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COMPARATIVE EXTERNAL CEPHALIC MORPHOLOGY OF SOME COREOIDS (HETEROPTERA : COREOIDEA) WITH REFERENCE TO THEIR PHYLOGENY*

IMTIAZ AHMAD and MOHAMMAD UMAR SHADAB†

Department of Zoology, University of Karachi, Karachi 32

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Abstract. The comparative external cephalic morphology of 9 species of the families Stenocephalidae, Rhopalidae, Alydidae and Coreidae of the superfamily Coreoidea is studied in detail in addition to an examination of all the representatives of these families from Pakistan and East Bengal. The results are compared with the data available in the existing literature and on the basis of these characters the phylogenetic positions of these families are also briefly discussed.

Spooner[63] worked on the phylogeny of the Hemiptera based on a study of the head capsule. A number of workers have given general morphological accounts of the hexapodan head, prominent among whom are Muir and Kershaw,[38] Tower,[68] Crampton,[14] Neiswander,[41] Snodgrass,[57–61] Malouf,[36] Qadri,[48,50] Ferris,[21–24] Butt,[13] MacGill,[34] Southwood,[62] Duporte,[16–19] Akbar,[9] Parson,[43–47] Banerjee,[11] Rai and Trehan,[51] Evans,[20] and Matsuda.[37]

From a study of the previous account on the heteropterous head it has been observed that a comparative morphological study of the head of coreoid bugs might help solve some of the existing phylogenetic problems within Coreoidea specially outlined by Schaefer,[52–55] Stys,[64–67] Ahmad,[1–7] Kumar,[29,30] and Ahmad and Shadab.[8]

Although Schaefer[53,54] has given some consideration to this structure for the higher classification of Coreoidea it is considered that this structure should receive more attention on account of the richness of consistently varying characters which it offers.

The present study is undertaken to discuss the morphotaxonomic features of the coreoid head in the light of existing phylogenetic problems. The coreoid heads of all Pakistani species and some exotic species are examined and an account of representative species of each family within the superfamily Coreoidea is discussed.

Material and Methods

Dried specimens of coreoid bugs were taken from material collected from Pakistan and some exotic material taken from the first author's collection and used for morphological studies of the head. For a clearer view the dried specimens were treated with relaxing fluid (prepared in the proportion of: ethyl alcohol 106, water 98, benzol 14 and ethyl acetate 38 ml). The head was removed and boiled in 10% KOH for 5–10 min. The material was then washed in water and bleached. After bleaching it was stained with borax carmine. Glycerine was used as clearing agent. The antennae, the dorsal, ventral and lateral views of head and dorsal and ventral views of the labium were drawn to scale on a graph paper. All drawings were made with the help of a Carl Zeiss binocular microscope in which a graticule was placed in the eye piece.

The characters of the coreoid head studied were median sulcus, anteocellar pits, antenniferous tubercles, basal antennal segments, and bucculae.

Variable Terminologies

Head

Clypeus. Clypeus : Myers,[40] Hamilton,[27] MacGill,[34] Qadri,[49] Akbar,[9] Banerji.[11] Anteclypeus : Butt,[13] Southwood.[62] Clypeolabrum : Muir.[39] Tylus : Snodgrass.[58]

Mandibular Plate. Mandibular Plate : Snodgrass,[58] Banerji.[11] Frontal Ridge : Muir and Kershaw.[38] Jugum : Knight,[28] Butt,[13] MacGill,[34] Newcomer,[42] Southwood.[62] Genae or Cheek Wings (Oberkieferlappen): Borner.[12] Paraclypeus: Spooner,[63] Ahmad.[1–6] Loral Plate : Parson.[46]

Maxillary Plate. Maxillary Plate : Muir and Kershaw,[38] Snodgrass,[58] Spooner,[63] Butt,[13] MacGill,[34] Newcomer,[42] Parson.[46] Lorum : Knight,[28] Southwood.[62] Galea or Lorum: Borner,[13]

External Morphology of Head of the Superfamily Coreoidea reuter *1910.*

Dorsally there are no external criteria for delimiting vertex, frons and postclypeus. On the posterior side of the head an occipital suture may or may not be present. When present it does not reach the sides of the head. In some specimens from the middle of the occipital suture there runs anteriorly a very short median suture which perhaps represents the abbreviated coronal suture or metopic suture of Snodgrass.[58]

The rim of the foramen is thickened and it may be considered that it has incorporated the post-occipital suture. It is produced backwards into a pair of short curved processes the *Occipitalia* of MacGillivary[35] or lateral apodemes. A pair of large dorsal ocelli are sometimes present on slight elevations near the well developed compound eyes. A pair of slight depressions called preocellary pits are usually present in front of the ocelli on inner side. The distance of the ocelli from the compound eyes varies in the different species.

