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XXXVII.—*The Systematic Position of the Peloridiidæ as elucidated by a further Study of the External Anatomy of Hemiodæcus leai, China (Hemiptera, Peloridiidæ).* By J. G. MYERS and W. E. CHINA.

A COMPLETE account of the history* of the Peloridiidæ and a discussion of the systematic position † of the family have already been published by one of the authors, and it is therefore only necessary here to explain that, in spite of the suggestions of various hemipterists, the relationships of the family have remained obscure. This, of course, has been due to the fact that, owing to the extreme rarity of the species and the consequent scarcity of material, no dissections have hitherto been possible. A male specimen of *Hemiodæcus leai*, Ch., from Hobart, has now been dissected and mounted permanently in balsam, so that a more detailed study of the anatomy has been possible.

The main points which had remained obscure were the structure of the gular, prosternal, and genital regions. This paper is the result of an examination of these parts with a view to using the decisive characters so disclosed in an attempt definitely to assign the family Peloridiidæ to its correct place in the classification of the Hemiptera.

The Head. (Figs. 1 & 2.)

The head is characterised by excessive modification in two, not necessarily connected, directions—firstly, great flattening and lateral expansion, and, secondly, very strong deflexion and complete annihilation of the gula.

Occipital View.

The occipital view of the detached head shows the foramen extremely large and exactly Homopteroid. There is no vestige of a gula. The head is attached to the thorax by thin membrane, and is not inserted. The antennæ are entirely hidden from dorsal view—hence the original allocation of *Peloridium* to the Cryptocerata.

Facial View.

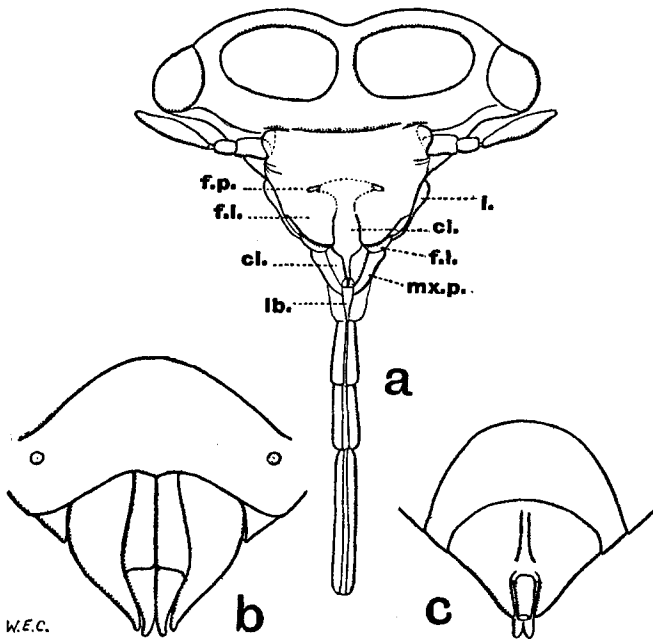
In the rest of our description the head is viewed facially, *i. e.*, topographically ventrally, owing to the strong deflexion. The antennal shelf and scrobe are very strongly developed. Antennæ are three-segmented.

* China, W. E., Ann. & Mag. Nat. Hist. (9) vol. xix. pp. 622-625, figs. (1927),

† China, W. E., Ent. Mo. Mag. vol. lx. pp. 199-203, figs. (1924).

The frontal pits marking the origin of the frontal apodemes are conspicuous. Of similar pits in the Cicadidæ one of us* has written, "Surely these pits, . . . situated exactly at the junction of the plates we are calling *frons* and *clypeus*, are homologous with the frontal pits of the cockroach and other orthopteroids, and, as such, good landmarks for the recognition

Fig. 1.

*Hemiodæcus leai*, Ch.

- a. Facial (ventral) view of head. *f.p.* = frontal pit; *f.l.* = frontal lobe; *cl.* = clypeus; *l.* = lorum; *lb.* = labrum-epipharynx; *mx.p.* = maxillary plate.
 b. Ventral view of female genital segments.
 c. Dorsal view of female genital segments.

of these two sclerites." We have adopted this interpretation in *Hemiodæcus*.

