Biological Sciences Section

EXTERNAL MORPHOLOGY OF CHRYSOCORIS STOCKERUS (LINN.) (PENTATOMOIDEA : SCUTELLERIDAE) WITH COMPARATIVE ACCOUNTS ON FOURTEEN RELATED SPECIES FROM PAKISTAN, AZAD KASHMIR AND BANGLADESH AND THEIR BEARING ON CLASSIFICATION

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Abstract. The external morphology of *Chrysocoris stockerus* (Linn.) (Scutelleridae) is carried out to understand and evaluate the significance of more reliable characters specially those of metathoracic scent gland ostioles and male and female genitalia and in this light fourteen other scutellerids from Pakistan, Azad Kashmir and Bangladesh representing nine genera, five tribes and four subfamilies are studied. The results are compared with the data available in the existing literature and already existing phylogenetic schemes are briefly reviewed.

The external morphology has long been regarded a conventional tool for taxonomical works and primarily for this reason most of the morphological investigations have been undertaken in the past for providing a better under-standing of these characters. Except that by Fedotov[20] not a single species of the present rather economically important family Scutelleridae has been worked out in the literature to date on the pattern of those of Tower,[81] Malouf,[45] Bonnemaisow,[10] Akbai[67] Beccari and Fenili[9] and MacGill.[44]

Heteropterous morphology in general and those of scutellerids including also those based on lone species are all reviewed in general works and also in the works dealing with comparative morphology covering one aspect or the other of the Heteroptera. Cobben[14] has cited 352 references ; Southwood[75] 330 references and Southwood and Leston's[76] 'Land and Water bugs of British isles' has given classified references on all sections.

In the light of above, to review all the morphological accounts in a work of present nature in which emphasis is laid on the aspects of phylogenetic importance would not only be superfluous but also out of place. However, some of the general accounts and particularly those on scutellerids, specially of Vidal,[83] Piotrowski,[62] Leston,[34] McDonald,[49–52] Kumar,[26–29] and Lattin[32] are included in the discussion.

McDonald[50,51] treated Scutellerinae of the sub-family rank and later[52] agreeing with Pendergrast [61] and Kumar[27,28] raised it to family level but considered it difficult to define the group on the basis of male and female genitalia. Below familial level also, the problem is far from settled. Kumar[29] concluded that his studies raised more questions than it answered and thought that their solution rested in an investigation of more members of Pachycorinae and Eurygasterinae. Similarly McDonald[52] emphasized the need of further work on the Palaearctic species of Odontoscelini for an adequate definition of the tribe.

It is apparent from above that studies on comparative morphology of scutellerids of Pakistan representing some of the Oriental, Palaearctic and Ethiopian fauna was needed not only for filling the gaps in our knowledge, but also in order to solve many existing phylogenetic problems regarding supergeneric categories within the family and that of the family within the superfamily Pentatomoidea.

Material and Methods

All the specimens used in the present studies were collected by the staff members of the USDA, ARC Research Project A17-ENT-37 from various localities of Pakistan, Azad Kashmir and Bangladesh during expedition programmes. The identifications of the specimens were largely made by Dr. Q. A. Abbasi, former Lecturer, Department of Zoology, University of Karachi and confirmed and compared with types (mostly lodged at British Museum Natural History, London) by the present first author. Some of the identifications were also confirmed by Mrs. G. M. Black and Dr. M. S. K. Ghauri of British Museum Natural History and Commonwealth Institute, London respectively.

The specimens were treated in hot 10% caustic potash (KOH) for obtaining clarity and then were washed with water. For decolorization, chlorination was carried out in potassium chlorate and hydrochloric acid (conc.) ($KClO_3$ + HCl) in fume cupboard and when the material was completely decolorized, it was washed with water and after passing through the grades of alcohol was stained with acid fuchsin. The material was studied in alcohol and later preserved in a solution of absolute alcohol and glycerine.

The mandibular and maxillary stylets with levers were dissected from the head, treated with alcoholic, grades and were mounted in balsam. The genitalia were examined from both dried as well as preserved specimens after treatment. For female genitalia the abdomen was removed from the specimen and boiled in 10% KOH, washed with water and after dissecting the abdomen the spermatheca was removed and studied in glycerine and was then preserved in microvial with a drop of glycerine. The abdomen, then was reattached with the specimen, with the help of insect gum.

In the case of male genitalia after removing the pygophore from the specimen and treating the same with KOH and washing thoroghly with water, was dissected and fully inflated in the same medium in a cavity block and after treating it in different grades of alcohol it was placed on a very fine cotton pad immersed in glycerine in a cavity plate with the help of fine forceps. The aedeagus was examined and later was preserved in microvial with a drop of glycerine.

All the illustrations including those of metathoracic scent gland ostioles, seventh sternum in female, female terminalia, spermatheca, dorsal and ventral views of pygophore, inflated aedeagi and parameres have been drawn to the given scales. The diagrams were made under the Poland stereo-scope and Leitz bionoculars, with various magnifications using squared ocular grid and graph papers. For the male genitalia all the conjunctival appendages were numbered in sequence from the dorsal to ventral surface.

Results and Discussion

External Morphology of Chrysocoris stockerus (*Linn.*)

Head. Areas and Sulci of the Cranium (Fig. 1). The dorsal view of the adult head capsule of *Chrysocoris stockerus* (Linn.) (Fig. 1)) is porrected, with prominent laterally projecting compound eyes, and a pair of small shiny ocelli (ocl) in between the eyes. The dorsal cranial sclerites and setae are similar to that of *Coridius* = (*Aspongopus*) *janus* (Fabr.) as reported by Banerji[8] except that neither occipital sulcus nor its internal ridge is present however the occiput (oc Snodgrass[72]) is marked behind the compound eyes, and there is a somewhat 'U'-shaped impression between the ocelli which internally bears a complete ridge providing evidence for the presence of a true sulcus.

On the basis of this U-shaped impression the small area enclosed by it may be assumed frons (f). However tentrorial pits are entirely absent as reported by Duporte[17] and Rawat[67]. On the other hand there is no epistomal sulcus between the clypeus and frons, so the region from the 'U'-shaped impression to the attachment of labrum (lbr) with clypeus (cly) may be termed as fronto-clypeal region.

Externally there is nothing to divide the clypeus into anteclypeus (tylus of many authors) and post-clypeus (Matsuda,[47] MacGill,[44] Southwood[73]).

Spooner[77] states that in Heteroptera the frons and clypeus are always fused. Anteriorly the clypeus slightly bends downward to reach the basal portion of the labrum. The slender, longer, tapering labrum (Fig. 9) is suspended from the clypeus by the intervention of a membrane. Myers[55] refers it the labrum-epipharynx, while Hamilton,[23] Butt,[12] MacGill,[44] Qadri,[64] Qadri and Aziz[65] and Akbar[6] labelled it as labrum. It is chitinized, broad at the base and tapering distally and hardly reaches beyond second labial segment. Ventrally the latter possesses a mid-longitudinal line, the labial groove (lbg), which retains the stylet bundle.

Knight,[25] Butt,[12] MacGill,[44] Necomer[56] and Southwood[73] named the mandibular plates as 'Jugum' while Muir and Kershaw[54] called these as frontal ridge. Spooner[77] named it as paraclypei but Snodgrass[70] and Ahmad and Shadab[4] referred these as 'mandibular plates' and the same term is used presently. These are separated from the clypeus along the clypeal cleft (cc). The pleurostomal suture reported by Banerji[8] in *Coridius janus* (Fabr.) could not be observed in the present study. Ventral to the mandibular plates (map) are the maxillary plates separated by the mandibulo-maxillary suture (Figs. 2, mdms).

Each maxillaryplate (mxp) ventrally produces an exo-skeletal lobe which extends downwards supporting the basal labial segment. These lobes are termed bucculae (Spooner[77]) (Fig. 2, b). Parsons[58] named these the gular lobes; Crampton and Sprague[15] called these the ventral part of the maxillary plate.

The gula (gu) (Fig. 2) is well developed and there is no mark of identification between the gula, genae and maxillary plates. Genae (ge) are present between the antennae and the compound eyes, posteriorly merging with gula while dorso-anteriorly separated from the antennal base.

Antennae (Fig. 4). The antennae are situated on the sides of the head capsule in front of the compound eyes in antenniferous tubercles (an). Each antenna is surrounded by circum-antennal sulcus (cas) and is five segmented. With the first (basal) segment larger than the second. The latter is the smallest. The third segment is slender and distinctly longer while the fourth segment is longest of all segments and is cylindrical whereas the fifth segment is only smaller than fourth and is somewhat flattened. Both the fourth and the fifth segments appear somewhat medially grooved. The basal portion of first antennal segment is yellowish and the entire antenna is of black colour, and is covered with minute bristles.

Compound Eyes (Fig. 1). The compound eyes are large as compared to the head. Each eye is surrounded by a circumocular sulcus (cos), is sessile and globular in shape. These are very prominent and reddish-orange in colour.

Labium (Figs. 5 & 6). The labium is four segmented (sg1—4), long and slender, reaching third coxae. The segmental nature of labium is important in classification and identification. According to Muir and Kershaw[54] entire surface of first labial

segment is fused with bucculae. Same is true in the present species.

Mandibular Stylets (Fig. 8). The mandibular stylets (mnst) are elongated but shorter than the maxillary stylets. These are long and hollow in structure. Their extreme tips are serrate. The mandibular lever (mnl) is triangular in shape and is directly attached to the stylet base (mnd) and jugal plate ventrad to the antennal base.

Maxillary Stylets (Fig. 7). The maxillary stylets (mxst) are a pair of long, slender, partly sclerotized and curved structures running on the inner surface of corresponding maxillary plates. Maxillary stylets are broader at the base and gradually tapering at the apices with pointed and saw-like tips. The maxillary lever (mxl) is also triangular in shape.

Thorax

Prothorax. (Figs. 10, 11) The prothoracic tergum (Fig. 10) is a large plate covering much of the anterior half of the body. It is more or less hexagonal in shape. The antero-lateral margin of the tergum is turned downward in order to meet the pleural region. Internally a transverse ridge (trr) runs along the middle of the pronotal plate and marks the posterior limit of prothoracic coxal cavity (cxc).

There is no demarcation between the notal and pleural areas. Externally a short pleural sulcus (ps, Fig. 11) divides the pleural area into two sclerites ; the larger one proximal to the head is the episternum (ep) and a smaller portion lying away from the head is epimeron (em). Internally the pleural sulcus produces a distinct pleural ridge, from the dorsal surface of which is pronounced pleural apophysis (pleural arm of many authors and pleural taken of Larsen[30,31]) bending inward towards the sternal apophysis or the furca (fur). The furcal bases are connected by a well developed sterna costa (sc).

Mesothorax (Figs. 12, 13 & 14). The mesothorax constitutes the largest portion of the pterothorax. Its dorsal anterior 1/4 area lies beneath the prothoracic notum. Tergum of the mesothorax is made up of two portions; an anterior notum and a post-notum (Fig. 14). The notum is composed of several distinct regions. The prescutal suture is absent. Two small prealar arms (pra) at antero-lateral angles of pronotum suggest that prescutum (psc) is completely fused with scutum, therefore, the former is represented by its anterior margin. A 'U'-shaped parapsidal sulcus (pps) runs in the middle of large scutum (sct.). Tower,[81] Taylor[80] and Malouf[45] erroeneously called the area bound by parapsidal suture, prescutum, as did many subsequent authors such as Larsen[30,31] and Parsons.[59] The internal ridge of the parapsidal sulcus is indistinct. The scutum is located medially, laterally and posteriorly to the parapsidal sulcus (pps).