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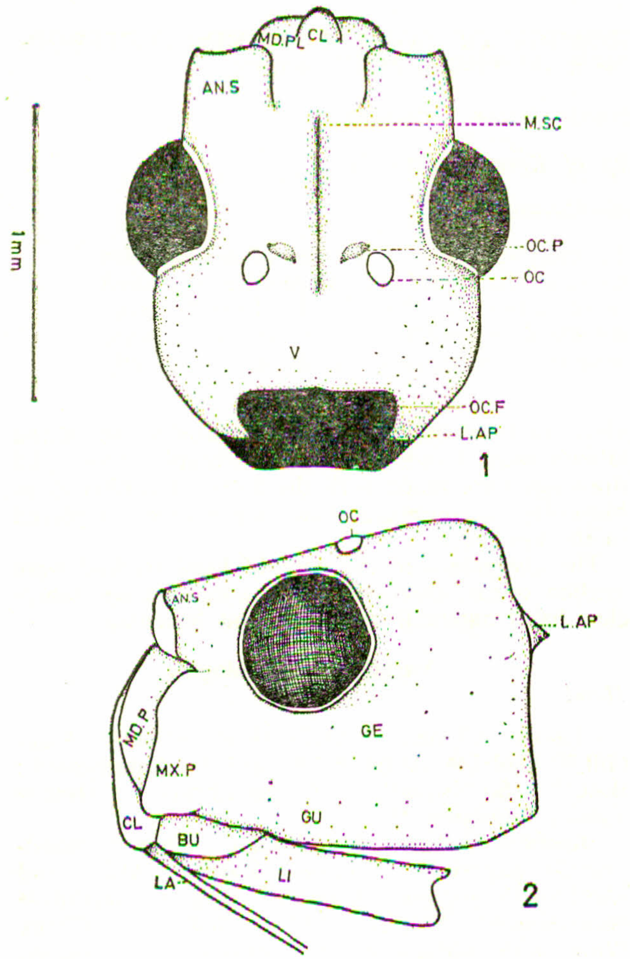
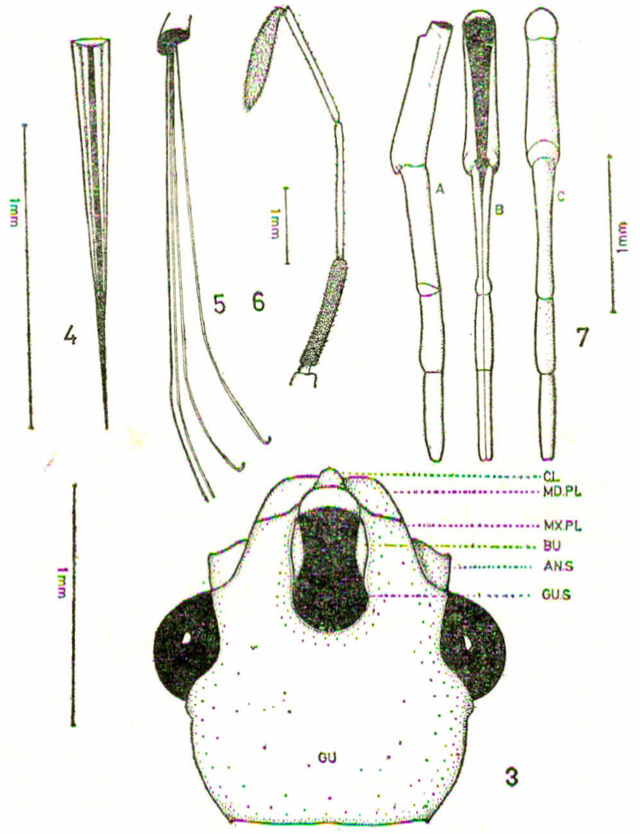
†Now at American Museum of Natural History, New York, U.S.A.





Figs. (1–7). *Cletus bipunctatus* (Westwood), 1–3 head, 1. dorsal view; 2. lateral view; 3. ventral view; 4. labrum, dorsal view; 5. mandibular and maxillary stylets, dorsal view; 6. antenna, dorsal view; 7. labium; (A) lateral view; (B) ventral view; (C) dorsal view.

Just above the compound eyes are the laterally placed antenniferous tubercles. Antenniferous tubercles sometimes, extend beyond the apex of the head. The length from the apex of the antenniferous tubercles to the apex of head varies among the different species. A mid-cephalic sulcus is always present. It is usually present on the dorsal side, in front of the eyes in the middle of the head. The mid-cephalic sulcus may be long and deep or short, wide and shallow (diverging anterolaterally and posterolaterally).

On the anterior area of the head a median clypeal region is separated from each mandibular plate by a mandibular suture. In most of the species the clypeus extends in front beyond the mandibular plates but in some species the mandibular plates are pointed anteriorly and extend beyond the clypeus sometimes enclosing the latter. Lateroventrally the mandibular plates are separated from maxillary plates by a genal suture which runs back almost to the level of the antenniferous tubercles. Anteroventrally the maxillary plates are enlarged to form the projecting bucculae. The size of the bucculae varies from very short in some families to very long in others. The maxillary plates are completely fused with the genae without any trace of a suture.

On the anteroventral side of the head the labium arises, ventrally from the apex of the head. The venter of the head shows a great extension of the gular area[63] which is formed by the ventral extension of the maxillary plates. The base of the labium is set in membrane and is accommodated in a broadly V-shaped anterior emargination of the gular region between the bucculae. The labium is four segmented and the segments vary in length. The distal end of the basal labial segment may or may not pass the base of the head. The apex of the labium usually extends on to the middle of the metacoxae. The venter of the head is sometimes mediolongitudinally grooved for the reception of the labium. The labrum is attached from the anteroventral extremity of the clypeus, by a clypeolabral suture. The portion of the labrum attached to the clypeus is broad at the base and tapers to a fine point toward the apex.

The antennae are usually long and slender. The first, second and third segments may be thin, long and slender, circular in cross-section or thick, clavate and triangular in cross-section, or flattened and expanded apically. The fourth segment is always fusiform and smooth, may be long or short and spindle-shaped. The ratio of the length of the head to the length of the first antennal segment varies from 3:1 to 1:8.

AN. S, antennal socket; Bu, bucculas; CL, clypeus; GE, gens; GU, gula; GU. S, gular suture; LA, labrum; L. AP, lateral apodemes; LI, labium; MD. P, mandibular plate; MX. P, maxillary plate; M. SC, median sulcus; OC, ocelli; OC. F, occipetal foramen and V, vertex.