The frons is wide, extending as two lobes beyond the frontal pits and alongside the clypeus. The apices of these lobes are strongly elevated, their side-walls appearing in facial view (unmounted) almost as separate sclerites. The

* Myers, J. G., P. Z. S. Lond. 1928, p. 373.

clypeus has the proximal half parallel-sided, situated between the lobes of the frons, while the distal half, though much wider, is laterally compressed (pinched up) dorsally (topographically ventrally) to appear very narrow in facial view.

Labrum or labrum-epipharynx, maxillary and mandibular setæ not remarkable.

The lora are fairly well-developed, but narrow. The maxillary plates are in the normal position (*i. e.*, much as in *Cicada*) and well-developed.

The vertex and genæ are greatly expanded cephalad and laterally. These expansions are strongly areolate.

The rostrum is four-segmented—not two-segmented, as originally suggested by the examination of an uncleaned specimen. It is very obtuse at the tip. The basal segment is very feebly "chitinised," and covered by prothoracic structures to be described later. The rostrum is not bent at the base, and thus resembles the Homopterous organ, though it must be remembered that many Heteroptera, *e. g.*, Corixids and certain Cryptostemmatids, Mirids, and Isometopids, show a similar condition. Indeed, in the Isometopidæ there is a genus *Skapana*, Dist., with the head strongly deflexed, which resembles the Peloridiids in having the vertex flattened and expanded anteriorly, and the pronotum laterally dilated into paranota. In the Termitaphididæ, too, this condition is approached.

The only thorough comparative study of head-structure in Heteroptera seems to be that of Muir and Kershaw*. It must be emphasised, however, that their *clypeus* is, in our interpretation †, the *frons*, their *labrum* our *clypeus*, and their *epipharynx* our *labrum* or *labrum-epipharynx*.

In the relative development of clypeus and frons *Hemiodæcus* looks Homopteroid rather than Heteropteroid. The lobes we have called non-committally "frontal lobes" seem, however, impossible to homologise with anything in either sub-order. It is true that lying alongside the clypeus they superficially resemble the "frontal ridges" or juga of many Heteroptera. But these are really represented in *Hemiodæcus* by the supra-antennal ridges, as in Auchenorrhynchous Homoptera ‡. Nor can the frontal lobes of *Hemiodæcus* be homologised with the lora of Auchenorrhyncha. In the first place, they are directly continuous with the rest of the frons, and not delimited by any ridge,

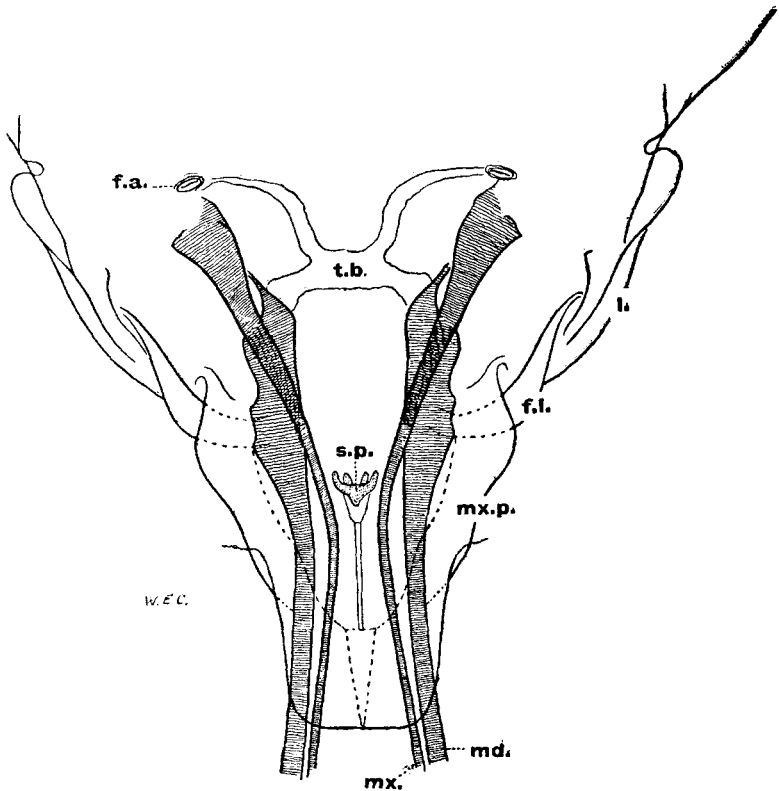
* Muir and Kershaw, 'Psyche,' xviii. 1911, pp. 1-12, pls. i.-v.