The anterior notal wing process (anp) arises as a small projection along the lateral border of the scutum, but the posterior notal wing process is not visible dorsally. Posteriorly the scutum extends onto the scuto-scutellar sulcus (sss) which separates it from the huge scutellum (sctl); the key character of the family. The scuto-scutellar suture is rarely found in Heteroptera. The ridge of scuto-scutellar suture is quite distinct internally. Larsen[30] has reported this suture in *Eurygaster* and *Odontoscelis.*

The scutellum (sctl) is a large 'U'-shaped sclerite which projects backwards covering mesothoracic post-notum, metathoracic tergum and all the abdominal tergites completely. The post-notum (pnt) is in the form of a narrow thin and membranous structure lying beneath the scutellum.

The mesosternum and metasternum are completed fused (Figs. 12 & 15) and bound medially by mesosternum which is separated by sterna-costal suture into the anterior basi sternum (bst) and posterior sternacosta (sc). The sternacosta connects the bases of the mesofurca (Fig. 13, mf). A median longitudinal groove runs through the basisternum which broadens posteriorly.

The mesofurca (Fig. 13 mf.) is T-shaped, a three branched structure, a posterior, a latero-medial and an antero-dorsal branch. The latter carries the thread-like furcal arm (fam) and its terminal funnel-shaped apodeme (tap). Malouf[45] misinterpreted sternacosta in *N. viridula* (L.) as antecostal ridge. The anterior margin of mesocoxal cavity (cxc1) is formed by precoxal bridge which is fused with episternum (ep 1). The pleural ridge (Fig. 13 pr) is reduced, externally represented only by dorsal part of the pleural sulcus (ps) and the pleural wing process. The pleural arms arise near the dorsal end of the ridge. The region anterior to the pleural ridge can be recognized as episternum only. The region posterior to the pleural ridge is greatly reduced and represents epimeron (em 1) which forms a narrow postcoxal bridge. A ventral evagination of the mesopleuron forms a supracoxal lobe (scl). The trochantin beneath the supracoxal lobe is easily removable.

The presternum is indistinctly fused with the meso-sternum. A thick band at the anterior margin (Fig. 13, pp) is a secondary evagination which is continuous with the prepectus of the mesopleuron (Matsuda[48]). Khanna[24] and Gupta[22] erroneously called this region the presternum.

Metathorax (Fig. 15). The metathoracic tergum is considerably shorter than the tergum of the mesothorax. The prescutum (psc) is completely fused with the scutum. A broad 'U'-shaped parapsidal sulcus runs in the latter. The scutellum (sctl) is a very thin and narrow plate behind the scuto-scutellar sulcus (sss) and the post-notum (pnt) is visible only laterally below axillary cords of the hind wings.

In metathorax (Figs. 12, 13), the metasternum and metapleuron are completely fused without any trace of the pleuro-sternal suture. The precoxal bridge is divided by the scent groove (or paracoxal suture ; Matsuda[48]) into an anterior 'laterale' (pre-episternum and an-episternum) (Fig. 13, al) and a posterior 'antecoxale' (ketepisternum Fig. 13, anc). The latter is fused with the anterior margin of the metacoxal cavity (cxc2) except at outer

end. The trochantin beneath the supracoxal lobe (scl) is easily removable.

The pleural ridge (pr) is vestigeal, externally represented by only dorsal part of the pleural suture and by the pleural wing process. The pleural arm is absent. The furcasternum (frt) extends antero-laterally, anteriad to the inner margin of the meta-coxal cavity. The meta-furcae (mtf) arise at this point and are smaller than the mesofurcae.

The extended antero-lateral angles of the furcasternum together with the meta-furcae form the inner orifice of the scent vestibule. The vestibule (vet) is an evagination of the anterior laterale which makes a secondary connection with the antecoxale, enclosing the entire scent groove ; except its outer end which forms the ostiole (o). The ostiole leads into a narrow peritreme (per) which runs laterally and then anteriorly. The metapleuron anterior, posterior, and outer to the peritreme is rugulose and appears distinct from rest of the meta-pleuron, and forms the evaporatoria (ev.). The structure of peritreme, the ostiole and the evaporatoria is usually consistent within a group and offers important taxonomical characters.

Wings

Forewings (Fig. 14, wng & Fig. 16). Hemelytra or mesothoracic wings are basally coraceous but smooth and membranous apically. The dorsal surface is divided into two parts by a transverse semicircular furrow (scf). The coraceous portion of the forewings is divided into three parts.

The apical membrane (mb) contains a large number of small vein-lets (vlt), which run on the longitudinal axis of the wings. These are simple, unbranched and are arranged into two groups, both having seven or eight veinlets respectively. The outer area of the coraceous basal portion lying the costal margin is the embolium (emb) and is marked off from the rest of the coraceous portion by means of R + M.

Next to the embolium is the corium (co) the largest median, triangular area, which is bound anteriorly by radiomedian vein (R + M) and posteriorly by a claval furrow (cf). Its outer margin is marked off from the apical membrane by the furrow (scf). Area inwardly located to the claval furrow is the clavus (cvl). This portion of fore-wing is structurally similar to corium and embolium.

Hindwings (Fig. 17). Hindwings appear to be entirely membranous yet the apical portion of the wing is much thicker than the posterior much delicate portion. The hind-wings also have the same margins and angles as the fore-wings.

The anterior margins of hindwings are formed of costo-subcostal vein (C+Sc) ; next to this vein is radius (R), next to the radius is the median (M) which runs in the longitudinal axis of hindwing.

There are three anal veins ending near the middle lobe of the wing. The second anal vein ends at the third lobe of the wing and the last anal vein is present in the middle of the third lobe of the wing. In the hind wings there are also present two wing folds. The first fold (f1) runs parallel with the margin of the cubitus (Cu) and the second fold (f2) runs parallel with the first anal vein. The terminologies of the wing veins are discussed by Leston.[42] In resting position the wings are folded at these impressions.

Legs

Prothoracic Legs (Fig. 18). The coxa (cox) is more or less cylindrical in shape and projects out farther from the body than the coxae of the second and third pairs of legs. A basicostal suture (bcs) closely surrounds its proximal end. Posteriorly this suture is very faint, producing a basi-costal ridge internally. Each tibia (tib) is flattened dorso-ventrally and is provided with a powerful spine (tibs) at its distal end.

There are three tarsal segments (tar); first two segments are with distal tarsal spines (trs). The distal tarsal segment is joined with pretarsus (Snodgrass[70]) (post-tarsus of Fox and Fox[21]) which consists of two larger claws (cls), a ventral triangular unguitractor plate (ugt) and the sac-like pulvilli (pul). Unguitractor spines noted by Parsons[60] in *Saldula* spp. and by Akbar[6] in *Leptocorisa* spp. are not found in the present species of *Chrysocoris*.

Mesothoracic Legs (Fig. 19). Unlike the prothoracic, mesothoracic legs articulate at two points so the movement is restricted. The mesothoracic coxae are closer to the body than those of prothoracic coxae. The basicostal suture is distinct and separates it from a very narrow basicoxite. The joints between the mesothoracic leg parts are similar to those of prothoracic legs and the locomotion is described by Lauck[33].

Metathoracic Legs (Fig. 20). Coxae are similar to pro-and mesothoracic ones. Only there is some variation in shape and size of different parts.

Abdomen

Pre-genital Tergites (Figs. 23 & 24). Just behind the postnotum of metathorax, there extends posteriorly the intersegmental membrane which is connected with the first abdominal tergite. This is membranous and is completely fused with metathorax; it cannot be identified separately. The second abdominal tergite is also reduced and modified. It is sclerotized with a transverse ridge in the narrow middle region. The third tergite is comparatively broader than the second, and is finely united with second tergite.

The posterior boundary of the second tergite is overlapping with the anterior boundary of the third tergite, and the intersegmental membrane can be seen only after moving the overlapping tergites. The fourth tergum is longest of all, and is equal to the length of the 2nd and the 3rd segments combined. The paired impressions of the larval dorsal abdominal scent glands are present between the 3rd and 4th, 4th and fifth and fifth and sixth tergites. The fifth, sixth and seventh tergites are partially fused with one another. The connexivum (conx) is completely segmented and ends at seventh tergite. The inner latero-tergites between the

abdominal tergites and connexivum are also completely segmented.

The Pre-genital Sternites (Figs. 21 and 25). The pregenital sternites are almost similar in both sexes. The first sternum has undergone complete fusion with metathoracic sternum and therefore the second sternum represents the first visible ventral sternite. Its anterior margin is concave, anterolateral margins are rounded and posterior margin is convex. The third sternite is a rectangular plate. The fourth sternum is larger than the fifth. The fifth, sixth and seventh sternites like preceeding segments have anterior concave and posterior convex margins. Each sternal sclerites on its peripheral area bears a dark pigmented spot which is divided into two by a transverse impression. Above the transverse impression lies the spiracle (sp) on either side and below it a pair of trichobothria (tb) are placed.

The Genital and Post-Genital Regions (Figs. 26 and 28). The genital region comprises the organs of copulation and oviposition. It consists of ninth segment in the male and eighth and ninth segments in the females. The eighth segment in the male is much modified into a cup-like structure which appears semi-membranous and is uniform in texture (Fig. 22).

Female Genital Region or Ovipositor (Fig. 28). The term ovipositor is used usually in those Heteroptera which have elongate lacineate gonocoxae and gonapophyses. These in the present species are modified into plate-like structures and are, therefore, known as genital plates, as in Pyrrhocoroidea and Coreoidea of the Trichophora. Schaefer,[68] however, prefers the term ovipositor for both types of structures for both are homologous and are involved in deposition of eggs.

In the female genitalia the eighth paratergites (8th pt) and the first gonocoxae (1st gcx) are the components of the eighth abdominal segment. The paratergites are small and triangular in form and each bears a spiracle (8th spr.) and both being medially fused. Ninth paratergites similarly are small and are quadrangular in form. The ninth paratergites (9th pt) in contrast appear externally the only remnants of the ninth segment. Unlike the eigth these are not medially fused and underneath, with the help of a membrane are connected with the post-genital segments. The tenth and eleventh appear quadrangular and are called the proctiger (prr). Latter distally bears the anal opening.

Each first pair of gonapophyses (vesicles of the eighth), the second pair of gonocoxae and the second pair of gonapophyses (vesicles of the ninth) appear medially fused and are partly membranous and semi-sclerotized or sclerotized. Schaefer[68] has homologised the fused first gonapophyses with the triangulin (tr) and the fused second gonapophyses with the arcus of the earlier authors. However, he did not refer the more posteriorly fused second gonocoxae in his paper. As considered by Dupuis[18,19], Stys[79] and Schaefer[68] the free part of the gonangulum probably has been lost.

The semi-sclerotized or somewhat membranous anterior extension of the ovipositor termed by Scudder[69] the genital chamber or "gynatrium" by Stys[78] is much reduced. A sclerotized saccular structure is connected through a proximal duct at the lateral side of common oviduct. The former appears more expanded and is the spermatheca (Fig. 29) serving for the storage of sperm either received directly from the penis during copulation or as conceived by Scudder[69] following Leston[34] indirectly by the migration of sperms after copulation from the genital chamber specially in the species of some Scutelleridae.

The spermatheca has the usual pentatomoid form with a bulb (spb), a pump region (spp) with distal and proximal flanges (ds. f; px. f) and a distal spermathecal duct (ds. sp. d). This duct leads to the median dilation (sp.d.) in which median duct (sm. sp. d.) and sclerotized rod are clearly visible.