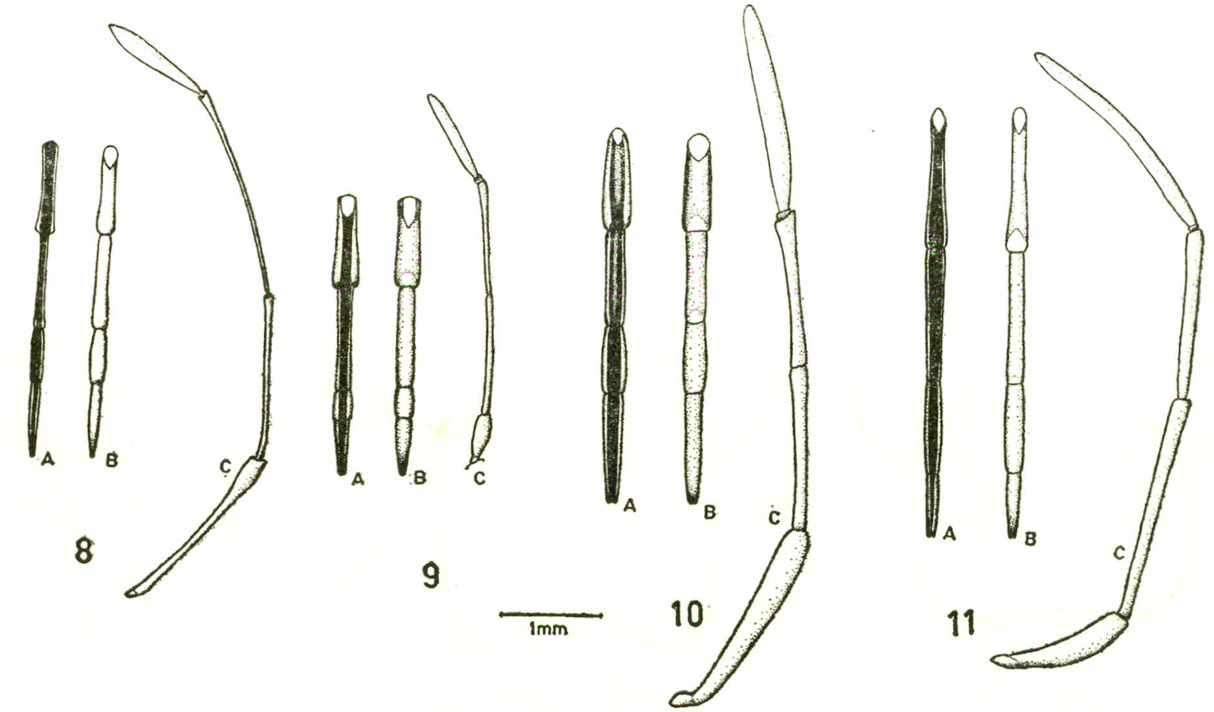


Fig. 8. *Hydarella orientalis* (Distant), (A–B) labium, (A) ventral view; (B) dorsal view; (C) antenna, dorsal view. Fig. 9. *Agraphopus viridis* (Jak.), (A–B) labium, (A) ventral view; (B) dorsal view; (C) antenna, dorsal view. Fig. 10. *Clavigralla horrens* (Dohrn.) (A–B) labium, (A) ventral view; (B) dorsal view; (C) antenna, dorsal view. Fig. 11. *Dicranocephalus lateralis* (Signoret.), (A–B) labium, (A) ventral view; (B) dorsal view; (C) antenna, dorsal view.

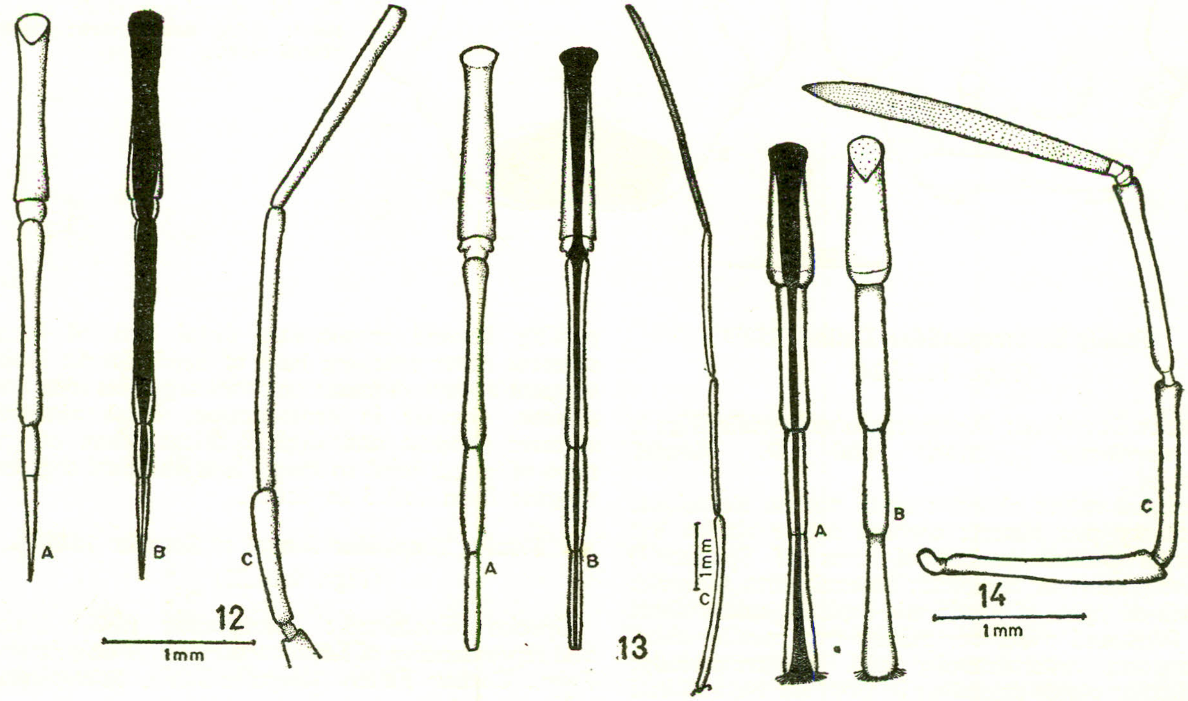


Fig. 12. *Micrelytra fossularum* (Rossi.), (A–B) labium, (A) dorsal view; (B) ventral view; (C) antenna, dorsal view. Fig. 13. *Stenocoris southwoodi* Ahmad., (A–B) labium, (A) ventral view; (B) dorsal view; (C) antenna, dorsal view. Fig. 14. *Daclera punctata* (Sign.) (A–B) labium, (A) dorsal view; (B) ventral view; (C) antenna, dorsal view.