† Myers, P. Z. S. Lond. 1928, pp. 368-380.

‡ Muir and Kershaw's homology of these with the "frontal ridges" of Heteroptera seems to be sound.

suture, or furrow. Also these lobes are distally elevated and thickened, as described above. Moreover, true lora (see fig. 1) seem to be present in a more normal form and lateral position. If this interpretation be correct, then a very conspicuous feature of the Peloridiid face is a structure

Fig. 2.



Hemiodæcus leai, Ch. Occipital view of posterior region of head, showing tentorium.

f.a. = frontal apodeme; *t.b.* = tentorial bridge; *s.p.* = salivary pump; *l.* = lorum; *f.l.* = apical thickening of frontal lobe; *mx.p.* = maxillary plate; *mx.* = maxilla; *md.* = mandible.

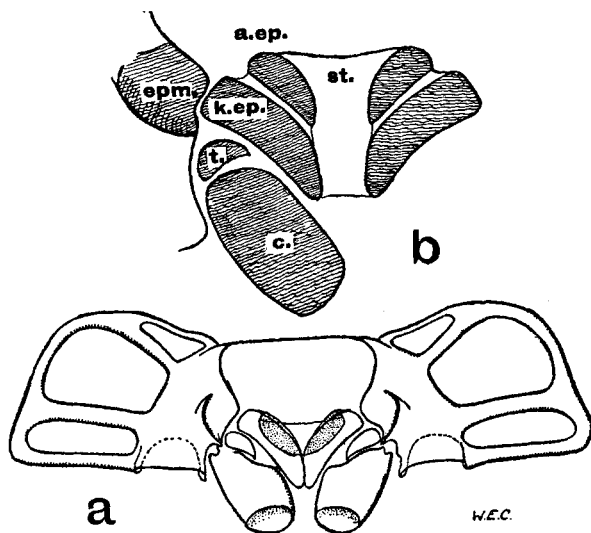
sui generis, throwing little light on relationships. It must be emphasised, however, that paucity of material renders it very difficult to decide exactly on the relations of the parts, and the interpretation of the frontal lobes here given must be considered provisional.

Prothorax. (Fig. 3.)

The pronotum is strongly dilated laterally in broad lobes (*paranota*) provided with large areolets. The prosternum, covered by the rostrum, seems to be entirely membranous. The epimeron is entire and convex. The trochantin is well developed.

The episternum is distinctly divided into two plates—a large kat-episternum and a smaller an-episternum. The line of division between these two plates is membranous

Fig. 3.

*Hemiodæxus leai*, Ch.

- a. Ventral view of prothorax, showing actual position of sternal sclerites.
 b. Diagrammatic representation of sternal sclerites, with the episternum and sternum flattened out. *st.* = sternum; *a.ep.* = an-episternum; *k.ep.* = kat-episternum; *epm.* = epimeron; *t.* = trochantin; *c.* = coxa.

and hinged, so that the an-episternum is folded at right angles beneath (*i. e.*, covered by) the kat-episternum. Thus the two kat-episterna (one from each side) meet in the middle ventral line covering the base of the rostrum, while the an-episterna form the side-walls of the sheath thus formed.

Tegmina.

There is a well-known general difference in the folding of the tegmina over the abdomen in the two sub-orders. In

the Homoptera the position is almost universally stegopterous—*i. e.*, the folded tegmina are held roof-wise, meeting more or less dorsally but overlapping only a little or not at all. In the Heteroptera, on the other hand, with a general flattening of the body, there is extensive overlapping of the apical portions of the fore wings, rendered possible by the shortening and widening of the clavus. The overlapping portion remains membranous, while the remainder becomes more coriaceous, giving the name to the sub-order. Cockroaches, exhibiting undoubtedly a very primitive type of wing-folding, are also greatly and probably primitively flattened. Their tegmina overlap to a considerable extent, but this overlapping is gradual, beginning at the base, so that the more membranous overlapped portion is consequently only indistinctly delimited. With Tillyard perhaps we may agree that the folded position in the primitive Hemiptera was probably stegopterous, and that the Heteropterous and Homopterous positions were derived from this in the way suggested above.

