroys a large number of them.

¹ Mani, *Rec. Ind. Mus.*, XXXVII, p. 444, (1935).

A REVISION OF THE INDIAN CHALCID WASPS OF THE SUB-FAMILY LEUCOSPIDINAE (PARASITIC HYMENOPTERA)¹.

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This paper is a resumé of my three years' work on the Indian Leucospidinae and represents the results of studies on practically all the material available in India. Fortunately unlike most other groups of the Chalcidoidea, the paratypes of several of the Indian species of Leucospidinae are available in this country. Through the courtesy of the authorities of the various institutions, I have been able to examine the valuable collections of the Zoological Survey of India, Indian Museum, Calcutta ; Imperial Agricultural Research Institute, New Delhi and the Agricultural College and Research Institute, Coimbatore. Dr. T. V. Ramakrishna Ayyar, late Government Entomologist, Madras, also very generously placed at my disposal his extensive collections of Leucospids. As a result, except for Cameron's species, which have not been recognised since they were first described, I have examined all the species so far described from India. In two earlier papers (15, 16) I have described seven new species and recorded one well known species for the first time from India. I also recently described the male of *Leucospis bengalensis* Weld, which was described from females only. Of the sixteen species dealt with in this paper one is new to science ; several of these species are redescribed, and notes on distribution and inter-relationships are added. A key to Indian species of *Leucospis* Fab. is also given. In the bibliography, the more important papers are arranged chronologically under authors, bringing the literature up to date.

I take this opportunity of recording my grateful thanks to Dr. Bains Prashad, Director, Zoological Survey of India, Indian Museum, Calcutta, for guidance, facilities for work and constant encouragement ; to Dr. T. V. Ramakrishna Ayyar, late Government Entomologist, Madras, for his valuable suggestions and for donations and loan of valuable material ; to Dr. Hem Singh Pruthi, Imperial Entomologist, Imperial Agricultural Research Institute, New Delhi and Mr. M. C. Cherian, Government Entomologist, Agricultural College and Research Institute, Coimbatore for loan of material for study.

LEUCOSPIDINAE.

The subfamily Leucospidinae is one of the easily recognised groups of the Chalcidoidea. Its members, mostly parasitic in the nest of bees, are found in all parts of the world, though the species are more numerous in the tropics than in the temperate regions. It comprises over two hundred species of the genera *Leucospis*, *Polistomorpha*, *Marres* and *Epexochlaenoides*.

Leucospids were recognised as a distinct group by Walker, though Dalla Torre (6) incorrectly gave the credit to Förster. Early workers

¹ This paper was prepared and submitted as a thesis for the M. A. degree in Research of the University of Madras in March, 1937.

like Walker, Haliday, Förster, etc., treated the group as a separate family. Howard (12) and Ashmead (1) recognised their close relationship to the Chalcidinae and placed them with the latter in the family Chalcididae. In 1890, Schletterer (19) comprehensively monographed the subfamily and recorded sixty species in three genera *Leucospis* (57 spp.), *Polistomorpha* (2 spp.) and *Marres* (1 sp.). In 1898, Dalla Torre (6) recorded eighty species from different parts of the world in his *Catalogus Hymenopterorum*; several of these species have, however, been regarded as synonyms by later workers. Crésson (5), Howard (12) and Ashmead (1) described several American species. Klug (14) made several additions to the European species. Kirby (13) also characterised the genera and described some species from England and other places. Ashmead (1) tabulated the genera in his monumental work on the classification of the Chalcid flies, and later Schmiedeknecht (20) monographed the subfamily in the *Genera Insectorum* series. Girault (11) studied the Australian forms and erected some new genera and species, most of which are not, however, valid. Weld (27) published a monographic revision of the Leucospidinae of the world, which is still a standard work of reference in the group.

Very little work has, however, been done on this group in India. *Leucospis guzeratensis* Westwood, the first species of the Leucospidinae to be recorded from India, was described by Westwood in 1839. Later on in 1906, Cameron (4) described two Indian species. In 1912, Enderlein (9) described one species from Ceylon. In 1922, Weld (27) described three Indian species, and in 1925, Brues (2) recorded one species from Malabar, South India. Several Indian species were recently described by me and altogether sixteen species have been recorded from India so far.

Leucospids are usually robust-bodied Chalcids, ranging in length from about 5 mm. to 15 mm. Pronotum is usually large. Black is the predominating colour, but most species are also conspicuously spotted or marked yellow, orange, red and sometimes white. Fore wings, while not in use, are longitudinally folded as in the Vespidae, which is an unusual feature among the Chalcids. Hind coxa and femur are very much swollen, the latter is also armed beneath with teeth. Hind tibia is strongly arched and always shorter than hind femur. Abdomen is elliptical or obovate in the lateral view; usually swollen behind the middle in the dorsal view; and sometimes subcompressed apically. Ovipositor is usually long, exserted, reflexed over the dorsum of abdomen, sometimes reaching forward to the scutellum of thorax. These characters readily serve to distinguish the Leucospidinae from the closely related Chalcidinae.

Genus **Polistomorpha** Westwood.

- 1839. *Polistomorpha*, Westwood, *Zeitschr. Entomol.*, I (2), p. 265.
- 1862. *Polistomorpha*, Walker, *Journ. Entomol.*, I, p. 22.
- 1874. *Polistomorpha*, Westwood, *Thesaur. Entomol. Oxon.*, p. 133.
- 1890. *Polistomorpha*, Schletterer, *Berlin. Entomol. Zeitschr.*, XXXV, p. 292.
- 1904. *Polistomorpha*, Ashmead, *Mem. Carnegie Mus.*, I (4), pp. 247, 402.
- 1906. *Polistomorpha*, Ducke, *Bull. Soc. Entomol. France*, pp. 163-166.
- 1909. *Polistomorpha*, Schmiedeknecht, *Gen. Ins.*, fas. 97, p. 14.
- 1922. *Polistomorpha*, Weld, *Proc. U. S. N. Mus.*, LXI, art. 6, p. 4.
- 1935. *Polistomorpha*, Mani, *Rec. Ind. Mus.*, XXXVII, pp. 242-243.