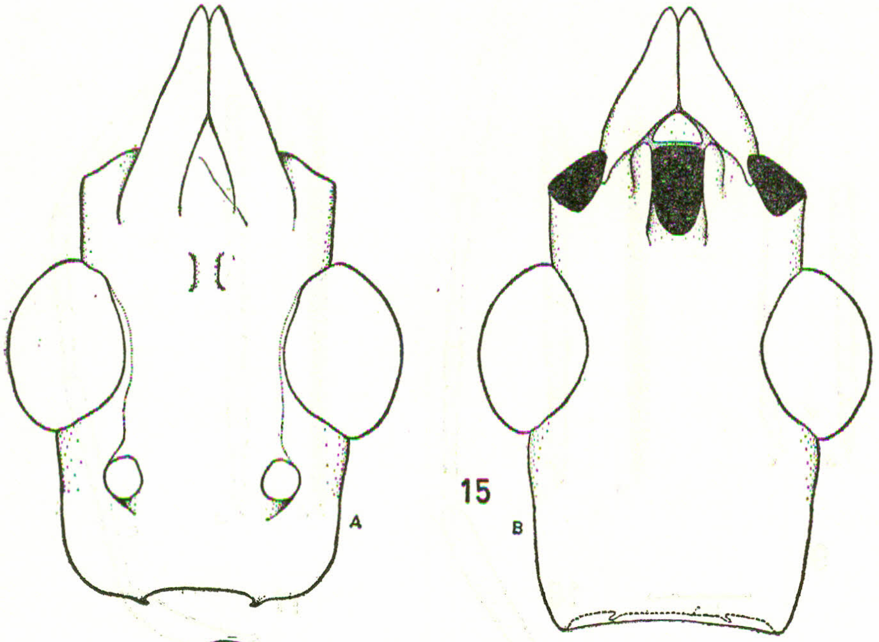


Fig. 15. *Dicranocephalus lateralis* (Sign.) Head: (15A) dorsal view; (15B) ventral view.

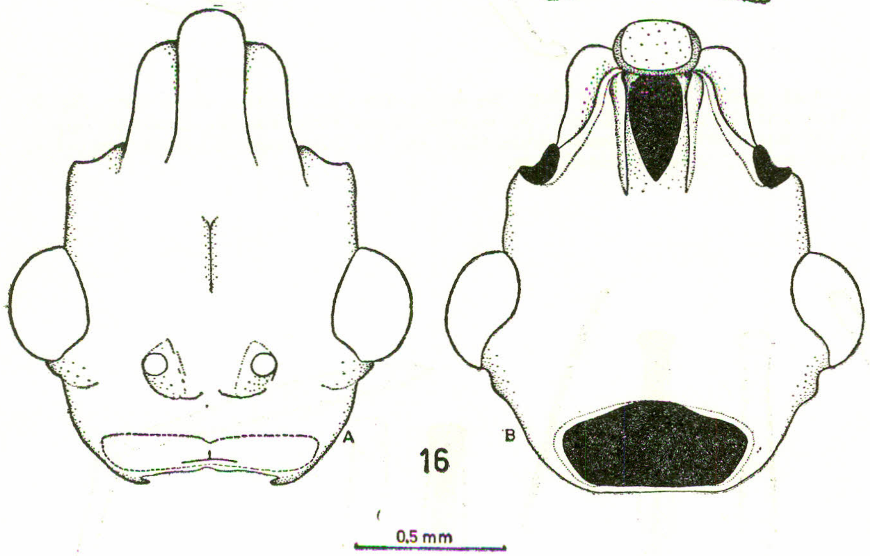


Fig. 16. *Agrophopus viridis* (Jak.). Head: (16A) dorsal view; (16B) ventral view.

Family Stenocephalidae Dallas 1852[15]
(Figs. 11,15,24)

Species Examined: *Dicranocephalus lateralis* (Sign.), *D. marginatus* (Ferrari) and *D. bianchii* (Jakovlev).

Occipital suture absent ; ocelli not on elevations. Preocellary pits absent; coronal suture absent but its arms present (epicranial arms of Spooner[63]) relatively short or complete; antenniferous tubercles far behind apex of head; mid-cephalic sulcus short very faint and wide, comprising two parallel short depressions, anterolaterally and posterolaterally; mandibular plates extending in front far beyond and enclosing clypeus and pointed anteriorly; bucculae short and broad but extending beyond insertion of antenniferous tubercles; apex of labium usually passing beyond mesocoxae, distal end of basal segment never reaching base of head, fourth labial segment always shortest; antennal segments long and slender, circular in cross-section, basal antennal segment shortest and slightly thicker than others, ratio of length head to length first antennal segment ranging from 1:0.5 to 1:0.7.

Family Rhopalidae Amyot et Serville 1843[10]
(Figs. 9,16,22)

Species Examined: *Agraphopus viridis* (Jak.) and representative of Leptocoris Hahn, *Brachycarenus* Fabr., *Corizus* Fallen, *Rhopalus* Schill, *Stictopleurus* Stål and *Liorlayssus* Stål.