This distinction between the two sub-orders is, however, by no means absolute. Among the Heteroptera the Notonectids fold their hemelytra in a distinctly stegopterous manner, and merely half the membrane overlaps. The whole membrane, moreover, is very small. The condition in Notonectids is thus practically identical with that in many Bythoscopine Jassids (Homoptera), where the folded position is the same, and the part of the membrane which overlaps is the *appendix*. There are in the Homoptera other truly stegopterous forms (in particular, certain Achilidæ) in which the tegmina overlap distally to a conspicuous extent, approaching the Heteropterous condition, an extreme case being that of *Achilus* itself. In the most flattened Homoptera, however (e. g., *Flatoides* group), they do not overlap.

In many Homoptera the nodal line, from the node to the tip of the clavus, is very strongly marked, delimiting a more membranous distal portion (membrane) from the coriaceous basal portion (corium + clavus). This is well shown in some Cicadidæ and Tropiciduchidæ. In certain cases the basal part is even thickened or granulate, as in the Cicadid genus *Orapa* (where the body also is considerably flattened, and the tegmina begin to overlap exactly at the nodal line), and in the Tropiciduchid genus *Taxilana*.

The Peloridiidæ are strongly flattened. The tegmina apically overlap considerably in the macropterous and slightly in the sub-brachypterous forms. The tegmen itself shows little differentiation into corium and membrane. From the

above discussion it will be obvious, therefore, that both the tegminal character and the manner of folding are useless as a guide to the systematic position of the Peloridiidæ. However, the occurrence of sub-brachypterous forms seems to be a Heteropterous character. In Homoptera (*e. g.*, in Delphacidæ) there seems to be no intermediate state between macroptery and distinct brachyptery occurring within the same species.

Trochantin. (Fig. 3 b.)

Imms* says that a trochantin occurs only in the more primitive orders of insects. Taylor † writes that, at least so far as the mesothorax is concerned, "a trochantin . . . is very probably present in most of the Heteroptera, though its position beneath the episternum prevents it from being easily detected." Speaking very generally, and with regard to all the thoracic segments, we have found that the trochantin is always very small in the Heteroptera. This is especially the case in the pagipodous forms, where, in some at least, it appears to be entirely absent.

In the auchenorrhynchous Homoptera, as Hansen pointed out, the trochantins are large and distinct. This has been confirmed by Funkhouser (Membracidæ), by Taylor, and by ourselves. Among the less specialised of the Sternorrhyncha, the Psyllids have well-developed trochantins very like those of Cicadas. These are well shown in Crawford's figures ‡. In the other Sternorrhynchous families this sclerite is apparently not distinguishable.

In *Hemiodæcus* the trochantin on every one of the thoracic pleura is large and distinct, resembling closely that of a cicada.

Female External Genitalia. (Fig. 1 b & c.)

Muir regards a complete ovipositor (present in Cicadidæ, Cercopidæ, Cicadellidæ, Membracidæ, Delphacidæ, and Cixiidæ [part.]) as the primitive type among the Homoptera.

In *Hemiodæcus* the ovipositor, though short, seems complete. We have refrained from dissecting the unique specimen of this sex.

* 'Text-book of Entomology,' London, 1925.

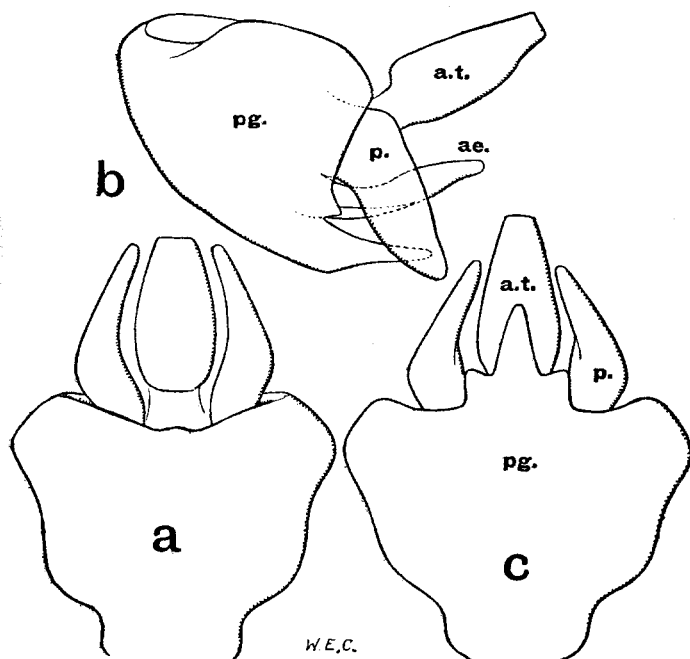
† Taylor, Ann. Ent. Soc. America, xi, pp. 225-250, pls. xx.-xxiii.