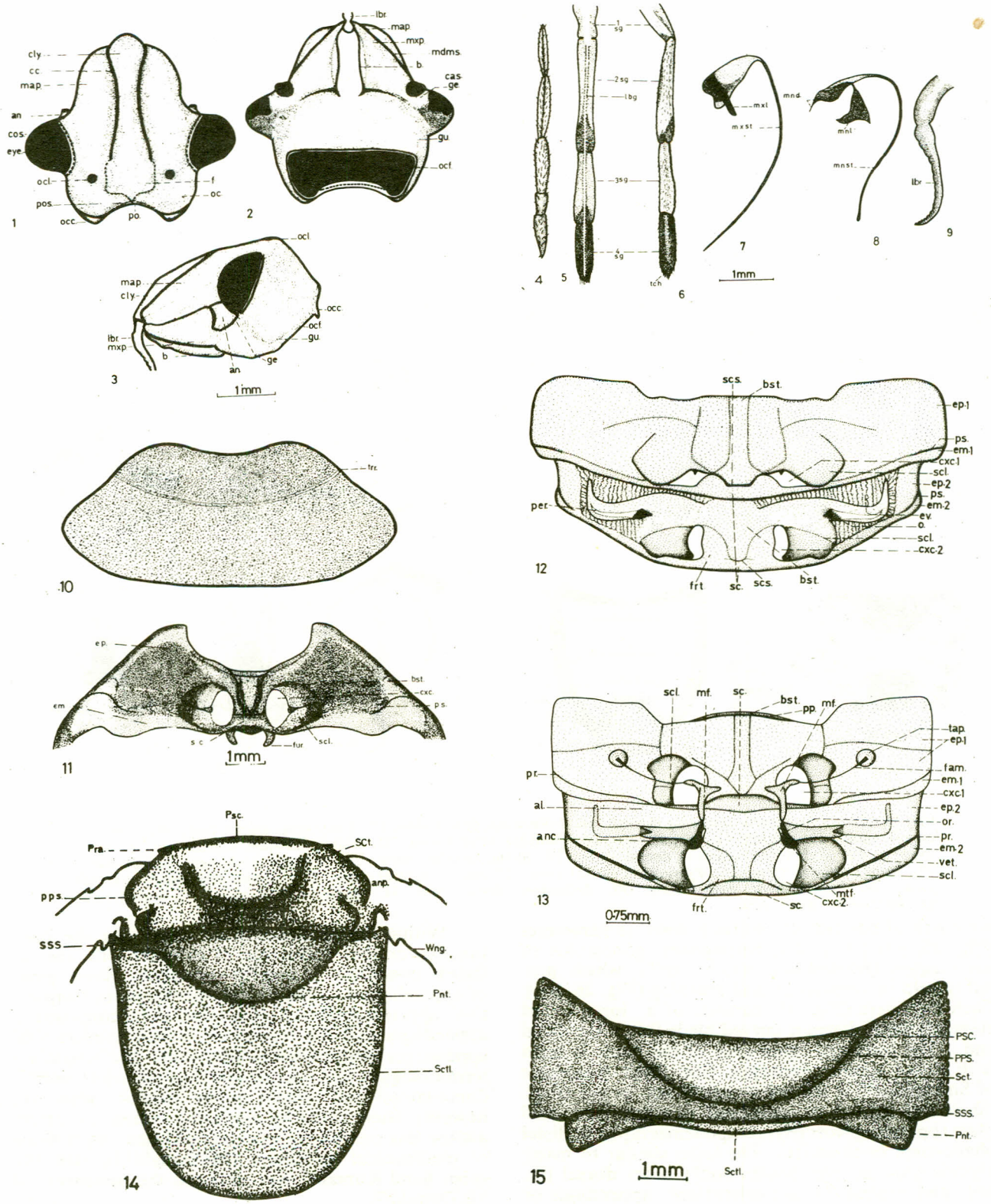
In some other species of the tribe Scutellerini, however, instead, externally the dilation does not show either median duct or sclerotized rod but, as noted by Pendergrast[61] and later by Kumar[29], it possesses ornamental lines and appears heavily sclerotized. The proximal spermathecal duct (px. sp. d) first dilates (px. s. sp. d) and then leads to the female's gonopore. Holes in the spermatheca are not observed as noted by Leston[34] and Scudder[69] which according to them in *Hotea* spp. are produced by insertion of the aedeagus during copulation.

Male Genitalia (Figs. 26, 27, 30, 31, 32 & 33). In Tuxen[82] Dupuis and Carvalho have given the pattern of the heteropterous genitalia. Ahmad and Southwood[5] have given hypothetical diagram of male aedeagus labelling all the thecal and conjunctival appendages following their position.

In the male genitalia the ninth segment is modified into characteristic cup-shaped structure known as the pygophore (Figs. 26 and 27, p) in which the organs of copulation are retained. The pygophore has two openings ; the anterior or proximal one an the dorso-posterior, distal, or terminal one. Through the anterior opening it is connected with the eighth segment which is also modified and membranouh in nature and acts as a connecting membranes between the seventh segment and male genital capsule. The dorso-posterior opening is larger and external in appearance and during copulation the aedeagus with its appendages is inflated through this opening (Bonhag & Wick[11], Qureshi *et al.*[65]). The fused tenth and eleventh segments are in the form of a quadrangular structure, the proctiger (Fig. 26, prr).

The dorsal margin of pygophore appears arched and is turned anteriad and appears raised. In some other species on its inner sides processes are seen and these also appear of taxonomic importance. Kumar[29] has found processes longitudinal and transverse on the main body of the pygophore ventrally which have not been observed in the present studies.

Within the pygophore on either side of the aedeagus proximally connected with the basal plate



Figs. 1—15. *Chrysocoris stockerus* (Linn.). 1. Head, dorsal view, 2. Same, ventral view, 3. Same, lateral view, 4. Antennae, dorsal view, 5. Labium, ventral view, 6. Same, lateral view, 7. Maxillary stylets, lateral view, 8. Mandibular stylets, lateral view, 9. Labrum, lateral view, 10. Prothorax, dorsal view, 11. Same ventral view, 12. Mesothorax, dorsal view, 13. Same ventral view, 14. Scutellum, dorsal view, 15. Metathorax, dorsal view,

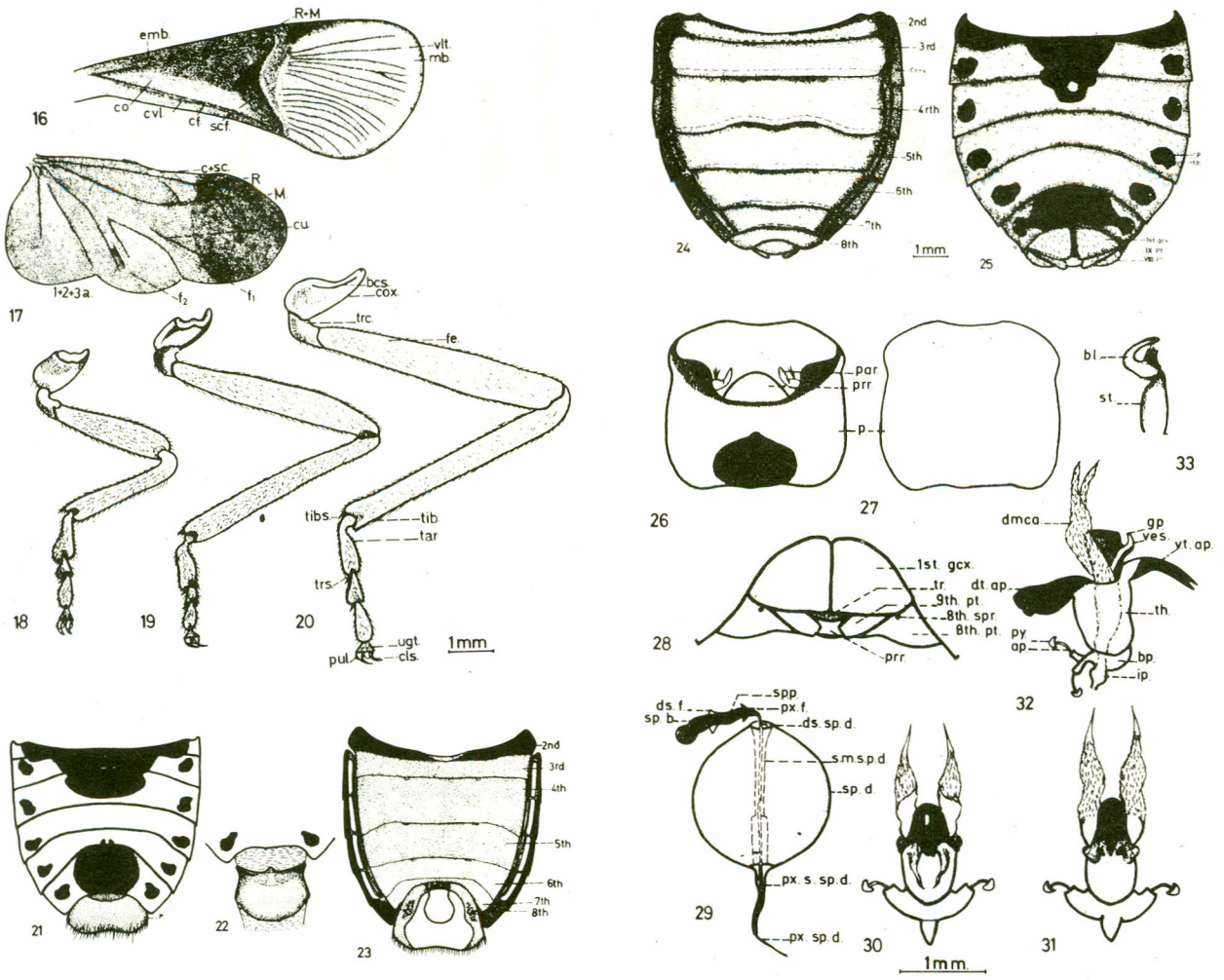


Fig. 16—33. *Chrysocoris stockerus* (Linn.). 16. Fore-wing, dorsal view, 17. Hind-wing, dorsal view, 18. Fore-leg, lateral view, 19. Middle-leg, lateral view, 20. Hind-leg, lateral view, 21. Male abdomen, dorsal view, 22. Same, showing 8th abdominal segment, dorsal veiw, 23. Same, ventral view, 24. Female abdomen, dorsal view, 25. Same, ventral view, 26. Pygophore, dorsal view, 27. Same, ventral view, 28. Female terminalia, ventral view, 29. Spermatheca, dorsal view, 30. Aedeagus, dorsal view, 31. Same, ventral view, 32 lateral/view, 33. Paramere, inner view.

are a pair of pointed structures known as parameres (Fig. 26, par ; Fig. 23), herpagones, gonostylus or the claspers (Ahmad and Southwood[5]) which probably help in copulation and grasping (Fig. 26, par). Each paramere (Fig. 33) consists of a long, broad stem (st) which bears a curved blade (bl) at the distal end. The proximal inner edge of the blade is beset with dense setae. Aedeagus (the fused mesomeae of Snodgrass[71]) is the main copulatory organ (Figs. 30, 31 and 32). It is composed of a proximal basal plate (bp) with pivots (py) or apodemes (ap) and distal phallosoma or theca (th). The latter similar to many alydids (Ahmad and Southwood[5]) bears dorsal (dt. ap) and ventral (vt. ap) sclerotized appendages or processes (also noted and/or drawn by Pruthi[63], Kumar[26·27·29] and McDonald[52] without comment) Ahmad and Southwood[5] found these appendages as of great taxonomic significance in Alydidae and probably these are of great taxonomic importance in Scutelleridae (Kumar[26·27·29], McDonald[50·52] and Lattin[32]).