Polistomorpha was erected as a subgenus of *Leucospis* Fab. in 1839 by Westwood for his species *surinamensis*; it was raised to a generic rank by Walker in 1860. Since then seven species have been described: *sphegoides* Walker¹ and *fasciata* Westwood² from the Amazon; *nigri-maculata* Cameron³ from Panama; *nitidiventris* Ducke⁴ from Europe; and *indica* Mani and *paivai* Mani (*vide infra*) from India. In 1922, Weld transferred the Mexican species *bulbiventris* Cresson⁵ from the genus *Leucospis* to *Polistomorpha*.

The genus has a wide range of distribution, though the species appear to be more numerous in the tropics than in the temperate regions. Of the two Indian species one is known from North and the other from South India.

The genus can be recognised by the following characters: Vertex not cornuted, posterior margin of head straight or nearly so; third antennal segment as long as or longer than second; pronotum equally broad both anteriorly and posteriorly; scutellum normal, never heart-shaped; central part of metathorax projecting; hind coxae with or without a strong erect spur above; abdomen spindle-shaped, never compressed, with or without median longitudinal furrow towards the posterior end, pointed apically; ovipositor limited to the underside of abdomen.

Polistomorpha is readily distinguished from *Marres* Walk. by its non-cornuted head. From *Leucospis* Fab. and *Epexochlaenoides* Gir. it is separated by the fact that the ovipositor is not reflexed over the dorsum of abdomen but lies on the under side.

The relationship of the Indian species to the other known species is shown in the key below, which is modified from Ducke (7).

Key to species.

- I. Hind coxa unspurred above; usually small species
 - A. Hind femur with over 10 teeth, first tooth large, rest small; carina on pronotum faint *P. bulbiventris* (Cresson).
 - B. Hind femur with only 5 teeth; first tooth small, second, third and fourth long, fifth large and tridenticulate; single well developed carina on pronotum *P. indica* Mani.
- II. Hind coxa spurred above; or at least with a carinate upper edge; usually large species
 - A. Hind femur with 8 teeth, first larger than the rest; two transverse carinae on pronotum *P. paivai* Mani.
 - B. Hind femur with only 6-7 teeth; first tooth larger than the rest
 - 1. Body black *P. sphegoides* Walker.
 - 2. Body testaceous
 - a. Fourth tergite of abdomen shiny, with a coarse punctation; first tooth of hind femur triangular *P. nitidiventris* Ducke.

¹ Walker, *Journ. Entomol. London*, I, p. 22, (1862).

² Westwood, *Thesaur. Entomol. Oxon.*, p. 133, (1874).

³ Cameron, *Trans. Amer. Entomol. Soc.*, XXX, p. 96, (1904).

⁴ Ducke, *Bull. Soc. Entomol. France*, p. 165, (1906).

⁵ Cresson, *Trans. Amer. Entomol. Soc.*, IV, p. 29, (1872).

- b. Fourth tergite of abdomen somewhat opaque, with a fine punctation ; first tooth of hind femur very long and sharp *P. fasciata* Westwood.
- c. Fourth tergite of abdomen opaque, finely and densely punctate ; first tooth of hind femur large and triangular *P. surinamensis* Westwood.

Polistomorpha indica Mani.

1935. *Polistomorpha indica*, Mani, *Rec. Ind. Mus.*, XXXVII, pp. 243-244, fig. 1.
 1936. *Polistomorpha indica*, Mani, *Rec. Ind. Mus.*, XXXVIII, p. 338.

This species was originally described from a specimen from Yercaud, South India, in a collection of Chalcids received from Dr. T. V. Ramakrishna Ayyar. The female is easily recognised by the presence of a single well developed transverse carina on the pronotum posteriorly parallel to its hind margin, with two transverse elliptic yellow spots at its ends. There is also a somewhat broad, transverse, complete yellowish band anteriorly on the pronotum. Dorsum of abdomen has three transverse, yellow bands. Hind femur has four simple and one (fifth) compound teeth. The upper edge of hind femur is bordered by a broad yellow band on the outer side ; there is also a longitudinal, oblong, yellow spot on the outer side just above the third, fourth and first part of the fifth teeth. The male is unknown.

Polistomorpha paivai Mani.

1936. *Polistomorpha paivai*, Mani, *Rec. Ind. Mus.*, XXXVIII, p. 338.

This species is closely related to *P. indica* Mani, from which, however, it is easily distinguished by the following characters : There are two transverse carinae on pronotum parallel to its hind margin, which is also carinate. Hind femur has eight teeth, the last one being compound. There is a single yellow, transverse band on the carina on pronotum. Hind femur has only a single irregularly-shaped yellow spot outside at the base and not extending to apex. There are only two transverse yellow bands on the dorsum of abdomen.

No females of the species have been discovered so far.

Described from a specimen in the collections of the Zoological Survey of India, Indian Museum, Calcutta, bearing the label : " Coll. Paiva, Katihar, Purneah Dist., 4-viii-1907 "

Genus **Leucospis** Fabricius.