‡ Crawford, D. L., 1914: "A Monograph of the Jumping Plant-lice, or Psyllidæ, of the New World." Smiths. Inst. U.S. N. M. Bull. lxxxv. 1904, ix. 186 pp., 30 pls.

Male Genitalia. (Figs 4 & 5.)

Before dealing with the genital appendages themselves, we must emphasise the strongly developed anal tube (tenth segment), similar in the two sexes, which is typical of the Homoptera. There are apparently no vestiges of the eleventh segment or of the anal style. The ninth segment or pygophor is large and well developed, but is not normally greatly retracted within the abdomen as it is in many Heteroptera.

Fig. 4.



Hemiodæcus leai, Ch. Male genital segments.

a. Dorsal view. b. Lateral view. c. Ventral view.

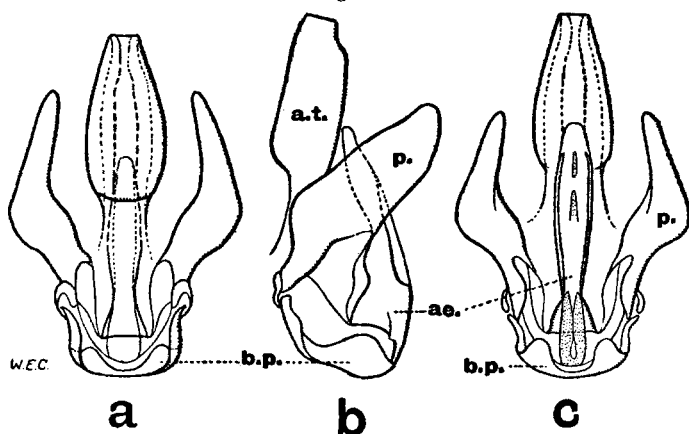
pg.=pygophor (ninth segment); a.t.=anal tube (tenth segment);
p.=paramere; ae.=ædeagus.

There are no sub-genital plates, such as are found in most Homopterous families, but the ventral posterior margin of the pygophor is prolonged into a trilobed process which must in some measure protect the ædeagus from below. Pruthi * maintains that the subgenital plates, which are usually large

* Pruthi, Trans. Ent. Soc. London, 1925, p. 240.

where the ninth sternite is small, are nothing but prolongations of the ninth sternite, in which case we have in *Hemiodæcus* an intermediate stage. The parameres are large and symmetrical, and have their bases in actual contact with the well-developed "basal plates," a wholly Homopterous character. When dissected the anal tube, parameres, "basal plates," and ædeagus come away from the pygophor in one piece, whereas in the Heteroptera the parameres always remain articulated into the walls of the genital chamber of the pygophor. The "basal plates" do not surround the basal foramen, but lie on the ventral surface of the segmental membrane within the ninth segment. The ædeagus is very

Fig. 5.



Hemiodæcus leai, Ch. Genitalia and anal tube, as they become detached from the pygophor.

a. Dorsal view. b. Lateral view. c. Ventral view. *b.p.* = basal plates; *p.* = paramere; *ae.* = ædeagus; *a.t.* = anal tube.

simple and is more or less completely exposed. Only the base and sides are "chitinised," although there are two median, narrow, chitinous plates. There is apparently a slight distal differentiation into phallosoma and vesica, the latter being membranous. It must be remembered that paucity of material has prevented a complete examination of these parts. Reference should be made to fig. 5. In most of these characters *Hemiodæcus* is distinctly Homopterous and of the three types defined by Pruthi (*tom. cit.* pp. 235-236), the genitalia most resemble Type A, found in Cicadidæ, but differ in the well-developed parameres. In

the presence of parameres and absence of subgenital plates, they resemble Type C found in the Fulgoridæ and Psylloidea. There are thus distinct differences in general plan sufficient to justify the proposal, based on other structures, to erect a new series of Homoptera.