Within the phallosoma or theca lies the conjunctiva or the endosoma of Pruthi[63]. In the inflated condition it usually possesses three pairs of appendages *i.e.*, the dorsal membranous conjunctival appendages (dmca), the dorsolateral conjunctival appendages and the frontal or ventral conjunctival appendages (Ahmad and Southwood[5]); McDonald's[52] terminology of first, second and third refers to dorsal, dorso-lateral and frontal in the present sequence; however, these could be confusing when the above author has confused these appendages with those of phallosomal processes (McDonald[52]). On the other hand Kumar[29] has reversed the sequence of McDonald[52].

The ejaculatory reservoir (McDonald[50·52] and the conducting chamber (Kumar[28·29]) is remarkably developed in this species. Ventral to which is attached the socalled vesica (ves). This is entirely sclerotized, short and curved dorsally and bears the gonopore (gp). McDonald[49 50·52] has used the structure as taxonomic tool and has

found it usually well developed in the entire tribe Scutellerini.

Kumar [28,29] has called this structure the conducting chamber having conducting canals and has attributed the function of controlling the flow of sperm through gonopore by this chamber and has described a very complicated structure with double system of canals. Previous authors including McDonald [49,50,52] have attributed the function of storage of sperms by this region. The histology of this region might further throw some light on the functional aspects of this organ.

The ejaculatory duct before entering into the basal plate forms a funnel-like vesicle forming an inflatory pump (ip) which pushes the semen into the aedeagus during copulation. In the present species as well as in many other scutellerines part of the ductus ejaculatorius and inflatory vesicles are strongly sclerotized and appear-like proximal processes of aedeagus. At the antero-lateral angles of the basal plate the dorsal knobs are produced into apodemes (ap) on each side which bear a pivot (py) at their distal end (Marks[46]), but these do not appear to have taxonomic significance.

Comparative Morphology

Table 1 gives a list of 15 species of the family Scutelleridae, presently studied with their tribal and sub-familial categories, with figure numbers referring to the illustrations through out the text and relevant descriptions, if any on any of the above categories in the literature todate.

Tables 2-5 give comparative accounts on head, metathoracic scent gland astioles, male and female genitalia and comparisons with other scutellerines reported in the literature are made under phylogenetic considerations.

TABLE 1.

Species examined	Figs. cited in the text	Previous descriptions
Subfamily: Eurygastrinae Tribe: Eurygastrini		
1. *Eurygaster integriceps*	(34-43)	Kumar [28,29] (conducting chamber, male and female genitalia, Fedetov,[20] Lattin,[32] McDonald[52] (male and female genitalia), Lodos[43] (only female terminalia), Piotrowski,[62] Vidal[83] and Wagner [84,85] (on inflated aedeagus), Scudder[69] (only female genitalia).
2. *Eurygaster maura*	(44-54)	
Subfamily: Odontoscelinae Tribe: Odontotarsini		
3. *Alphocoris lixoides*	(55-63)	Kumar[29] and McDonald[52] (only male and female genitalia).
Subfamily: Pachycorinae Tribe: Pachycorini		
4. *Deroplax sp.*	(64-70)	Kumar [28,29] (only conducting chamber, male and female genitalia), Lattin,[32] McDonald[49–52] (male and female genitalia), Leston[34] (only male genitalia), Pendergrast[61] (only spermatheca), Scudder[69] (only female genitalia).
5. *Deroplax zahidae* (MS)	(71-74)	
6. *Hotea curculionoides*	(75-78)	
7. *Hotea nigrorufa*	(79-82)	
Subfamily: Scutellerinae Tribe: Elvisurini		
8. *Solenostethium rubropunctatum*	(83-93)	Kumar[28,29] (male and female genitalja), Leston[34] (male genitalia), McDonald[49–51] (male genitalia and female terminalia).
Tribe: Scutellerini		
9. *Cantao ocellatus*	(94-104)	Kumar[26–29] and McDonal d[49–52] (male and female genitalia), Leston[34] (male genitalia), Pendergrast[61] (only spermatheca), Pruthi[63] (only male genitalia), Scudder[69] (female terminalia and spermatheca).
10. *Chrysocoris stockerus*	(1-33 & 105)	
11. *Poecilocoris latus*	(115-124)	
12. *Poecilocoris* (*Parapoecilocoris*) *interruptus*. (Probably anohter genus)	(140-149)	
13. *Poecilocoris* sp.	(106-114)	
14. *Scutellera fasciata*	(125-135)	
15. *Scutellera nobilis*	(136-139)	

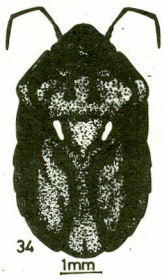


Fig. 34. *Eurygaster integriceps*, dorsal view.

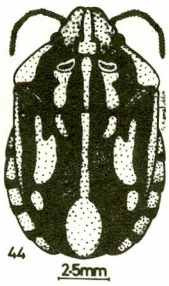
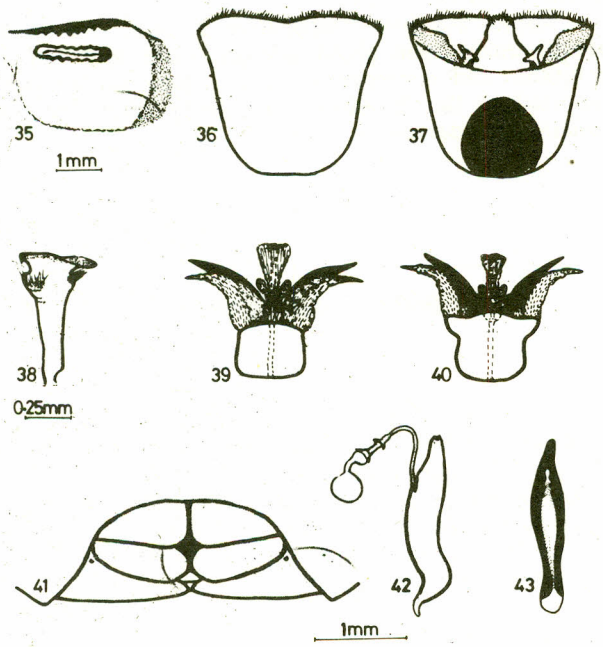
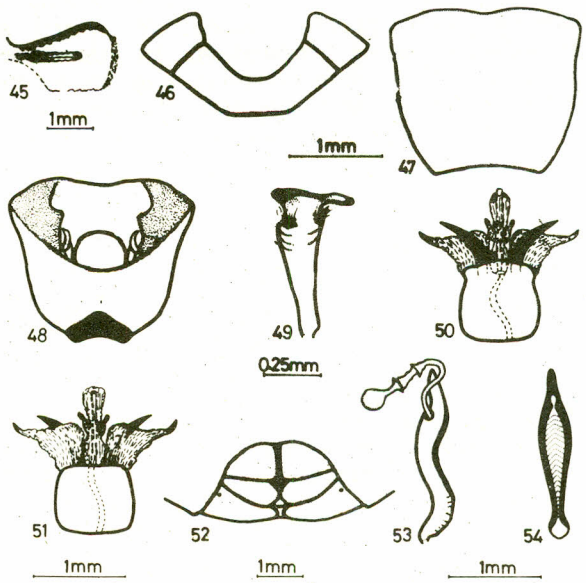


Fig. 44. *Eurygaster maura*, dorsal view.



Figs. 35—43. *E. integriceps*. 35. Metathoracic scent gland ostiole, ventral view, 36. Pygophore, ventral view, 37. Same, dorsal view, 38. Paramere, inner view, 39. Aedeagus dorsal view, 40. Same, ventral view, 41. Female terminalia, ventral view, 42. Spermatheca, dorsal view, 43. Median dilation dorsal view.



Figs. 45—54. *E. maura*. 45. Metathoracic scent gland ostiole, ventral view, 46. 8th abdominal segment, 47. Pygophore, ventral view, 48. Same, dorsal view, 49. Paramere, inner view, 50. Aedeagus, ventral view, 51. Same, dorsal view, 52. Female terminalia, ventral view, 53. Spermatheca dorsal view, 54. Median dilation, dorsal view.

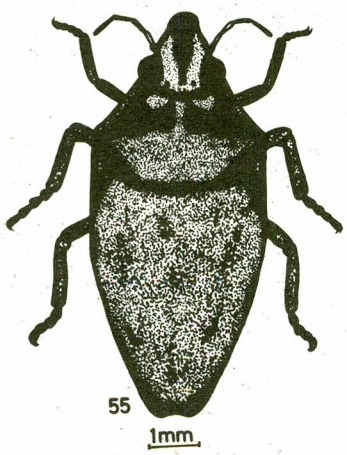
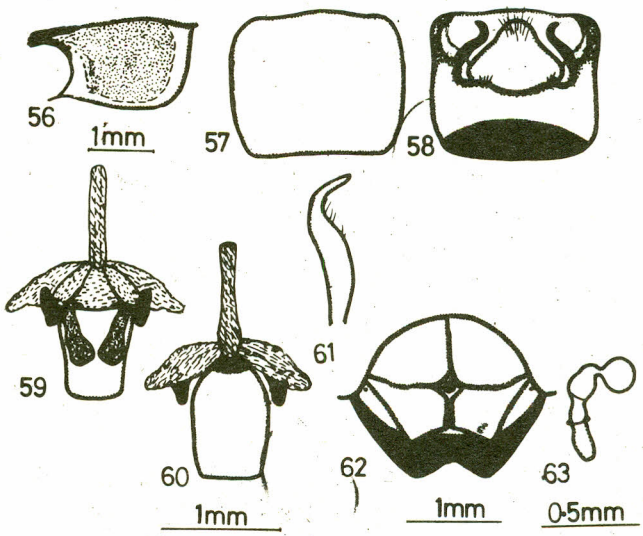


Fig. 55. *Alphocoris lixoides*, dorsal view.



Figs. 56—63. *A. lixoides*. 56. Metathoracic scent gland ostiole ventral view; 57. Pygophore, ventral view, 58. Same, dorsal view, 59. Aedeagus, ventral view, 60. Same, dorsal view, 61. Paramere, inner view, 62. Female terminalia, ventral view, 63. Spermatheca, dorsal view.

Figs. 64. *Deroplax* sp., dorsal view.

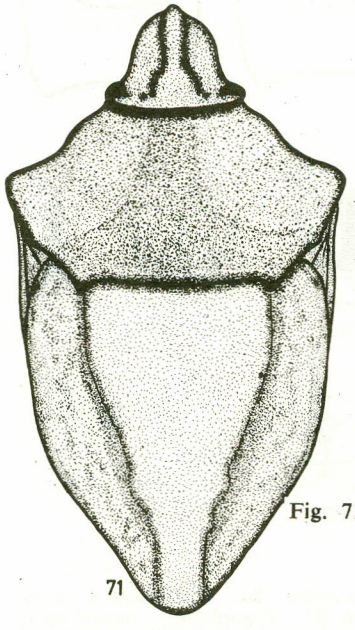


Fig. 71. *Deroplax zahidae* (MS), dorsal view.