1775. *Leucospis*, Fabricius, *Syst. Entomol.*, I, p. 361.
 1874. *Leucospis*, Westwood, *Thesaur. Entomol. Oxon.*, p. 135.
 1890. *Leucospis*, Schletterer, *Berlin. Entomol. Zeitschr.*, XXXV, p. 141.
 1894. *Exochlaenus*, Shipp, *Entomologist*, XXVII, p. 16.
 1904. *Leucospis*, Ashmead, *Mem. Carnegie Mus.*, I (4), p. 247.
 1909. *Leucospis*, Schmiedeknecht, *Gen. Ins.*, fas. 97, p. 14.
 1922. *Leucospis*, Weld, *Proc. U. S. N. Mus.*, LXI, art. 6, pp. 4-35.
 1935. *Leucospis*, Masi, *Boll. Soc. Entomol. Italiana*, LXVII, pp. 36-43.
 1935. *Leucospis*, Mani, *Rec. Ind. Mus.*, XXXVII, p. 244.

This genus was erected by Fabricius in 1775 and was comprehensively dealt with by Schletterer in his monograph on the genera *Leucospis*,

Polistomorpha and *Marres*. In 1894, Shipp transferred the species *L. anthioides* Westw. to his new genus *Exochlaenus*; and this was accepted by Ashmead and Schmiedeknecht. In his recent monograph on the Leucospidinae, Weld has reunited under *Leucospis* all the species referred to *Exochlaenus*, which according to him is not distinct from the former. From a study of the various Indian species Dr. Ramakrishna Ayyar and I agree with Weld's view.

Body more or less robust. Head triangular in the front view; vertex not cornuted; cheek long, not converging below; posterior margin of head curved inwards; maxillary palpi quadriarticulate; labial palpi triarticulate; mandibles short and broad. Eyes large. Antennae slightly thickened apically, with 12 segments. Pronotum nearly of equal width both anteriorly and posteriorly. Mesonotum longer than pronotum in the median line, at least never shorter. Scutellum never heart-shaped. Metanotum either rounded or with a spinous process apically. Hind coxa with or without a spur above. Hind femur with less than twenty teeth, which are never minute or comb-like. Fore tibia with one spur; hind tibia with two spurs. Abdomen elliptic or obovate in the lateral view, more or less compressed sub-apically; the apex rounded. Ovipositor reflexed over the dorsum of abdomen.

Abdomen is composed of eight tergites, not counting the median segment (propodium), but several of the tergites are more or less telescoped and hidden from view. First tergite is narrow and ring-like, forming a short constricted portion between the median segment and the second (the *first* apparent) tergite. Second tergite is well developed and in some species is longer in the median line than the others. Third and fourth tergites are usually telescoped together but the former is distinctly visible in the female of *L. indiensis* Weld. Fourth and fifth are together shorter than the second tergite. Sixth tergite is usually the largest. Seventh is small and is easily recognised by its conspicuous spiracle. Eighth varies according to sex; in female it consists of two halves, enclosing the ovipositor. In male several of the tergites are more or less fused together.

Species of *Leucospis* are parasitic in the nests of bees and attack *Chalicodoma*, *Megachile*, *Anthidium* and *Osmia*. No work has been done so far on the biology of any Indian species.

Leucospis guzeratensis Westwood¹, described in 1839, was the first species of *Leucospis* recorded from India. Eleven more species and one variety have since been described from different parts of India: *nursei* Cameron² and *quettaensis* Cameron² from Quetta; *viridissima* Enderlein³ from Ceylon; *malabarensis* Brues⁴ from Malabar, South India; *indiensis* Weld⁵ from Coimbatore; *bengalensis* Weld⁶ from Pusa; *mee-nakshiae* Mani⁷ from Tanjore; *bombayensis* Mani⁸ from Bombay;

¹ Westwood, *Zeitschr. Entomol.*, I (2), p. 253, (1839).

² Cameron, *Journ. Bombay Nat. Hist. Soc.*, XVII, pp. 91-92, (1906).

³ Enderlein, *Entomol. Mitteil.*, I (5), p. 144, (1912).

⁴ Brues, *Psyche*, XXXII, p. 27, (1925).

⁵ Weld, *Proc. U. S. N. Mus.*, LXI, art. 6, p. 20, (1922).

⁶ Weld, *ibid.*, p. 32.

⁷ Mani, *Rec. Ind. Mus.*, XXXVII, p. 244, (1935).

⁸ Mani, *ibid.*, p. 246.

ramakrishnai Mani¹ from Pusa and *assamensis* Mani² from Assam. *L. ornatifrons* Weld,³ originally described from the Philippines also occurs in South India. *L. bengalensis* var. *mackenziei* Mani² is known from Chapra, Bihar.

A key to all the species so far described from India is given below. Cameron's two species *nursei* and *quettaensis* are placed in the key from Cameron's descriptions only. All the species so far described from India have one or two transverse carinae on pronotum parallel to its hind margin, which latter is also sometimes carinate. The following nine species have a single carina on pronotum: *L. indiensis* Weld, *L. darjilingensis*, sp. nov., *L. ornatifrons* Weld, *L. malabarensis* Brues, *L. viridissima* Enderlein, *L. meenakshiae* Mani, *L. nursei* Cameron and *L. quettaensis* Cameron.

Key to species.