Short occipital suture usually present; ocelli present on low broad elevations; preocellary pits absent;

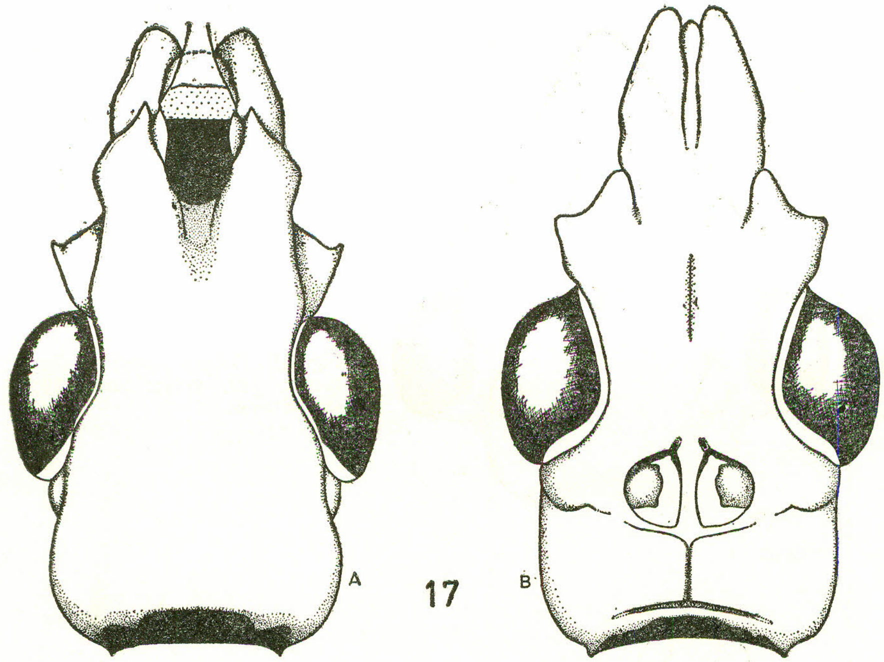


Fig. 17. *Stenocoris southwoodi* Ahmad. Head: [17A) ventral view; (17B) dorsal view.

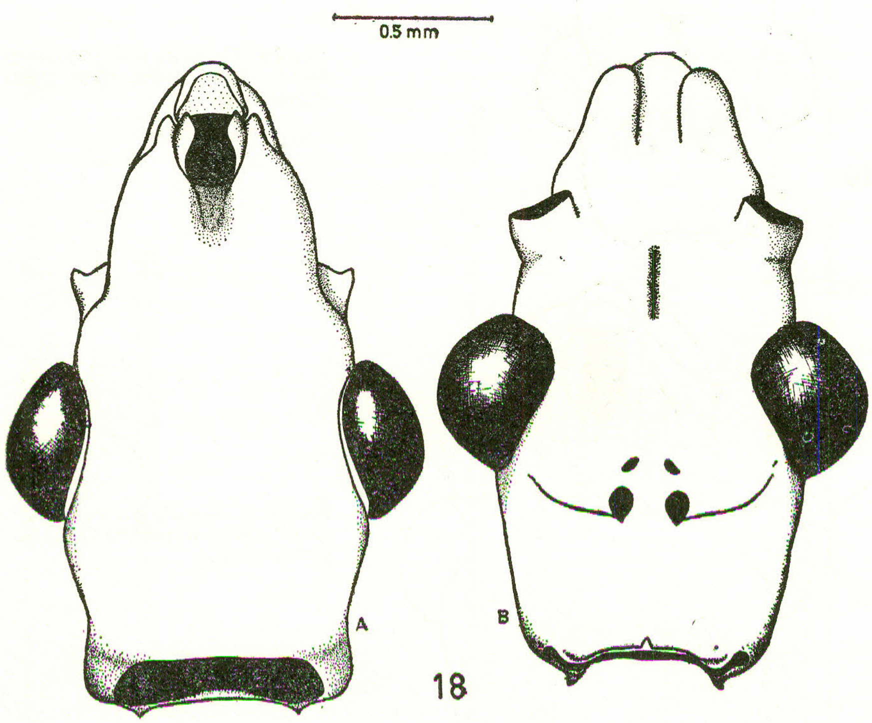


Fig. 18. *Micrelytra fossularum* (Rossi). Head: (18A) ventral view; (18B) dorsal view.

very short coronal suture present running anteriorly from middle of occipital suture; antenniferous tubercles far behind apex of head; shallow, broad midcephalic sulcus always present diverging anterolaterally; clypeus always extending in front beyond mandibular plates before deflection; bucculae broad, long and extending beyond the insertion of antenniferous tubercles; apex labium reaching mesocoxae, in some species and just passing beyond metacoxae in others; distal end of basal segment sometimes reaching base of head, third segment shortest; basal antennal segment thick and shortest, other three long and slender; all segments circular in cross-section; ratio of length head to length first antennal segment ranging from 1: 0.25 to 1: 0.45.

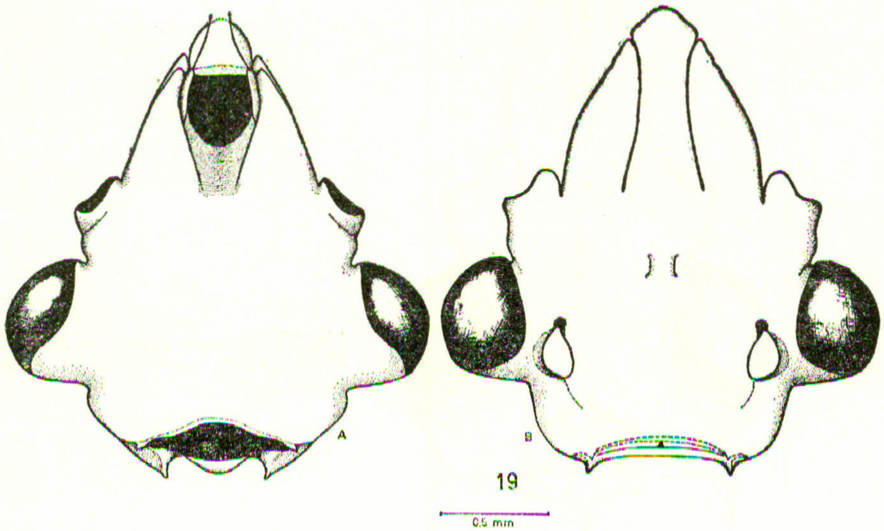


Fig. 19. *Dalcera punctata* (Sign.) Head: (19A) ventral view; (19B) dorsal view.