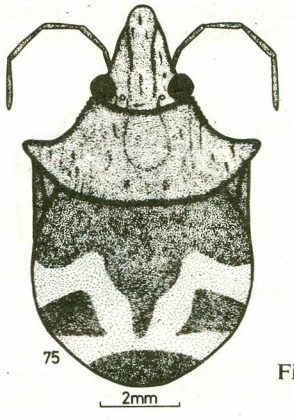
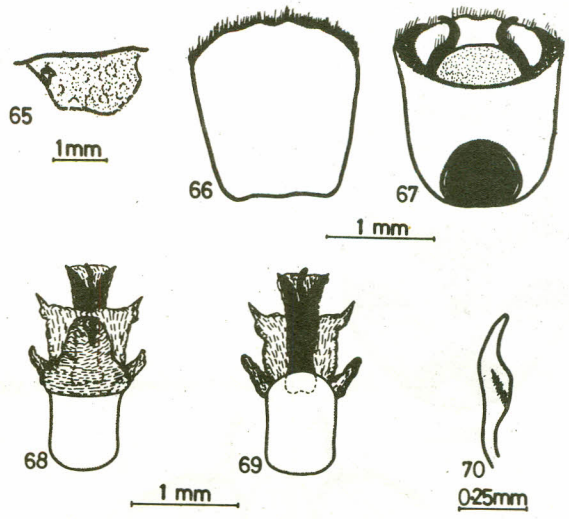
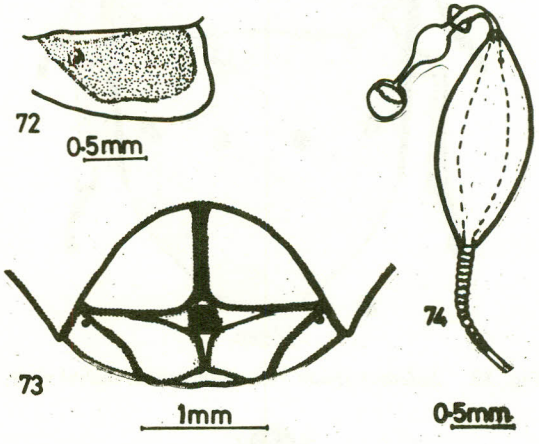


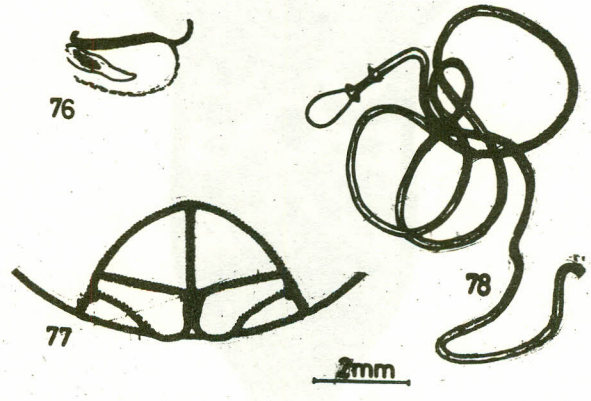
Fig. 75. *Hotea curculionoides*, dorsal view.



Figs. 65—70. *Deroplax* sp. 65. Metathoracic scent gland ostiole, ventral view, 66. Pygophore, ventral view, 67. Same dorsal view, 68. Aedeagus, dorsal view, 69. Same ventral view, 70. Paramere, inner view.



Figs. 72—74. *D. zahidae*. 72. Metathoracic scent gland ostiole, ventral view, 73. Female terminalia, ventral view, 74. Spermatheca, dorsal view.



Figs. 76—78. *H. curculionoides*. 76. Metathoracic scent gland ostiole, ventral view, 77. Female terminalia, ventral view, 78. Spermatheca, dorsal view.

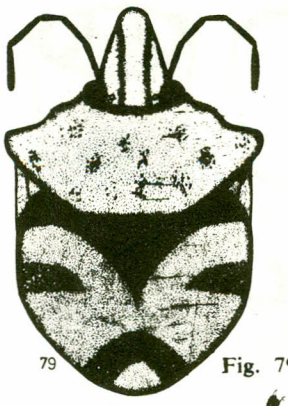


Fig. 79. *Hotea nigrorufa*, dorsal view.

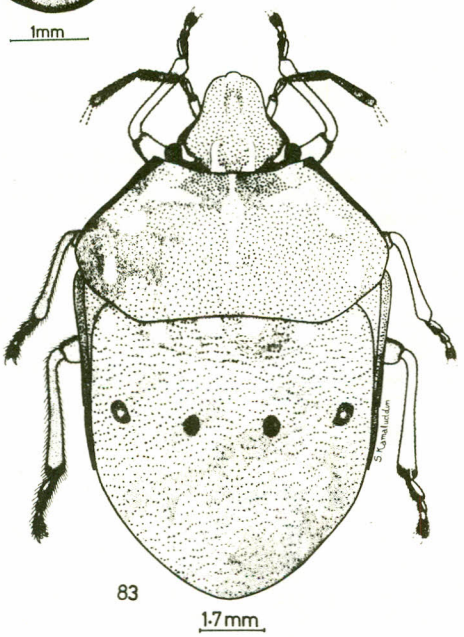
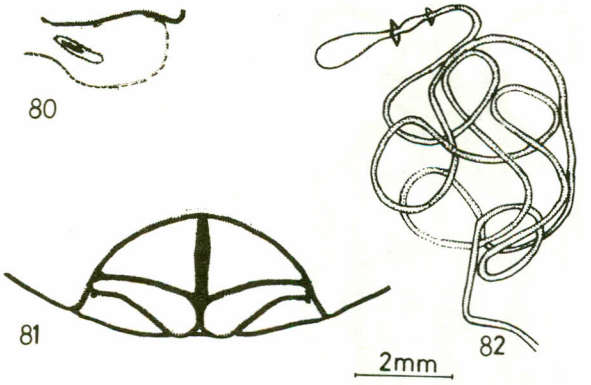
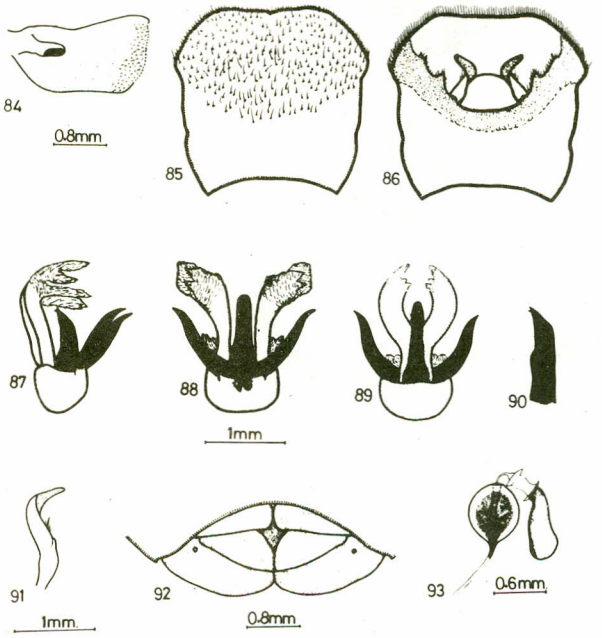


Fig. 83. *Solenostethium rubropunctatum*, dorsal view.

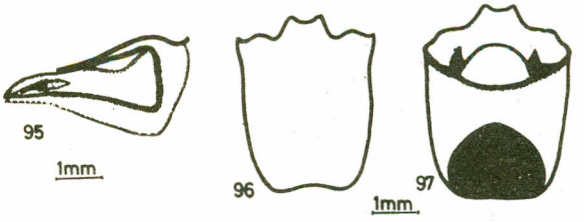
Fig. 94. *Cantao ocellatus*, dorsal view.



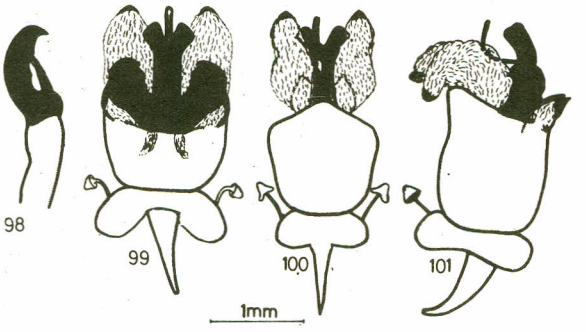
Figs. 80—82, *H. nigrorufa*. 80. Metathoracic scent gland ostiole, ventral view, 81. Female terminalia, ventral view, 82. Spermatheca, dorsal view.



Figs. 84—93. *S. rubropunctatum*. 84. Metathoracic scent gland ostiole, ventral view, 85. Pygophore, ventral view, 86. Same, dorsal view, 87. Aedeagus, lateral view, 88. Same, dorsal view, 89. Ventral view, 90. Fused vesica and penal lobes, anterior view, 91. Paramere, inner view, 92. Female terminalia, ventral view, 93. Spermatheca, dorsal view.



Figs. 95—97. *C. ocellatus*. 95. Metathoracic scent gland ostiole, ventral view, 96. Pygophore, ventral view, 97. Same dorsal view.



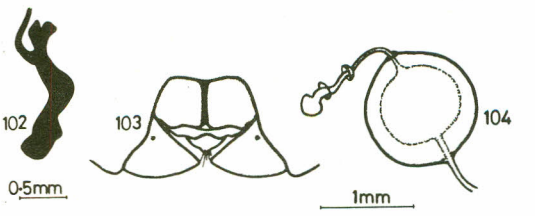
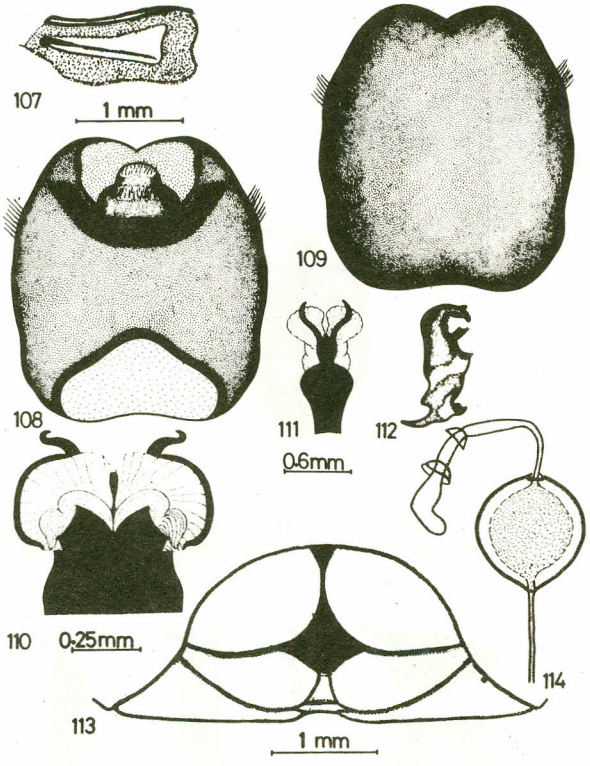


Fig. 98—104. *C. ocellatus*. 98. Paramere, inner view, 99. Aedeagus, ventral view, 100. Same, dorsal view, 101. Lateral view 102. Fused vesica and penal lobes, anterior view, 103. Female terminalia, ventral view, 104. Spermatheca, dorsal view.



Figs. 107—114. *Poecilocoris* sp. 107. Metathoracic scent gland ostiole, ventral view, 108. Pygophore, dorsal view, 109. Same, ventral view, 110. Aedeagus, dorsal view, 111. Same ventral view, 112. Paramere, inner view, 113. Female terminalia, ventral view, 114. Spermatheca, dorsal view.