- | | |
|---|-------------------------------------|
| 1. Pronotum with only <i>one</i> transverse carina parallel to its hind margin | 2. |
| Pronotum with <i>two</i> transverse carinae parallel to its hind margin | 11. |
| 2. Ovipositor reflexed over the dorsum of abdomen but not reaching the hind margin of the second (first apparent) tergite of abdomen | 3. |
| Ovipositor reflexed over the dorsum of abdomen, reaching forward beyond the hind margin of the second tergite of abdomen | 4. |
| 3. Ovipositor nearly touches the anterior margin of the sixth tergite; pronotal carina faint; hind coxa with a sharp angle above; metanotum rounded apically | <i>L. indiensis</i> Weld. |
| 4. Metanotum simple, rounded posteriorly | 5. |
| Metanotum produced or spined (bidentate) | 10. |
| 5. Ovipositor reaches forward a little of the middle of the second tergite | <i>L. darjilingensis</i> , sp. nov. |
| Ovipositor reaches forward of front margin of the second tergite | 6. |
| 6. Ovipositor reaches metanotum, small species | <i>L. ornatifrons</i> Weld. |
| Ovipositor reaches forward beyond metanotum | 7. |
| 7. Ovipositor reaches forward beyond the apex of scutellum | <i>L. malabarensis</i> Brues. |
| Ovipositor reaches apex of scutellum | 8. |
| 8. Pronotum reticulately sculptured, length of female 12.5 mm., colour metallic | <i>L. viridissima</i> Enderlein. |
| Pronotum umbilicately or rugosely punctate | 9. |
| 9. Spots and markings mostly reddish in colour; length of female 9.25 mm.; pedicel of antenna about half the length of the first funicular segment; fourth funicular about three fourths length of third; mesopleura with a large sub-triangular spot | <i>L. meenakshiae</i> Mani. |
| Spots and markings gamboge yellow; length of female 10 mm.; pedicel of antenna less than half the length of the first funicular segment; fourth funicular equal to third; mesopleura unspotted | <i>L. assamensis</i> Mani. |

¹ Mani, *Rec. Ind. Mus.*, XXXVII, p. 248, (1935).

² Mani, *Rec. Ind. Mus.*, XXXVIII, p. 338, (1936).

³ Weld, *Proc. U. S. N. Mus.*, LXI, art. 6, p. 22, (1922).

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|--|--|
| 10. Hind femur with 8 teeth | <i>L. nursei</i> Cameron. |
| Hind femur with 10 teeth | <i>L. quettaensis</i> Cameron. |
| 11. Ovipositor does not reach the middle of second tergite of abdomen | 12. |
| Ovipositor reaches forward of the middle of the second tergite of abdomen | 13. |
| 12. Length of female 11-12 mm. ; propodium with distinct median keel and prominent lateral carinae ; hind femur with 10 teeth | <i>L. bengalensis</i> Weld. |
| Length of female 9.5 mm. ; propodium without median keel and lateral carinae ; hind femur with 11 teeth | <i>L. bengalensis</i> var. <i>mackenziei</i> Mani. |
| 13. Sixth tergite of abdomen most usually with spots or markings, rarely without | 14. |
| Sixth tergite of abdomen always without spots or markings | <i>L. guzeratensis</i> Westwood. |
| 14. Length of female 5.5 mm. ; with numerous white spots and markings | <i>L. bombayensis</i> Mani. |
| Length of female 10 mm. ; with a few pale yellow or yellow spots ; sixth tergite is rarely unspotted ; hind femur always unspotted ; pubescence of abdomen as in <i>L. guzeratensis</i> Weld | <i>L. ramakrishnai</i> Mani. |

***Leucospis indiensis* Weld.**

1922. *Leucospis indiensis*, Weld, *Proc. U. S. N. Mus.*, LXI, art. 6, p. 20, pl. iii, fig. 19.

1935. *Leucospis indiensis*, Masi, *Boll. Soc. Entomol. Italiana*, LXVII, (3), p. 41.

1936. *Leucospis indiensis*, Mani, *Rec. Ind. Mus.*, XXXVIII, p. 339.

This species was originally described by Weld from a female collected by Dr. Ramakrishna Ayyar at Coimbatore, South India. I recently recorded this species from the Sunderbans, Bengal. Masi has recently described the male.

This species is easily recognised by the single, faint, transverse carina on pronotum, ovipositor reaching only the anterior margin of the sixth tergite of abdomen, sharply angled hind coxa and apically rounded metanotum. From the closely related *L. ornatifrons* Weld this species is readily distinguished by its much larger size, ovipositor not reaching metanotum and by colouration.

Female.—Length 10.5-11.25 mm. Head somewhat wider than the anterior margin of pronotum, densely clothed with silvery white pubescence ; finely, closely and rugosely punctate. Inner border of eyes more pronouncedly sinuate than in *L. guzeratensis*. Ocelli reddish brown, the front one placed outside the antennal fovea. Vertex more or less striated on the outer side of lateral ocelli. Occipital carina, though distinct between eyes, disappears behind them. Pronotum with long, faint, transverse carina, parallel to its hind margin and covered by a white, pale yellow or yellow band ; the anterior white or yellow band on pronotum is long, and follows its front margin ; it is separated from the front margin of pronotum by a distance about twice that between the posterior band and posterior margin of pronotum ; punctation rugose. Scutellum umbilicately punctate. Metanotum rounded apically. Spiracular areas of propodium densely clothed with long, silvery white pubescence. Hind coxa with a sharply angled upper margin, where there is no punctation.

Abdomen reddish towards the base ; in the dorsal view narrowed just in front of and swollen behind middle, compressed apically ; in the lateral view broadest in the middle, depressed apically. Ovipositor very nearly touches the anterior margin of sixth tergite ; its groove is rather deep.

General colour of body black ; spotted or marked white, pale yellow or yellow as follows : Narrow, long transverse bands anteriorly and posteriorly on pronotum ; the posterior band shorter than the anterior ; a semi-circular spot on the smooth polished postero-median area of propodium ; two small subtriangular spots postero-laterally on second tergite ; one narrow band posteriorly on sixth tergite ; fore femur apically above ; outer basal half of fore tibia ; base and apex of middle tibia ; there is a broad irregular band near basal tooth of hind femur and extends across front and upper margin to apex ; outside of hind tibia apically.