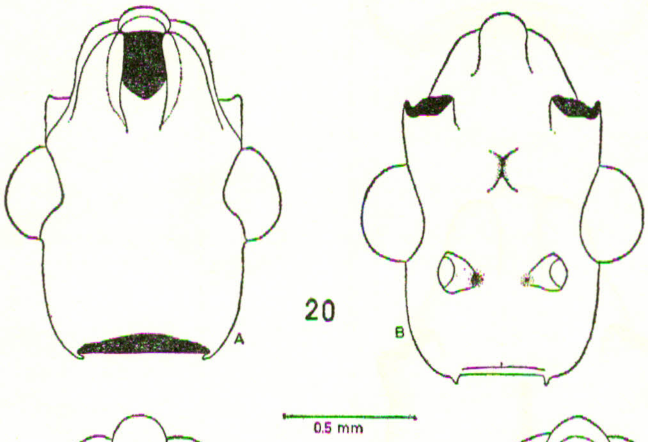


Fig. 20. *Hydarella orientalis* (Dist.) Head: (20A) ventral view; (20B) dorsal view.

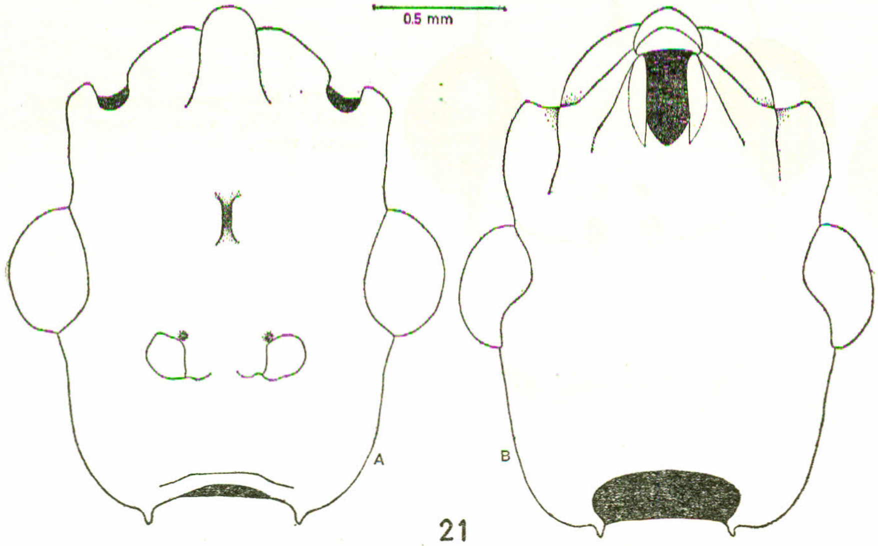
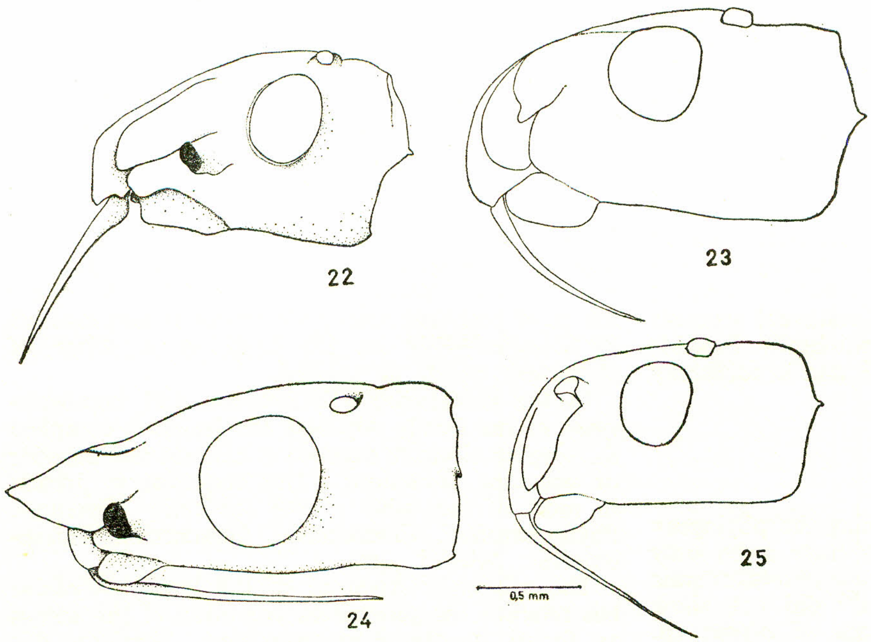


Fig. 21. *Clavigralla gibbosa* (Spin.) Head: (21A) dorsal view; (21B) ventral view.

Family Alydidae Amyot et Serville 1843[10]
(Figs. 12, 13, 14, 17, 18, 19, 26, 27, 28)

Species Examined : *Micrelytra fossularum* (Rossi), *Daclera punctata* Sign., *Stenocoris southwoodi* Ahmad and the representatives of *Akbaratus* Distant, *Comptopus* Amyot et Serville, *Hypselopus* Burm., *Nariscus* Stål, *Riptortus* Stål and *Tenosius* Stål.

Occipital suture always present extending to lateral sides of head; ocelli usually present on slight elevations; preocellary pits present on inner sides; coronal suture with at least its arms always present;