Fig. 115. *Poecilocoris*, dorsal view.

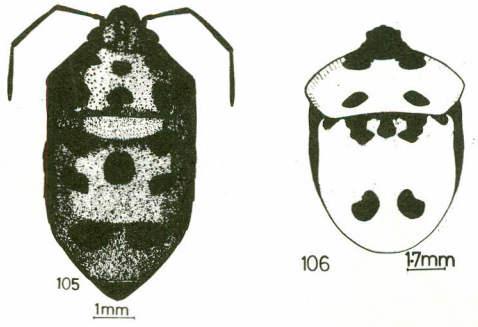
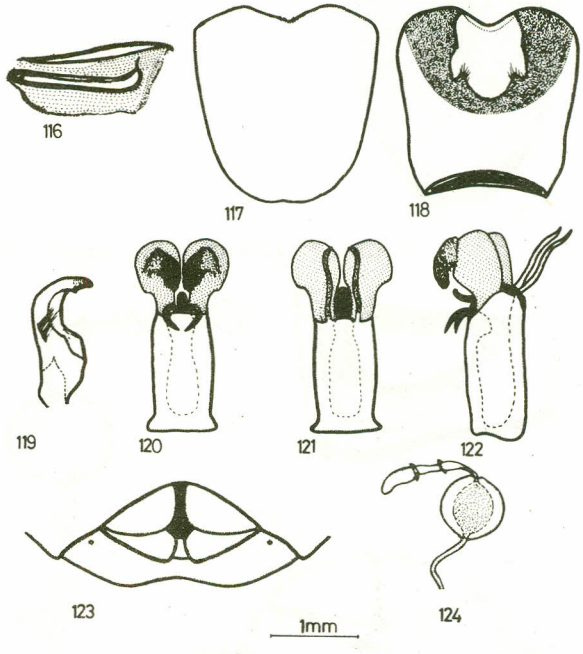


Fig. 105. *Chrysocoris stockerus*, dorsal view.

Fig. 106. *Poecilocoris* sp., dorsal view.



Figs. 116—124. *P. latus*. 116. Metathoracic scent gland ostiole, ventral view, 117. Pygophore, ventral view, 118. Same, dorsal view, 119. Paramere, inner view, 120. Aedeagus, dorsal view, 121. Same, ventral view, 122. lateral view, 123. Female terminalia, ventral view, 124. Spermatheca, dorsal view.

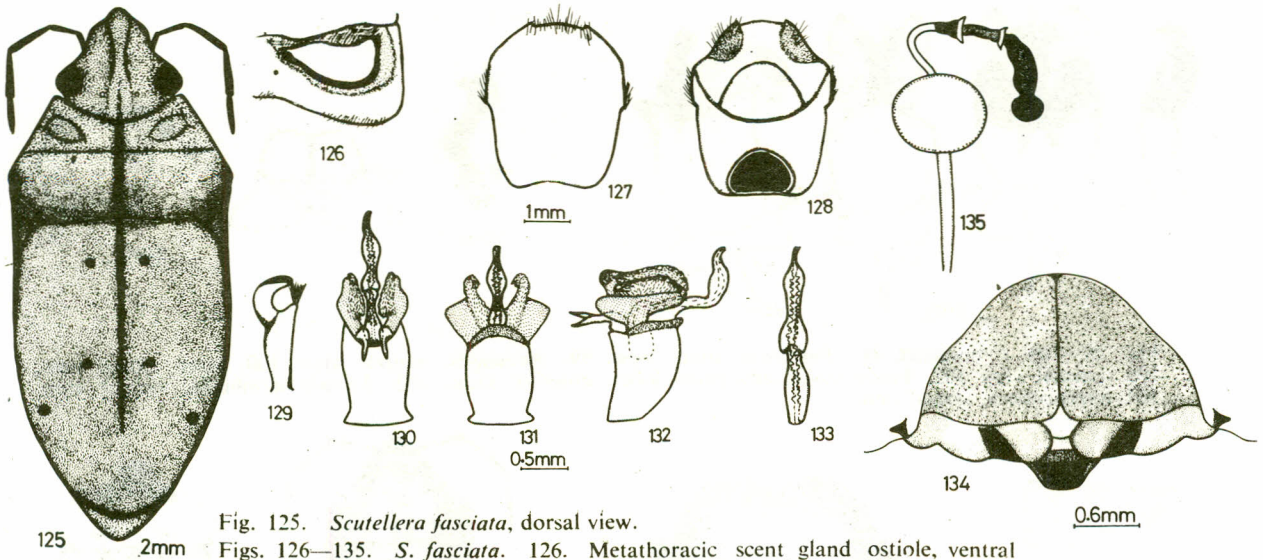


Fig. 125. *Scutellera fasciata*, dorsal view.

Figs. 126—135. *S. fasciata*. 126. Metathoracic scent gland ostiole, ventral view, 127. Pygophore, ventral view, 128. Same, dorsal view, 129. Paramere, inner view, 130. Aedeagus, dorsal view, 131. Same, ventral view, 132. lateral view, 133. Fused vesica and penal lobes, anterior view, 134. Female terminalia, ventral view, 135. Spermatheca, dorsal view.

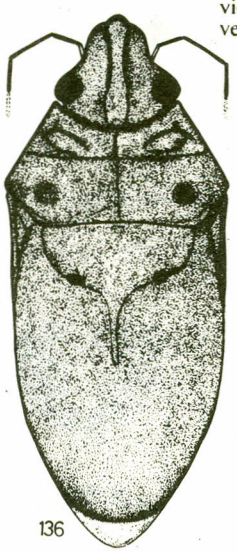
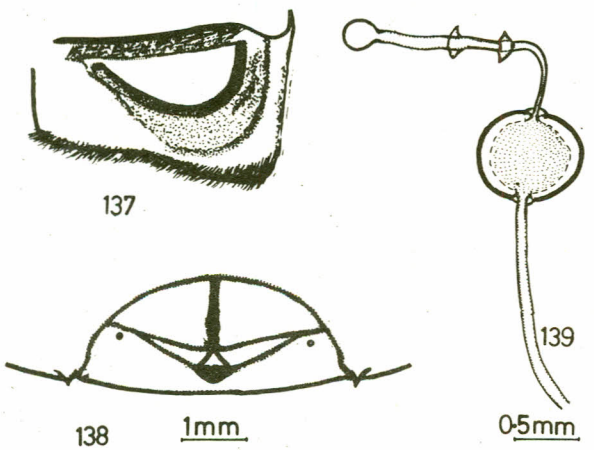
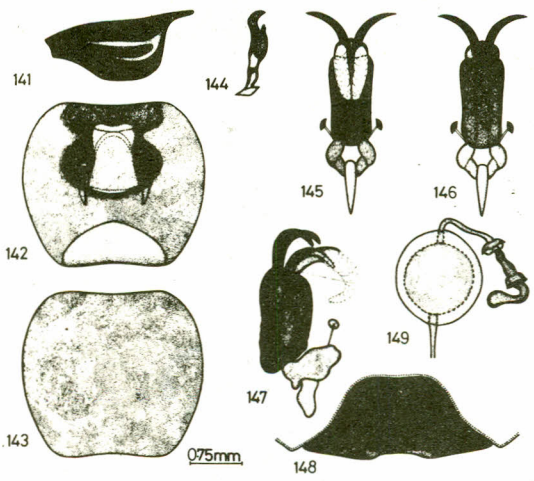


Fig. 136. *Scutellera nobilis*, dorsal view.

Figs. 140. *Poecilocoris* (Parapoecilocoris) *interruptus* (probably a distinct genus) dorsal view.



Figs. 137—139. *S. nobilis*. 137. Metathoracic scent gland ostiole, ventral view, 138. Female terminalia, ventral view, 139. Spermatheca, dorsal view.



Figs. 141—149. *P.* (P) *interruptus* (probably a distinct genus). 141. Metathoracic scent gland ostiole, ventral view, 142. Pygophore, dorsal view, 143. Same, ventral view, 144. Paramere, inner view, 145. Aedeagus, dorsal view, 146. Same, ventral view, 147. Lateral view, 148. Female terminalia, ventral view, 149. Spermatheca, dorsal view.

TABLE 2. COMPARATIVE CHARACTERS OF HEAD.

Species	Clypeus		Mandibular sulci	Ocelli	
	Length in proportion to mandibular plates	Shape		Shape	Inter-ocellar distance in proportion to distance from an ocellus to an eye
1	2	3	4	5	6
E. integriceps	As long as	Convex, raised in the middle.	Very prominent, marked with thin lines.	Small, rounded and some-what raised.	Closer to eyes than to each other.
E. maura	As long as	Convex, deflected anteriad.	Less prominent.	Very small and rounded.	Closer to eyes than to each other.
A. lixoides	As long as	Raised throughout its length.	Less prominent.	Very minute and depressed.	Much closer to eyes.
Deroplax sp.	Extending beyond	Convex and raised posteriorly.	Marked with thin lines.	Very prominent and large.	Much closer to eyes.
D. zahidae	Extending beyond	Smoothly convex posteriad.	Less distinct.	Very prominent.	Much closer to eyes.
H. curculionoides	Extending beyond	Anteriorly much raised, convex.	Marked with thin lines.	Very prominent.	Much closer to eyes.
H. nigrorufa	Extending much beyond	Anteriorly much raised, convex.	Absent or indistinct.	Very prominent.	Much closer to eyes.
S. rubropunctatum	Extending beyond	Convex and raised anteriad.	Somewhat faint.	Very prominent and large.	Much closer to eyes.
C. ocellatus	Extending beyond	More convex, raised anteriad and posteriad.	Marked with faint groove.	Very large and prominent.	Closer to eyes.
C. stockerus	Slightly extending beyond	Convex, moderately raised throughout.	Marked with deep grooves.	Moderate but prominent.	Closer to eyes.
P. latus	Extending far beyond	Broadly convex, raised anteriad.	Marked with deep grooves.	Small, prominent and rounded.	Closer to eyes.
Poecilocoris sp.	Slightly extending beyond	Less convex, raised anteriad.	Marked with deep, anterior and posterior lines, medially very faint.	Large prominent, not raised.	Closer to eyes.
S. fasciata	Extending beyond	Much convex, raised anteriad.	Anteriorly marked with deep groove, posteriorly with thin line .	Large, prominent and rounded.	Closer to eyes.
S. nobilis	Extending beyond	Much convex, raised anteriad and posteriad.	Anteriorly marked with deep groove, posteriorly with thin lines.	Prominent and oval.	Much closer to eyes.
(*P.*) *interruptus* Westwood (but probably another genus)	Slightly extending beyond	Broadly convex, raised anteriad and posteriad.	Marked with deep anterior groove, posteriorly marked with faint line.	Very small, rounded and raised.	Much closer to eyes.

Phylogenetic Considerations

Whereas Leston[34–38], China and Miller,[13] Miyamoto[53] and McDonald [49,50,51] considered subfamilial status of Scutelleridae as valid, the general concensus has been for the familial status of the group. Pruthi[63] though treated the group as a subfamily within the family Pentatomidae but regarded its male genitalia on the same plan as that of Plataspidae and Cydnidae and considered it somewhat more specialized. Southwood[74] and Nuortera[57] considered its salivary glands distinct among Pentatomoidea.

Leston[39] for the first time gave the group family rank without comment and in the following year[40] considered Scutellerinae excluded from Pentatomidae. In the same year[41] he considered on the basis of chromosome number that the central group of pentatomoid families represented by the series Tessaratomidae, Scutelleridae and Cydnidae with Phloeidae an early off-shoot of the first named and Brachyplatidae (and probably Aphylidae) an evolved off-shoot of the second. Contrary to Pruthi[63] he regarded Scutelleridae constituting the group of lower Pentatomoidea with Acanthosomatidae, Tessaratomidae and Brachyplatidae.