***Leucospis darjilingensis*, sp. nov.**

This new species is easily distinguished from the closely related *L. ornatifrons* Weld, *L. meenakshiae* Mani and *L. assamensis* Mani by its relatively shorter ovipositor and spotted eighth tergite of abdomen.

Female.—Length 8 mm. Head somewhat wider than the anterior width of pronotum ; not narrow in dorsal view ; frons rugosely sculptured, moderately densely pubescent ; line from front ocellus to lower border of clypeus nearly equal to the greatest distance between eyes ; outer edges of scapal furrows faintly carinate ; eyes very slightly sinuate ; front ocellus outside the scapal furrows ; postocellar space nearly equal to the ocellocular ; occipital carina faint ; striations on the outer side of lateral ocellus rather prominent. Pronotum about three fourths the length of mesonotum in the median line, with one faint transverse carina parallel to its hind margin, which is also rather faintly carinate. Pro- and mesonotums closely rugosely punctate. Front half of thorax bent downwards. Scutellum broadly rounded apically. Propodium slightly longer than the metanotum in the median line, without a median keel but with lateral carinae and hairy spiracular areas. Hind coxa closely and minutely punctate. Hind femur about twice as long as wide, closely setigerous, punctate ; teeth five ; first tooth small ; second long and blunt ; third and fourth longer and sharper than second ; fifth tridenticulate. Fore wings faintly clouded apically.

Seen from above, abdomen has a length about twice its greatest width ; second tergite longest, with a single median longitudinal furrow for ovipositor ; third and fourth tergites covered. Seen from the side, abdomen is straight along the dorsum, narrow basally, wide apically ; finely punctate, pubescence more dense apically than elsewhere. Ovipositor reaches the basal one fourth of second tergite.

Body spotted or marked yellowish brown as follows : A broad band, irregular in width, which begins near the front, where it is broadest, extends across upper margin to apex ; a stripe posteriorly from the base to apex of hind tibia on the outer side ; scape of antennae below ; and two oblong, oblique stripes on eighth tergite. Other spots and markings are brick red as follows : Frons between eyes and antennal foveae,

broader below than above; spur between the antennal foveae (scapal furrows); broad, curved, transverse band anteriorly on pronotum; a darker band on the pronotal carina posteriorly; a curved band at posterior margin of scutellum; elongated spot on metapleura; short stripes above and below on fore femur; fore tibia in front; fore tarsus; middle tibia in front; middle tarsus; hind coxa at base above and at apex below; hind tarsus; pair of oblique bands on second tergite, beginning antero-medially and running latero-posteriorly, narrow at base and broad apically; narrow transverse band on fifth tergite; broad transverse band posteriorly on sixth tergite. Propodium unspotted.

Holotype.—One pinned female, Mus. Coll., Darjiling, Himalayas, 1000-3000 ft., May, 1912. Reg. No. 1571/H3. In the collections of the Zoological Survey of India, Indian Museum, Calcutta.

***Leucospis ornatifrons* Weld.**

1922. *Leucospis ornatifrons*, Weld, *Proc. U. S. N. Mus.*, LXI, art. 6, p. 22.

1935. *Leucospis ornatifrons*, Masi, *Boll. Soc. Entomol. Italiana*, LXVII, p. 41.

1935. *Leucospis ornatifrons*, Mani, *Rec. Ind. Mus.*, XXXVII, p. 245.

This species was described by Weld from Manila, Philippine Islands and was later recorded by Masi from Borneo and other places. It is represented by one specimen in a collection of Leucospids from South India received about three years ago from Dr. Ramakrishna Ayyar, bearing the label "Coll. T. V R., Salem, 2-8.xii.1914"

This is a small species (length about 6-7 mm.) with a single carina on pronotum, in which respect it resembles *L. darjilingensis*, but it is easily distinguished from the latter species by its rather long ovipositor reaching metanotum. Face has a conspicuous yellowish marking. Sixth tergite of abdomen and pleurae are spotted. Median segment is unspotted.

***Leucospis malabarensis* Brues.**

1925. *Leucospis malabarensis*, Brues, *Psyche*, XXXII, p. 27.

This is a medium-sized species easily recognised by the single pronotal carina, carinate posterior margin of pronotum, ovipositor reaching forward of the apex of scutellum, apically rounded metanotum and yellow and ferruginous markings. Frons minutely and reticulately sculptured. Outer edges of scapal furrows are distinctly carinate. Basal tooth of hind femur is small, the next three long and widely separated, fifth shorter, sixth compound. Pleurae and spiracular areas of propodium have long, villous, silvery white pubescence.

According to Brues this species differs from *L. nursei* Cam. and *L. quettaensis* Cam. in the apically rounded metanotum. The species is known from Malabar, South India.

***Leucospis viridissima* Enderlein.**

1912. *Leucospis viridissima*, Enderlein, *Entomol. Mitteil.*, I, p. 144.

This Ceylonese species is distinguished from all the other Indian species so far described by its metallic colouration. From *L. malabarensis* it is further distinguished by its much larger size (length 12.5

mm.) and shorter ovipositor. Pronotum reticulately sculptured; mesonotum and scutellum are also similarly sculptured. Head, thorax, abdomen, legs, antennal scapes and sheath of ovipositor are deep metallic green; dorsum of thorax and anterior part of abdomen are not, however, metallic.

***Leucospis meenakshiae* Mani.**

1935. *Leucospis meenakshiae*, Mani, *Rec. Ind. Mus.*, XXXVII, pp. 244-246, fig. 2.