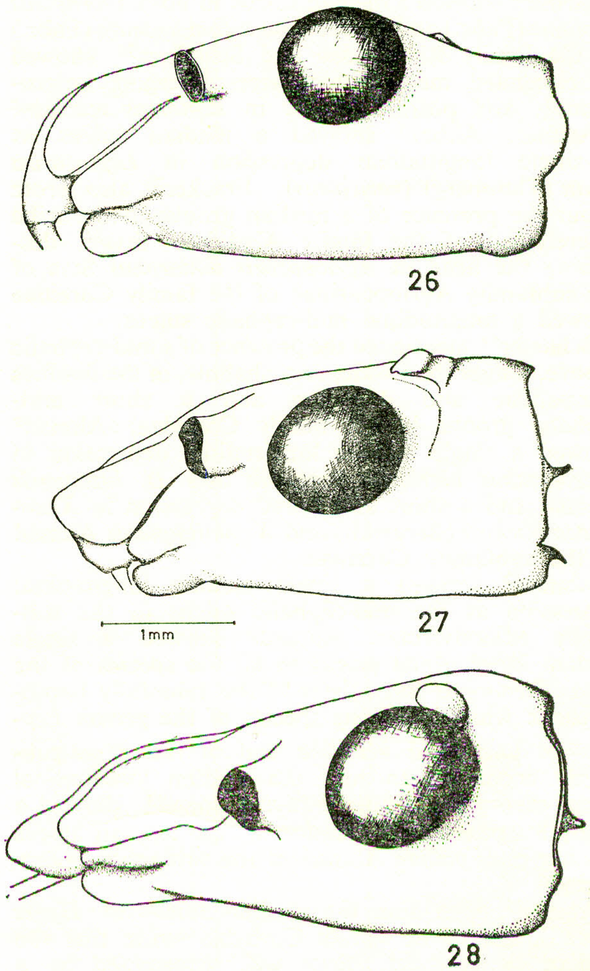
Figs. (22–28) Head, lateral view; 22. *Agraphopus viridis* (Jak); 23. *Clavigralla gibbosa* (Spin.); 24. *Dicranocephalus lateralis* (Sign.); 25. *Hydarella orientalis* (Dist.); 26. *Micrelytra fossularum* (Rossi.); 27. *Stenocoris southwoodi* Ahmad; 28. *Declera punctata* (Sign.).

antenniferous tubercles remaining far behind apex of head; median sulcus long and deep or short, wide and shallow diverging anterolaterally and posterolaterally; mandibular plates in some species extending far beyond apex of clypeus enclosing the same; apex of labium usually reaching mesocoxae, distal end of basal segment sometimes reaching base of head, third segment shortest, bucculae very short, never reaching antenniferous tubercles; antennal segments long and slender, varying in length and circular in cross-section, fourth segment always longest; ratio of length head to length first antennal segment ranging from 0.65 : 1 to 2 : 1.

Family Coreidae Leach 1815[33]
(Figs. 1–8, 10, 20, 21, 23, 25)

Species Examined : *Cletus bipunctatus* (Westw.) *Hydarella orientalis* (Dist.), *Clavigralla gibbosa* (Spin.) *C. horrens* (Dohrn) and the representatives of *Hygia* Uhler, *Cletomorpha* Mayr, *Centrocoris* Kol, *Dasynus* Burm., *Homoeocerus* Burm., *Fracastorius* Distant, *Aschistocoris* Bergroth, *Leptoglossus* Guerin, *Notobitus* Stål, *Physomerus* Burm., *Acanthocoris* Amyot et Serville, *Petaloenemis* Stål, *Brachytes* Westw., *Dalader* Amyot et Serville, *Petillia* Stål, *Derepteryx* White, *Elasommia* Stål, *Ochrochira* Stål *Mictis* Leach and *Anoploenemis* Stål.

Occipital suture usually absent; ocelli present, not on elevations; deep preocellary pits always present in front or on inner sides of ocelli; coronal suture usually absent, arms sometimes present, antenniferous tubercles usually a little behind apex of head but sometimes extending beyond it; midcephalic sulcus always present, deep, elongated but sometimes short diverging anterolaterally and posterolaterally; in all species clypeus always extending beyond mandibular plates; bucculae broad



and long extending beyond antenniferous tubercles; apex labium sometimes reaching well beyond fore-coxae or sometimes reaching on to third abdominal sternum but usually reaching metacoxae, first labial segment usually passing base of head (in Pseudo-phloeinae never reaching base of head); length of labial segments varying in subfamily Coreinae (in subfamily Pseudophloeinae, third segment shortest); antennal segments usually long and slender but sometimes short and stout, basal segment thick in most species while apical segment usually shortest (in subfamily Pseudophloeinae always shortest); ratio of head to length of first antennal segment ranging from 1:0.8 to 1:8. (in subfamily Pseudo-phloeinae from 1:0.8 to 1:1.25 and in subfamily Coreinae 1:1 to 1:8).

Discussion

Most of the workers while tracing the phylogeny within the superfamily Coreoidea have given only a limited consideration to the morpho-taxonomic characters of the head. Spooner[63] did not show any median sulcus in his diagram of *Alydus* sp. of the family Alydidae and *Leptocorisa trivittatus* Say and *Corizus* sp. of the family Rhopalidae.

Gross[26] showed a median sulcus in both *Liorhyssus hyalinus* (Fabr.) and *Leptocorisa rufomarginata* (Fabr.) of the family Rhopalidae and Schaffner[56] showed an elongated median depression diverging antero-laterally and posterolaterally in *Riptortus macleani* Schaffner. Akbar[9] showed a median sulcus as a single longitudinal depression in *Leptocorisa acuta* (Thunberg) (*varicornis*). Fracker[25] also wrote about the presence of a median groove in the tribe Micrelytrini of the family Alydidae. Stys[66] describing the head of *Agriopocoris dimorphus* Stys of the subfamily Agriopcorinae of the family Coreidae showed a longitudinal mid-cephalic sulcus.

Schaefer[54] mentioned the presence of a mid-cephalic groove, longer than wide, very shallow, in the families Rhopalidae and Alydidae and a short mid-cephalic groove in the family Coreidae; Ahmad[1] showed a single median longitudinal depression in *Dicrorymbus nigridens* Bergroth and *D. luzonensis* Ahmad and a short and broad depression in *Xeno-ceraea backeri* (Bergroth) and *X. phillippianis* Ahmad of the subfamily Coreinae.

Ahmad[2] showed a single median longitudinal depression as the mid-cephalic sulcus in the sub-family Micrelytrinae. Ahmad[3] showed a single median longitudinal sulcus in all the species of the genus *Stenocoris* Burmeister of the submfaily Lepto-corisinae while in all the species of the genera *Leptocorisa* Latr. and *Mutusca* StåI of the same sub-family according to him the median longitudinal sulcus diverged anterolaterally. Ahmad[5] showed a single longitudinal depression as the median sulcus in *Longicoris pallida* Ahmad of the subfamily Micre-lytrinae.