Similarly Cobben[14] discussing the phylogeneses of eclosion in association with egg shape and the micropylar ring in pentatomoids has shown, scutellerids somewhat closer to the ancestral form retaining some of their ancient features as also regarded by Ahmad and Abbasi.[3]

McDonald[52] while finally recognizing the family status of Scutelleridae found it very difficult to define and distinguish it on the basis of male and female genitalia.

Although Leston[41] and Cobben[14] found the group very stable which is also apparent from the structure of scent gland ostioles and male and female genitalia similar to other externally visible consistent characters like highly developed scutellum (discussed below) the group, nevertheless shows remarkable variations generally in the structure of male and female genitalia.

The evaporatoria in the scent gland ostioles is usually highly developed and is different in texture in comparison to the general pleural surface. In the males the parameres are always with a more or less erectstem and a long (almost an independent looking) or a short (appearing a part of stem) rather curved and lunate blade. The ejaculatory duct before entering into the aedeagus is generally sclerotized. In some species even the inflatory vesicle is also remarkably sclerotized. Theca is always well marked and sclerotized, sometimes provided with dorsal and ventral processes as in scutellerines.

There are usually three pairs of conjunctival appendages. The dorsal membranous conjunctival lobes are usually well developed, sometimes partly sclerotized and partly membranous, occasionally subdivided into 2-3 apical processes. The dorso-lateral appendages rarely uniformly sclerotized are usually membranous, sometimes appearing like conjunctival lobes whereas the frontal or ventral pair of appendages except in *Alphocoris* are always membranous, usually very small and unless the aedeagus is fully inflated difficult to be detected.

Penal lobes (of McDonald[52], Abbasi and Rishi[1] and Ahmad and Abbasi[2]) a pentatomid character which are developed to support the vesica are entirely absent, instead usually the conducting chamber (Kumar[29]) or the ejaculatory reservoir (McDonald[52]) is usually very well developed. In some species of Scutellerini the ejaculatory reservoir itself supports the vesica and in one species (*Cantao ocellatus*) the bilobed remarkably elongated ejaculatory reservoir appears like penal lobes of many pentatomids. It could well be that ejaculatory reservoir developed remarkably in some scutellerids to support vesica before the penal lobes developed in the members of Pentatomidae.

The female genitalia including the spermatheca as suggested by McDonald[51,52] and later by Schaefer[68] are on the same pentatomid plan. The spermatheca which appeared different to Pendergrast[61] from other pentatomids, probably only because he studied five species, and out of which four species belonged to a single sub-family Scutellerinae.

No doubt in the majority of the species in the subfamily the spermathecae are characterized by a long tubular apical bulb, a long pump region and a large spherical or ovoid dilation. In some as Pendergrast (op. cit.) has observed, this dilation is heavily sclerotized and deeply pigmented. Not only that, as the above author has observed in *T. diophthalmus* of another subfamily Pachycorinae, this structure is lacking, instead the dilation is thin-walled, is saccular and unsclerotized but also in some other scutellerines (Kumar [26,27] and present studies) thin-walled unsclerotized dilation is present with clearly visible pentatomid-type or sclerotized rod. It could well be that pentatomid type of spermatheca in these species indicate their advanced position in the group.

Below family level the characters of scent gland ostioles and male and female genitalia are more useful in demarcating various supergeneric categories and in showing their mutual relationships.

Eurygastrinae: Leston[34] included in his tribe Eurygastrini the subtribes Odontocelaria, Odontotarsaria and Eurygastraria. McDonald[52] has not only agreed with Lattin[32] in separating Eurygastrini from other subgroups of Leston (op. cit.) but also in his final scheme raised the group to subfamily rank. However, he disagreed with the action of Wagner[85] in raising the group to family status.

The present studies support McDonald's[52] action. Eurygastrinae with nearly equally developed clypeus and mandibular plates, remarkably broad head, smoothly tapering anteriad with thin slit-like short transverse peritreme of metathoracic scent gland ostioles having wrinkled anterior and posterior margins, and in the males with T-shaped parameres, membranous simple vesica with wide opening and without inner supporting appendages, highly sclerotized dorso-lateral conjunctival appen-

dages and in females with elongated and sclerotized spermathecal dilation clearly stands apart from other subfamilies of Scutelleridae.

In fact the members of this subfamily appear apparently more related, to some of the members of the subfamily Scutellerinae rather than Odontocelinae or Pachycorinae in having distinct peritreme of metathoracic scent gland ostioles and relatively broad head which is much more broader than long.

On the other hand it could well be that the less developed peritreme and other characters of male and female genitalia listed in the Tables 3-5 specially of spermatheca relate the group to some members of Pachycorinae and that the members of this subfamily similar to some of the scutellerines convergently have specialized to suit special habitus and habits.

Distant[16] has included *Melandoema* Jakovlev from Turkestan and North West India in this tribe. Although he has not commented on its metathoracic scent gland ostioles but in his diagram neither the peritreme nor the ostiole are distinct and scutellum is also practically covering the entire abdomen. In view of these two characters it appears more closely related to Odontotarsini (discussed below).

Odontocelinae: After removal of Eurygastraria, the remaining groups of Leston's[34] tribe Eurygastrini are costomarily grouped under Odontocelini to which McDonald[52] in his final scheme has alloted a subfamilial rank. Distant[16] has treated the two divisions Odontotarsaria and Odontocelaria separately. The present sample is very poor including only one species and therefore it would be unwise to make any conclusive statement at this point.

However, the lack of distinct scent gland ostioles alongwith the peritremes, in the males, the entirely membranous dorsal conjunctival lobes and greatly sclerotized frontal conjunctival appendages with broad rounded apices and in the females very small spermatheca, with indistinct distal flange and median dilation, clearly separate this group from other subfamilies of Scutelleridae. The elongated body, the elongated head, the remarkably developed ninth paratergites and the absence of median dilation in the spermatheca show the group somewhat primitive and in some way relate it to some of the Pachycorinae.

Pachycorinae: During the present studies only represetatives of two genera *Hotea* and *Deroplax* are included. Kumar[29] and McDonald[52] have included representatives of six and ten genera respectively. The former author has included the presently studied genera in his studies and the latter has included a species of *Tetyra* for which Stål (in Distant[16]) raised the group Tetyraria including the presently studied genera *Hotea* and *Deroplax* and was followed in this by Distant[16]. Kumar[29] has found in *Hotea* and *Deroplax* one pair of conjunctival processes and a similar type of conducting chamber and on the basis of these characters he has refuted Leston[34] who suggested to raise a new subtribe to accommodate *Hotea* which according to him had very little in common with *Deroplax*.

No doubt *Hotea* has a typical obovate body and a very long head having accuminate clypeus in contrast to *Deroplax* sp. with comparatively elongated oval posture and less elongated head. *Hotea* has a reduced but a distinct peritreme in the metathoracic scent gland ostioles in contrast to almost an indistinct peritreme in the metathoracic scent gland ostioles of *Deroplax* sp. In the present species of *Hotea* the sepermathecal duct is uniformly thin and remarkably elongated without a median dilation in contrast to a somewhat developed median dilation in *Deroplax* sp.

On the other hand Scudder[69] has found in *D. redtenbacheri* and in *H. curculionoides* a similar form of spermatheca with a very long duct as reported only in *Hotea* species in the present studies. Finding a very peculiar form of spermatheca in *H. subfasciata*, Scudder (op. cit.) has suggested the placement of *H. curculionoides* and *H. subfasciata* in two different genera.

Probably there is much variation in the group because the group is a primitive one with some members adapting rapidly in accordance with their peculiar habitus. In the entire group, the median dilation is never developed as in pentatomids with sclerotized rod and in some species of *Hotea* (Kumar[29]) the distal flange is also lacking with a reduced pump region in the spermatheca. Contrary to Kumar[29] the present studies revealed three pairs of conjunctival appendages in *Deroplax* sp. similar to those in *Acantholomidea porosa* (Germar) reported by McDonald[52]

Scutellerinae: This is the largest subfamily and in the present studies also five genera and seven species are included. Pendergrast's[61] material of five species of the family Scutelleridae included four from this subfamily. Kumar[29] has also included representatives of eleven genera in the tribe Scutellerini alone in addition to one genus of Elvisurini and one genus of Sphaerocorini. McDonald[51] although studied only one species of Scutellerini, previously he included thirteen species with reference to his studies on male genitalia[49,50] and nine species with reference to female genitalia[51] (in both *T. diophthalmus* was erroneously included in Scutellerini).

The members of this subfamily show rather stable and somewhat advanced characters. All have relatively a broader head with less developed mandibular plates; all have a well developed metathoracic scent gland ostioles with highly developed peritreme; almost all have well developed parameres with erect stem and a curved and lunate blade with tuft of hairs on the inner basal side of blade; all have thecal processes; in all, the dorsal conjunctival lobes are complicated, and in majority of species the ejaculatory reservoir is greatly developed and in some this supports the vesica.

In females also the eighth paratergites are quite developed (a pentatomid character) and in the spermatheca the pump region with distal and proximal flanges are well developed and usually there is an ovoid or spherical sclerotized and pigmented median dilation which in some (*Chrysocoris*) has ac-

TABLE 3. COMPARATIVE CHARACTERS OF THE METATHORACIC SCENT GLAND OSTIOLE.

Species	Ostiolar shape	Peritreme					Evaporatoria		
		Colour in comparison to evaporatoria	General shape	Anterior, posterior and outer margins	Form of apex	Transverse length in proprtion to evaporatoria	Colour	Texture	Transverse length in proportion to tergopleural line
1	2	3	4	5	6	7	8	9	10
E. Integriceps	Elongated, slit-like.	Yellowish with castaneous tips, concolourous.	Elongated.	All sides raised with ant., post., outer and margins sinuate.	Narrowly rounded.	Reaching beyond middle.	Yellow.	Faintly rugulose.	Reaching one third distance.
E. maura	Elongated, slit-like.	Castaneous, concolourous.	Elongated.	All sides raised with ant. and post. margins serrate.	Narrowly rounded.	Reaching on to the middle.	Black.	Dull velvety.	Reaching closer to.
in *A. lixoides* *Deroplax* sp. and *D. zahidae*	metathoracic scent gland ostioles indistinct or absent.								
H. curculionoides	Elongated, slit-like.	Pale yellow, contrasting.	Very small	Posterior margin slightly raised.	Subacute, slightly curved anteriad.	Too small to compare.	Ochraceous.	Smooth with black punctures.	Reaching near.
H. nigrorufa,	Very small.	a	b	s e	n	t	Yellowish with reddish tinge.	Rugulose with black punctures.	Reaching near.
S. rubropunctatum	Large, wide and ovate, located at apex of vestibular hump.	Peritreme absent, vestibular hump prominently developed.					Yellowish with reddish tinge.	Dull, covered with silvery hairs.	Reaching near.
C. ocellatus	Large, somewhat elongated.	Metalic green, somewhat concolorous.	Enlarged paddle-like.	Margins faint.	Broadly truncated.	Slightly beyond middle.	Light metallic green.	Rugulose, furnished with silvery hairs.	Reaching near.
C. stockerus	Rounded	Palish-yellow, contrasting.	Greatly elongated, leaf-like.	Posterior and outer margins raised, anter less prominent.	Less broadly rounded with apex curved anteriad.	Far beyond middle.	Black.	Rugulose and wrinkled.	Reaching on to the middle.
P. latus	Ovate.	Yellowish, only little contrasting.	Elongated, leaf-like.	Posterior and outer margins raised, anterior less prominent.	Less broadly rounded with apex indistinct, pointing anteriad.	Much beyond middle.	Palish.	Dull and smooth.	Reaching beyond. middle.
Poecilocoris sp.	Large and ovate.	Yelowlish-brown, concolorous.	Remarkably elongated, thin strip like.	Raised from all sides.	Broadly rounded.	Reaching middle.	Yellowish brown.	Rugulose.	Reaching near.
S. fasciata	Rounded.	Palish-yellow, contrasting.	Greatly enlarged, leaf-like.	Posterior and outer margins raised, anterior less prominent.	Broadly rounded.	Much beyond middle.	Bluish black.	Shining, covered with silvery hairs.	Reaching one third distance.
S. nobilis	Ovate, slit-like	Palish-yellow, contrasting.	Greatly enlarged, leaf-like.	Raised from all sides.	Broadly rounded.	Far beyond middle.	Bluish black.	Rugulose.	Reaching closer to.
(*P.*) *interruptus* Westwood (but probably another genus)	Large and ovate	Metallic bluish black, contrasting.	Elongated, slit-like.	Raised from all sides, post. margin less prominent.	Acuminate, subacute, and turned anteriad.	Reaching on to evaporatoria.	Black.	Dull and rugulose.	Reaching beyond middle.