This species very closely resembles *L. ornatifrons* Weld, from which, however, it is easily distinguished by the relatively longer ovipositor, clouded fore wings and other characters. Spots and markings are usually more reddish or orange than yellow.

Female.—Head transverse, slightly wider than the anterior margin of pronotum; frons rugosely punctate, shortly pubescent; outer edges of scapal furrows distinctly carinate; there are two faint depressions a little below the lower level of scapal furrows; line from the front ocellus to the lower level of clypeus about equal to the greatest distance between eyes; malar space about one fourth the length of eyes; eyes slightly sinuate; front ocellus at the apex of the antennal foveae; postocellar space about one half the ocellocular; occipital carina prominent in the median line and faint behind the eyes; occiput is faintly striate outside the eyes. Propodium almost equal in length to metanotum in the median line, nearly twice laterally, without median keel but with prominent lateral carinae and hairy spiracular areas. Hind coxa closely punctate.

Holotype re-examined. Coll. Miss Meenakshi, Tanjore, 29-xi-1932. Reg. No. 893/H3. In the collections of the Zoological Survey of India, Indian Museum, Calcutta.

***Leucospis assamensis* Mani.**

1936. *Leucospis assamensis*, Mani, *Rec. Ind. Mus.*, XXXVIII, p. 339.

This species agrees with *L. meenakshiae* Mani in all essential characters but differs in the following:—

Female.—Head densely clothed with silvery white pubescence. All spots and markings on body are wholly gamboge yellow. Pedicel of antenna somewhat less than half the length of first funicular segment. Hind femur glossy, more finely and closely punctate than hind coxa; third tooth stouter than second. Spot on face between eyes and scapal furrows relatively larger and contiguous with eye and borders of furrows. Anterior band on pronotum not dilated at ends. Mid-dorsum of mesonotum unspotted. Mesopleura usually unspotted. There is sometimes a minute subelliptic spot on either side of eighth tergite of abdomen. Metanotum usually rounded apically, sometimes slightly pointed. Lateral carina on propodium faint. Fore wings hyaline basally and faintly clouded antero-apically.

Holotype re-examined. Coll. S. E. Peal, Sibsagar, Assam, Reg. No. 930/H3. In the collections of the Zoological Survey of India, Indian Museum, Calcutta.

***Leucospis nursei* Cameron.**

1906. *Leucospis nursei*, Cameron, *Journ. Bombay Nat. Hist. Soc.*, XVII, p. 92.

This species was described by Cameron from Quetta, and has not since been recognised, though Brues (2) discusses its relationship to *L. malabarensis* Brues in the light of Cameron's description.

***Leucospis quettaensis* Cameron.**

1906. *Leucospis quettaensis*, Cameron, *Journ. Bombay Nat. Hist. Soc.*, XVII, p. 91.

This species, described by Cameron from Quetta, has not also been since recognised. According to Cameron it differs from *L. nursei* Cameron mainly in its smaller size.

***Leucospis bengalensis* Weld.**

1922. *Leucospis bengalensis*, Weld, *Proc. U. S. N. Mus.*, LXI, art. 6, p. 32.

1936. *Leucospis bengalensis*, Mani, *Rec. Ind. Mus.*, XXXVIII, p. 339.

This species has two pronotal carinae. It was originally described by Weld from females collected by Dr. Ramakrishna Ayyar at Pusa. I recently described the male from a specimen in the material received from Dr. Hem Singh Pruthi, Imperial Entomologist, New Delhi.

The female ranges in length from about 11 to 12 mm. Occipital carina is not very high. In addition to the two usual carinae, the hind margin of pronotum is also carinate. Fore wings are dark and have a purplish iridescence. Hind coxa is unspurred above. Propodium has a distinct median keel and prominent lateral carinae. Ovipositor reaches the basal fourth of second tergite ; fovea of ovipositor reaches the base of abdomen.

Male.—Length 10 mm. Head narrower than the anterior margin of pronotum ; coarsely rugosely sculptured ; covered with moderately dense, short, silvery white pubescence ; line from front ocellus to the lower edge of clypeus about one and one third the greatest distance between eyes ; clypeus sinuate at lower edge, with minute teeth in the median line ; eyes very slightly sinuate ; post-ocellar space somewhat less than ocellocular ; third funicular segment of antennae somewhat shorter than fourth. Pronotum transversely rugosely punctate ; almost equal in length to mesonotum in the median line ; with two transverse carinae parallel to its hind margin, which is also carinate, anterior carina short, posterior long. Mesonotum somewhat more coarsely sculptured than pronotum. Scutellum coarsely umbilicately punctate. Propodium about twice the length of metanotum in the median line, rugosely sculptured, median keel absent, lateral carinae prominent, spiracular areas hairy. Hind coxa closely punctate. Hind femur finely, closely and setigerously punctate, twice as long as wide, with ten teeth beneath ; front tooth broad and blunt ; second small, next longer, the last four gradually growing smaller and semifused.

Abdomen almost equal to the rest of body in length, seen from above narrow and constricted in the second tergite ; swollen behind ; sixth tergite largest and covers three fourths the abdomen. Wings brown, with a slight iridescence. Scape yellowish white beneath nearly the

whole of its length. Hind coxa unspotted. A narrow, transverse yellowish band at basal third and two large napiform markings laterally at basal two thirds on sixth tergite. A small spot on anterior carina on pronotum in the median line.

Allotype re-examined. Coll. F. M. Howlett, Pusa. 4-iv-1911.

***Leucospis bengalensis* var. *mackenziei* Mani.**

1936. *Leucospis bengalensis*, var. *mackenziei*, Mani, *Rec. Ind. Mus.*, XXXVIII, p. 339.