Ahmad[6] describing the median sulcus of *Hygia opaca* Uhler of tle family Coreidae wrote that the median longitudinal sulcus was represented by a very small inverted V-shaped mark in the middle of the head. Lansbury[31,32] showed a faint mid-cephalic sulcus in the form of two separated parallel depressions diverging antero and posterolaterally in *Dicranocephalus pseudotestaceus* Lansbury.

During the present study it is assumed that a very faint mid-cephalic sulcus seems to have originated in the family Stenocephalidae in the form of two separated parallel depressions diverging antero-laterally and posterolaterally. These parallel depressions seem to have fused medially and only diverged anterolaterally in the family Rhopalidae. The conclusion that Stenocephalidae and Rhopalidae are the most primitive among Coreoidea is also reached by Schaefer[52,53,55] on the basis of a series of characters which he studied.

In the subfamilies Micrelytrinae and Leptocori-sinae of the family Alydidae the fusion is complete forming an elongate depression without any anterior or posterior diversions. This condition is present in most of the tribes of the subfamily Coreinae, Phyllomorphini, Centrocorini, Gonocerini, Homo-eocerini, Mictini, etc.

The subfamily Alydinae of the family Alydidae has retained the generalized condition of this sulcus as found in the Stenocephalidae. Similarly this condition is also retained in the subfamily Pseudo-phloeinae and in the tribes Physomerini and Col-purini of the subfamily Coreinae of the family Corei-dae. Ahmad[7] has considered Colpurini as generalized based on the characters of the female genitalia and has suggested that the group be elevated to subfamily rank. Hydarines which are generally considered belonging to this group (Cobben 1968, Ahmad 1970) on the other hand show these depres-sions fused similar to most coreines as discussed above but diverging anterolaterally and posterolaterally.

Schaefer[54] in the description of the head of the coreoid families did not mention anything about the occipital suture, coronal suture or coronal arms. The description of these sutures given by Akbar[9] in the head of *Leptocorisa acuta* (Thunberg) (*vari-cornis*) is very similar to those present in *Stenocoris southwoodi* Ahmad studied by the present authors. The present study also shows that the ocellus-eye distance varies from species to species. The occipital suture and the coronal suture are absent in the family Stenocephalidae. In the family Rho-palidae both of the above sutures are slightly deve-loped and in the family Alydidae these are well deve-loped. Also in *Hydarella orientalis* (Distant), Hydarinae, (Ahmad, 1970) and *Clavigralla gibbosa* (Spinola) (Pseudophloeinae, Coreidae) these are well developed unlike those of many coreine species studied presently. An interocellar suture is present in the family Stenocephalidae, in complete form in *Dicranocephalus lateralis* (Signoret), *D. marginatus* (Ferrari) and *D. bianchii* ((Jakovlev). It is slightly developed in the families Rhopalidae, Alydidae and Coreidae.

Preocellary pits are absent in the families Steno-cephalidae and Rhopalidae but present in the fami-lies Alydidae and Coreidae.

Ahmad[1] showed that the clypeus is deflected downwards a little before the mandibular plates in *Dicrorymbus nigridens* Bergroth and *Dasynus* *bucculentus* Stål of the subfamily Coreinae. He again in the following year noted that the clypeus is deflected downwards much before the mandibular plates in the species of the genera *Stenocoris* Burmeister, *Leptocorisa* Latr. and *Mutusca* Stål whereas in *Lyrnessus* Stål, *Cosmoleptus* Stål and *Noliphus* Stål of the tribe Noliphini of the same subfamily the clypeus is deflected downwards a little beyond the mandibular plates. The antenniferous tubercles in these genera are extended only a little short of the apex of the head.

The clypeus is deflected downwards much before the apex of the mandibular plates in the family Stenocephalidae and some genera of the subfamilies Leptocorisinae and Micrelytrinae of the family Alydidae. Among the families Coreidae and Rhopalidae, and in the species of the subfamily Alydinae and in the representatives of some genera of the subfamilies Leptocorisinae and Micrelytrinae of the family Alydidae the clypeus deflects downwards beyond the mandibular plates. The clypeus immediately starts deflecting downwards beyond the base of the antenniferous tubercles in the family Coreidae but runs forward for some distance and then it is deflected downwards in the families Stenocephalidae, Rhopalidae and Alydidae.

The bucculae are very short in the family Alydidae where they do not reach the antenniferous tubercles. In the families Stenocephalidae, Rhopalidae and Coreidae they are large and reach beyond the insertion of the antenniferous tubercles. Probably both alydids and coreids have diverged from rhopalid-like ancestors. The former showing specialization of the above character whereas the latter retains the ancestral condition of the buccula (but specializing in others). This conclusion is also in agreement with Ahmad[2] and Ahmad and Shadab.[8]

The length of the labium varies from species to species. The distal end of the basal segment never reaches the base of the head in the family Stenocephalidae nor in the representatives of the subfamily Pseudophloeinae examined but in the other families this condition varies to a great extent.

The basal antennal segment is thick and short in the families Stenocephalidae and Rhopalidae but varies in the families Alydidae and Coreidae. In the family Alydidae the fourth segment is the longest. The ratio of the length of the head to the length of the first antennal segment is the lowest in the family Rhopalidae, gradually increasing in the families Stenocephalidae, Alydidae and in the family Coreidae in ascending order. Peculiar variations occur in the first antennal segment in some coreids. In *Hydarella orientalis* (Distant) its distal end is clavate while in *Paranotocoris echinus* Ahmad and Shadab it bears many long tubercles a little before the end.

Detailed study of the above characters in the coreoid species examined indicate that the representatives of the family Stenocephalidae are probably the most primitive. From similar ancestors probably arose the rhopalids. Similar ancestors probably gave rise on the one hand to the alydids and on the other to the more advanced coreids through relatively primitive psuedophloeines and hydarines. This conclusion goes hand in hand with the findings of Schaefer[53,55] Ahmad[7] and Ahmad and Shadab.[8]

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