Singh-Pruthi has laid great stress on what he calls the "basal plates" and their characteristic and different structure in the two sub-orders. Muir* has strongly criticised his conceptions on general morphological grounds, and given good reason to suppose that the so-called "basal plates" of Heteroptera are not homologous with those of Homoptera. It seems, too, that the "basal plates," called "ædeagus-style-connective" by Lawson †, are not homologous with those of Cicadidæ, which are merely portions of the perianthrium. The condition in *Hemiodæcus* seems to resemble considerably that of the cicadas. It is important to remember that any inferences regarding relationship based on these structures are independent of the truth of Singh-Pruthi's or Muir's views on their homology ‡.

Scent-glands.

We have found no sign of metapleural scent-gland orifices in the adult of *Hemiodæcus*.

In the single available nymph (that of *Xenophyes cascus*, Bergr.), belonging to the Peloridiidæ, there is no indication whatever of dorsal abdominal scent-gland openings. Such openings are very characteristic of the Heteroptera, occurring in all the families of land-bugs (Cryptostemmatid nymphs apparently not known) and in some of the aquatic forms. In the shore-dwelling bugs of the families Ochteridæ and Gelastocoridæ these glands are said to be absent (*Kirkaldy*).

Thus all purely terrestrial Heteroptera seem to be supplied with nymphal scent-glands. The Peloridiidæ are decidedly terrestrial, and their lack of these organs must be regarded as significant.

THE RELATIONSHIPS OF THE PELORIDIIDÆ.

Peloridium was originally placed in the Heteroptera largely on account of its general appearance. Breddin

* Muir, Proc. Hawaiian Ent. Soc. vi. 1926, pp. 323-334, 1 pl.

† Lawson, Sci. Bull. Univ. Kansas, xii. no. 1, 1920, pp. 45-46.

‡ Heberdey (Zeits. f. Morph. u. Ökol. d. Tiere, x. 573, 1928) has recently, and we think with good reason, suggested the term "Basalstücke" as more appropriate than "basal plates."

emphasised the Heteropterous appearance of the abdomen, tarsal segmentation, structure and articulation of the antennæ.

All of these characters can, however, be matched in true Homoptera, and we must seek more fundamental ones. It appears at once that the Peloridiidæ have no really clear-cut Heteropterous characters. As Muir* has recently emphasised, the only universally valid character separating the two sub-orders, Heteroptera and Homoptera, is the presence or absence of a gula. In this respect the Peloridiidæ are most unequivocally Homopterous. To place them in the Heteroptera would be to invalidate any certain means of separating the two sub-orders. Nevertheless, so strong is the faith one is accustomed to place in habitus that the absence of gula alone might be regarded as only of convergent significance, and the Peloridiidæ placed, as by Reuter, Bergroth, and others, as aberrant relatives of the Ochterids.

We believe, however, that the Peloridiidæ have nothing whatever to do with the latter family. It may be convenient here to summarise the chief characters which have influenced us in placing this family:—

I. *Heteropterous Characters* :—

To a certain extent, general appearance.
Occurrence of sub-brachyptery.

II. *Homopterous Characters* :—

Complete absence of gula.
Strong "cicadoid" development of trochantin.
Large and separate anal tube.
Condition of "basal plates" of male genitalia.
Absence of scent-glands in nymphs and adults.
Rostrum not bent at base.
Antennal ledges not developed into frontal lobes.

III. *Characters sui generis* :—

Ensheathing of base of rostrum by propleural structures.
Structure of the frontal lobes.

Of the Homopterous characters, the first to the fourth inclusive seem to be absolute, while the others may be shared by certain rare Heteroptera.

But let us examine the ensemble of characters from

* Muir, Ent. Mo. Mag. lxi. 1923, p. 254.

another point of view. In head-structure one would ordinarily assume that the Heteropterous condition was the more primitive*, yet the wings of Heteroptera seem the more specialised, while Tillyard, judging solely from wing-remains, would trace the Homoptera to Lower Permian times, and recognise no Heteroptera till the Triassic.