This variety of *L. bengalensis* Weld is easily distinguished from the typical form by the following characters:—

Female.—Length 9.5 mm. Markings on anterior carina on pronotum relatively longer in some specimens. Propodium without a median keel or lateral carina. Hind femur with 11 teeth, basal tooth broad and blunt, second and third teeth minute, fourth to seventh large, eighth to eleventh small, semifused. Face relatively more densely clothed with longer silvery white hairs.

Holotype re-examined. Coll. Mackenzie, Chapra, Bihar. Originally described from a specimen received from Dr. Hem Singh Pruthi, Imperial Entomologist, New Delhi.

***Leucospis guzeratensis* Westwood.**

1787. *Leucospis petiolata*, Fabricius, *Mantiss. Ins.*, I, p. 285.

1793. *Leucospis petiolata*, Fabricius, *Syst. Entomol.*, II, p. 247.

1798. *Leucospis atra*, Fabricius, *Syst. Entomol.*, Suppl., p. 259.

1839. *Leucospis atra*, Westwood, *Zeitschr. Entomol.*, I, (2), p. 252.

1839. *Leucospis petiolata*, Westwood, *Zeitschr. Entomol.*, I, (2), p. 253.

1839. *Leucospis guzeratensis*, Westwood, *Zeitschr. Entomol.*, I, (2), p. 253.

1890. *Leucospis guzeratensis*, Schletterer, *Berlin. Entomol. Zeitschr.*, XXXV, p. 224.

1898. *Leucospis guzeratensis*, Dalla Torre, *Cat. Hymen.*, V, p. 411.

1909. *Leucospis guzeratensis*, Schmiedeknecht, *Gen. Ins.*, fas., 97, p. 16.

1922. *Leucospis guzeratensis*, Weld, *Proc. U. S. N. Mus.*, LXI, art. 6, p. 33.

This species is easily recognised by the two transverse carinae on pronotum, relatively long ovipositor reaching forward of the middle of the second tergite, single spot on pronotum and unspotted sixth tergite. It exhibits a great variation in size, the length ranging between 9-12 mm. It was originally described from Gujerat, Bombay Presidency and Tranquebar, Madras Presidency. It is represented by one female in a small collection of Leucospids (taken at Coimbatore) received from Mr. M. C. Cherian, Government Entomologist, Coimbatore. Weld has also recorded the species from the same place.

From *L. bengalensis* Weld this species is distinguished by its relatively longer ovipositor; large, sharp, basal tooth and blunt, small apical teeth of hind femur; basally and posteriorly semi-hyaline fore wings; absence of median keel on propodium; and an irregular transverse band on anterior pronotal carina.

***Leucospis bombayensis* Mani.**

1935. *Leucospis bombayensis*, Mani, *Rec. Ind. Mus.*, XXXVII, p. 246.

This species resembles *L. guzeratensis* Westw. in its two pronotal carinae and long ovipositor but it is easily distinguished from it by its

smaller size, spotted sixth tergite and non-iridescent fore wings. It bears a superficial resemblance to *L. ornatifrons* Weld and *L. meenakshiae* Mani, from both of which it is easily separated by the presence of two carinae on pronotum.

Female.—Head somewhat wider than the anterior margin of pronotum, densely clothed with silvery white hairs; line from the front ocellus to the lower border of clypeus about equal to inter-ocular space; eyes very slightly sinuate; postocular space twice the ocellocular; malar space about one fourth the length of eye; occipital carina wanting; striations on the outer side of lateral ocelli rather faint. Pronotum rather bent downwards, with two transverse carinae parallel to its hind margin, which is also carinate. Propodium about twice the length of metanotum in the median line, without a median keel but with distinct lateral carinae and hairy spiracular areas. Scutellum obtusely rounded apically.

Holotype re-examined. Coll. R. B. S. Sewell and H. S. Rao, Satara, Bombay, 24-iii-1932. Reg. No. 894/H3. In the collections of the Zoological Survey of India, Indian Museum, Calcutta.

***Leucospis ramakrishnai* Mani.**

1935. *Leucospis ramakrishnai*, Mani, *Rec. Ind. Mus.*, XXXVII, p. 248.

This species is very closely related to *L. guzeratensis* Westw. and *L. bengalensis* Weld. From the former it is easily distinguished by its unspotted hind femur, usually spotted sixth tergite and two small spots medially on anterior carina of pronotum. From the latter it is distinguished by its relatively longer ovipositor.

The species was originally described from Pusa. In a small collection of Leucospids recently received from Mr. M. C. Cherian, Government Entomologist, Coimbatore, it is represented by one female bearing the label: "Pudur, Visiting flowers of Mango" This is the first record of the species from South India.

Female.—Head almost as wide as anterior margin of pronotum; face rather densely clothed with long, silvery white hairs; line from the front ocellus to the lower edge of clypeus about one and one seventh of the inter-ocular space; malar space about one third the length of eye; clypeus truncate at the lower edge; eye distinctly sinuate; spur between scapal furrows carinate; occipital carina rather prominent between the two lateral ocelli, wanting beyond; postocellar space about one and one fourth the ocellocular. Lateral margin of pronotum carinate. Scutellum obtusely rounded apically; transversely and deeply punctate along the posterior margin. Propodium slightly longer than the metanotum in the median line, without median keel but with prominent lateral carinae and hairy spiracular areas. Fifth tergite of abdomen about one and one fourth times the fourth tergite along the median line. Ovipositor reaching a little forward of the basal fourth of second tergite. Second tergite is more densely hairy and sculptured than sixth tergite.

Holotype re-examined. Coll. Ramakrishna, Pusa, 23-v-1906. Reg. No. 885/H3. In the collections of the Zoological Survey of India, Indian Museum, Calcutta.

Genus **Epexochlaenoides** Girault.

1915. *Epexochlaenoides*, Girault, *Mem. Queensland Mus.*, IV, p. 357.
 1922. *Epexochlaenoides*, Weld, *Proc. U. S. N. Mus.*, LXI, art. 6, p. 35.

This genus bears a general resemblance to *Leucospis* but differs in the comb-like teething following the large basal tooth of hind femur (teeth over twenty in number); pear-shaped, apically subglobose abdomen; and large sixth tergite. Only two species of this genus are known: *E. bicinctus* Gir. from Australia and *E. pyriformis* Weld from India.

Epexochlaenoides pyriformis Weld.

1922. *Epexochlaenoides pyriformis*, Weld, *Proc. U. S. N. Mus.*, LXI, art. 6, p. 35.
 1936. *Epexochlaenoides pyriformis*, Mani, *Rec. Ind. Mus.*, XXXVIII, p. 338.

This species was originally described by Weld from Pusa and I recently recorded it from Bombay. In a collection of Chalcids received for identification from Dr. Hem Singh Pruthi, Imperial Entomologist, New Delhi, this species is represented by a series of specimens labelled as parasitising *Rhynchium nitidulum*.

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1874 *Thesaur. Entomol. Oxon.*, pp. i-xxiv, 133-155, pls. XXV-XXVIII.

ACANTHOCEPHALA FROM INDIA.

DESCRIPTION OF THE MALE OF *Eosentis rigidus* VAN CLEAVE OCCUR-
RING IN THE INTESTINE OF *Scizothorax zarudnyi* FROM SEISTAN.

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Calcutta.

Van Cleave¹ erected the genus *Eosentis* from a single female specimen and no male of *E. rigidus* has ever been described so far. Recently, however, I found both males and females of this species in the intestine of *Scizothorax zarudnyi* collected by Dr. N. Annandale from Seistan. Thirty five specimens, of which twelve are males, were taken out of the small intestine of one fish. As the specimens were rather stiff owing to the action of preservatives for many years, they were softened in a mixture of alcohol and glycerine, spread out and pressed between two slides, stained and mounted in balsam. The identification was confirmed by examination of the holotype in the collections of the Indian Museum.

According to Van Cleave *Eosentis* is distinguished from the other closely related genera by the difference in the number of cuticular nuclei, though the exact number is not mentioned by him. The nuclei are quite distinctly seen in the holotype; there are 8-9 cuticular nuclei in the mid-dorsal and 1-2 in the mid-ventral lines. This number is found constant in a large series of specimens and may, therefore, be taken as the distinguishing character of the genus *Eosentis*. In this respect *Eosentis* differs from the closely related *Neoechinorhynchus*, in which there are only 4-5 cuticular nuclei in the mid-dorsal and 1-2 in the mid-ventral lines. Another point in which this genus differs from *Neoechinorhynchus* is the number of the nuclei in the lemnisci; in *Eosentis* there are always 3 in both, while in *Neoechinorhynchus* there are 2 in one and 1 in the other. On the basis of these characters I have placed two of my recent species *devdevi* and *yalei*² in *Eosentis*. There are 6-8 nuclei in the prostatic gland in *Eosentis*.

The proboscis is short and globular with 3 circlets of 6 hooks each. The hooks of the anterior circlet are nearly twice the length of those of the middle and basal circlets. The proboscis sheath is single-walled, thick and muscular, with the nerve gland situated near its base. The two lemnisci are filamentous structures and some times reach up to the anterior end of the posterior testis. Each lemnisci has 3 nuclei.

The male genitalia consists of two oval testes, situated one behind the other and closely apposed. The vasa efferentia from the testes join each other near the prostatic gland and form the vas deferens, which ends in a muscular cone-shaped penis. Prostatic gland is a

¹ Van Cleave, H. J.—Two New Genera and Species of Acanthocephala from fishes of India. *Rec. Ind. Mus.*, XXX, pp. 147-149 (1928).

² Datta, M. N.—Scientific results of the Yale North India Expedition. *Biological Report No. 20*. Helminth parasites of Fishes from North India, with special reference to Acanthocephalans. *Rec. Ind. Mus.*, XXXVIII, pp. 211-229 (1936).

single syncytial mass having 6-8 nuclei in it. It leads into a prostatic reservoir which gives out a prostatic duct leading to the base of the penis. There is a balloon-shaped, thin-walled seminal vesicle and an eversible bursa.

The female genitalia agrees with the description of *E. devdevi* of the author (1936).

Measurements.—Males 2.4—7.5 mm. $\times$ 0.65—0.92 mm.; females 4.8—12.0 mm. $\times$ 0.7—1.5 mm.; proboscis 1.21 $\times$ 1.10 mm.; proboscis sheath 0.35 $\times$ 0.22 mm.; lemnisci (i) 4.31 $\times$ 0.24 mm., (ii) 3.92 $\times$ 0.24 mm.; testis anterior 1.12 $\times$ 0.65 mm., posterior 1.10 $\times$ 0.70 mm.; prostatic gland 0.79 $\times$ 0.40 mm.; prostatic reservoir 0.24 $\times$ 0.15 mm.; seminal vesicle 0.62 $\times$ 0.22 mm.; bursa 0.88 $\times$ 0.40 mm.; hooks anterior 0.130 mm., middle 0.050 mm., basal 0.045 mm.

Allotype.—In the collections of the Zoological Survey of India, Indian Museum, Calcutta.

Host.—*Scizothorax zarudnyi* (Nikolsky).

Location.—Intestine.

Locality.—Hamun-i-Helmand near Labi.

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