It is, therefore, by no means improbable that the Peloridiidæ, as Reuter suggested, are very primitive. It may even be that they are descended in the direct line from the common ancestors of the two sub-orders, and are thus strictly neither Heteroptera nor Homoptera. In this view, which is supported by the peculiar features listed under III., the four main Homopterous characters would be primitive ones, which the Homoptera have retained while the Heteroptera have lost them. This hypothesis would be best expressed by adopting Muir's suggestion, and putting the Peloridiidæ in a separate sub-order, Pseudohomoptera. The conjunction, however, of the four characters which are otherwise now peculiar to Homoptera, together with at least three others far more characteristic of Homoptera than of Heteroptera, seems to us to outweigh the peculiar Peloridiid structures, and to rank the family in the Homoptera. We therefore suggest for it a new series, Coleorrhyncha.

* We believe that there is no need to agree with Muir (Classif. Fulg.) that the immediate ancestor of the two sub-orders (Heteroptera and Homoptera) had a Heteropterous type of head. This opinion is apparently based on a confusion of ideas, as follows:—It is generally admitted that a porrect head is more generalised and primitive than a deflexed one, and that the most primitive insects had a porrect head. But, looked at from the general point of view (rather than the Hemipterist's), the immediate ancestor of Heteroptera and Homoptera was very far indeed from being a primitive insect. It must, for instance, have had sucking mouth-parts somewhat like those of both sub-orders, and these mouth-parts, as Muir emphasises, are extremely specialised, and might well have been associated with a deflexed head which is correlated with a phytophagous diet, and the primitive Hemiptera may well have been phytophagous. This view is in keeping with the much greater specialisation of Heteroptera than Homoptera in many other respects—hemelytra, feeding-habits, special adaptations for swimming, etc.

On this view the immediate ancestor of the two sub-orders was what we should now regard as much more Homopteroid than Heteropteroid, save probably in leg-structure, in which it and modern Heteroptera are more generalised. Now, the Peloridiidæ are precisely this—Homopteroid in a number of important features which may well have been primitive and Heteropteroid in the legs (and perhaps in the flattening of the abdomen). The family would thus seem very near the ancestral stock of the two sub-orders.

The major classification of the Hemiptera will thus, confined to key-characters, be modified as follows :—

Gula present	HETEROPTERA.
Gula absent	HOMOPTERA.
*Rostrum arising from base of head.	
Base of rostrum sheathed by propleural structures	COLEORRHYNCHA, nov.
Base of rostrum entirely free from prothorax	AUCHENORRHYNCHA.
*Rostrum arising between or caudad of fore coxæ	STERNORRHYNCHA.

XXXVIII.—*Descriptions of a new Skink from Christmas Island and a new Frog from Annam.* By MALCOLM A. SMITH.

WHEN Mr. Boden Kloss visited Christmas Island in 1923 he brought back with him some reptiles which he sent me for determination. Among them was a skink which agreed well with the description of *Lygosoma atrocostatium*, Lesson, but on comparison with that species was obviously distinct. I have recently examined all the specimens of *atrocostatum* in the British Museum of Natural History, together with the material originally collected on Christmas Island, which includes *Lygosoma nativitatis*, Boulenger (Monogr. Christmas I., 1900). In consequence, I find that I am unable to separate *nativitatis* from *atrocostatum*, which has a much greater variation in the number of its scale-rows than was originally conceived, while the skink obtained by Mr. Kloss is new. It may be known as

Lygosoma sinus, sp. n.

Description of the type (Brit. Mus., 1898. 9. 19. 4).—Habit lacertiform. Snout elongate, a little more than twice the length of the eye-opening ; lower eyelid with a transparent

* It is difficult to express this in exact morphological terms. The text-books (*e. g.*, Imms, Tillyard) usually state it in the above manner. The actual difference is well described by Muir (1923) as follows :—“The labium [in the Auchenorrhyncha], while being intimately related to the prosternum, is still in close relationship with the head-capsule.” In the Sternorrhyncha, on the other hand, a portion of the head-capsule, along with the clypeus, labium, and tentorial structure, is more or less detached from the head-capsule. . . .” We find that in the Psyllid, for instance, if the head is removed, the rostrum, mouth-setæ, and related parts remain attached to the prothorax, with which is strong fusion.