TABLE 4. COMPARATIVE CHARACTERS OF MALE GENITALIA.

Species	Pygophore		Paramere		Phallosoma		Endosoma		
	Ventro-posterior margin and tongue	Dorso-lateral margins	Stem	Blade	Ventral thecal appendages	Dorsal thecal appendages	Vesica and tip of ejaculatory duct	Dorsal membranous conjunctival appendages	Dorsolateral conjunctival appendages
1	2	3	4	5	6	7	8	9	10
E. integriceps	Smooth, medially curved.	Arched and depressed.	Comparatively short.	Very short, T-like.	Absent	Absent	Membranous enclosing ejaculatory duct.	Paired, medially fused with sclerotized apices.	Paired, sclerotized, elongated, cutely pointed and sword-like.
E. maura	Sinuate, medially curved.	Arched.	Elongated.	Short, T-like.	Absent	Absent	Membranous, enclosing ejaculatory duct.	Paired, fused at base with semi-sclerotized apices.	Paired, sclerotized, elongated, acutely pointed and sword-like.
A. lixoides	Slightly sinuate, medially convex.	With prominent hooks.	Short, outer margin sinuate.	Lunate, without tuft of bristles.	Long, paddle-shaped with truncated apex.	Indistinct	Sclerotized, enclosing ejaculatory duct.	Membranous, bilobed, smoothly tapering apically and attached only at base.	Paired, sclerotized, apically lobe-like.
Deropalx sp.	Sinuate, medially notched.	Produced into upturned subacute spines.	Small, outer margin strongly sinaute.	Very small apex broadly acute with sharp and thick bristles near base.	Absent	Absent	Membranous, tip of ejaculatory duct coming out.	Largely membranous, trilobed, median lobe thickly sclerotized.	Paired but fused throughout largely membranous, with sclerotized tips at both sides.
Males of *D. zahidae*, *H. curculionoides* and *H. nigrorufa* were not available.									
S. rubropunctatum	Faintly serrate and medially concave.	Acutely and conspicuously projected, inward with knob-like projections.	Short, bent, outer margin concave.	Curved, without tuft of bristles, short and lunate.	Long, tapering distad and apically serrate.	Small, fused knob-like in the middle.	Sclerotized, stout with inner margin serrate and tip oothed, enclosing ejaculatory duct.	Large sclerotized, paired, elongated with trilobed membranous apical portions, attached only at base.	Paired, fused medially, very small, entirely membranous, lobe-like.
C. ocellatus	Sinuate with median bilobed projection, laterally rounded.	Acutely projected.	Elongated and erect.	Stout, vertical at base with tuft of bristles.	Knob-like, fused with swollen base and acute apex.	Small, fused knob-like in the middle.	Sclerotized, stout, Y-shaped, exposing tip of ejaculatory duct.	Membranous paired with sclerotized rounded tips and fused only at base.	Paired, sclerotized, rounded, lobe-like apically.
C. stockerus	Sinuate, medially concave.	Lobed	Elongated and erect.	Vertical but curved with a tuft of bristles at base.	Long, slender and horn-like.	Paired, long curved with wide apex.	Sclerotized, somewhat stout, inwardly curved at apex, enclosing tip of ejaculatory duct.	Largely sclerotized, membranous only in middle, paired, fused only at base, with horn-like acute apices.	Indistinct.
P. latus	Medially, V-shaped truncated at sides.	With subacute knobs.	Elongated and erect.	Vertical, curved with bilobed apex and thin bristles at base.	Long and uniformly slender.	Paired, short slender but prominent.	Sclerotized, slender, inwardly curved, enclosing ejaculatory duct.	Large sclerotized paired, paddle-like with membranous lobe-like apical portion only at base.	Indistinct or absent.
Poecilocoris sp.	Medially, V-shaped truncated at sides.	With rounded konbs.	Elongated and erect.	Vertical, long bilobed at apex, inner margin dentate,thin bristles at base.	Long and uniformly slender.	Paired, short slender but prominent.	Sclerotized, slender, inwardly curved, venclosing ejeculatory duct.	Large sclerotized, paired, like oval with membranous baloon-like apical portion outer at base.	Indistinct or absent.

continued

TABLE 4. COMPARATIVE CHARACTERS OF MALE GENITALIA.

1	2	3	4	5	6	7	8	9	10
(P.) interruptus Westwood (but probably another genus)	Sinuate, medially concave.	Without prominent knobs.	Elongated and erect.	Small, vertical, curved with tuft of bristles at base.	Remarkably long and uniformly slender.	Paired, very short but prominent.	Sclerotized, slender but more stout, enclosing ejaculatory duct.	—do—but more elongated and stout.	Indistinct or absent.
S. fasciata	Emarginate, medially concave and laterally hooked.	Smoothly arched with rounded tips.	Elongated and erect.	Small, lunate at base with tuft of bristles.	Fused, small-collar-like in the middle.	Short, slender and curved.	Sclerotized, stout with sinuate lateral margins, enclosing coiled wriglish ejaculatory duct.	Modified into stout, broad, cup-like sclerotized appendages, with spicules.	Very small, membranous indistinct.
S nobilis	Males not available.								

TABLE 5. COMPARATIVE CHARACTERS OF FEMALE GENITALIA.

Species	7th abdominal sternum		First gonoxae	8th and 9th paratergites	Spermatheca				
	Posterior margin	Posterolateral tips			Bulb	Pump	Distal flange	Proximal flange	Median dilation
1	2	3	4	5	6	7	8	9	10
E. integriceps	Medially arched.	Subacute	Moderately concealed, with straight parallel sided inner margins and rounded but with subacute apices.	8th with posterior margin substraight extending posteriad to 9th.	Rounded	Small	Prominent	Prominent	Thickly sclerotized.
F. maura	Medially arched.	Subacute	Moderately concealed, with straight parallel sided inner margins and rounded apices.	8th with posterior margin substraight extending posteriad to 9th.	Bulbus	Small	Prominent	Prominent	Thickly sclerotized.
A. lixoides	Medially deeply but smoothly arched.	Subrounded	Largely exposed, with straight inner margins, posterior margin sinuate with rounded apices.	8th pushed laterad by much larger 9th into strip-like sclerites.	Bulbus	Small but distinct	Indistinct	Distinct	Indistinct
Female of *Deroplax* sp. not available for studies.									
D. zahidae	Smoothly, medially arched.	Subacute	Only little concealed, inner margins straight, posterior margins straight, nearly with subrounded apices.	8th pushed laterad by much larger 9th into small sclerites.	Small, semicircular	Well developed	Prominent	Prominent	Dumble-shaped and transparent.
H. curculionoides	Smoothly medially arched	Indistinct	Only little concealed, conical, with straight inner and posterior margins and acute apices.	—do— but into relatively larger sclerites.	Oval	Prominent	Small	Small	Absent

continued

continued

TABLE 5. COMPARATIVE CHARACTERS OF FEMALE GENITALIA.

1	2	3	4	5	6	7	8	9	10
H. nigrorufa	Smoothly medially arched.	Indistinct	—do—but posterior margins medially concave.	—do—but into relatively larger sclerites.	Elongated	Prominent	Small	Small	Absent
S. rubropunctatum	Somewhat sinuate laterally but medially concave having slight conical projection.	Subacute	Largely concealed with straight inner and sinuate posterior margins with rounded apices.	8th with posterior margins convex, medially apart, extending posteriad to equally developed 9th.	Elongated	Small	Distinct	Distinct	Rounded, thick walled.
C. ocellatus	Sinuate, medially deeply emarginate.	Rounded	Largely exposed, somewhat conical with sinuate posterior margins and subrounded apices.	8th very large, medially apart, extending behind strip-like 9th.	Bilobed with apical spherical portion.	Well developed	Distinct	Distinct	Baloon-like, thick-walled.
C. stockerus	Slightly laterally sinuate, medially arched with minute median projection.	Acute	Largely exposed, inner margins straight, tips rounded.	8th triangular, inner tips remarkably narrowed, meeting 9th posteriad.	Elongated but apically spherical.	Well developed	Distinct	Distinct	Baloon-like, transparent with inner sclerotized rod.
P. latus	Slightly laterally sinuate and medially concave.	Acutely produced	Partially concealed, inner margins straight posterior margins subtruncate with subrounded apices.	8th with posterior margin rounded inner apices somewhat fused extending behind 9th.	Elongated but apically spherical.	Well developed	Distinct	Distinct	Short, rounded and thickwalled,
Poecilocoris sp.	Slightly laterally sinuate, medially arched.	Subrounded	Only little concealed, inner margins convex, with broad apices.	—do—but somewhat smaller than 9th.	fusi-form, faintly constricted.	Well developed	Distinct	Dinstinct	Baloon-like, compressed at side, thick-walled.
S. fasciata	Deeply concave in middle.	Rounded	Largely exposed plate-like, tips rounded.	8th with posterior margin elongated and slightly short of 9th, latter small, lobe-like.	Elongated but apically spherical.	Prominent	Distinct	Distnct	Spherical, thick walled.
S. nobilis	Concave in middle.	Acute	Largely exposed, conical, tips subacute.	8th with posterior margin much larger than and extending behind 9th. Latter very small.	Elongated but apically spherical.	Prominent	Distinct	Distinct	Spherical, thick-walled.
(*P*) *interruptus* Westwood (but probably another genus)	Smoothly arched with faint rounded median projection.	Subacute	Only little concealed, inner margins straight, posterior nearly straight, subrounded.	8th very large, post margins convex, extending much behind, smaller 9th.	Spherical	Well developed	Prominent	Prominent	Baloon-like, thick-walled.

quired the pentatomid-type of sclerotized rod.

McDonald[51] considered the characters of female genitalia of little importance in separating the tribes and subtribes. On the basis of male genitalia, however [49'50] the above author separated Sphaerocorini and Elvisurini from Scutellerini and *T. diophthalmus* of Pachycorinae according to himself stood quite apart. In Sphaerocorini the above author found strigil on ventral margin of pygophore whereas this character was not found in any member of Scutellerinae.

In Elvisurini the above author found dorsal conjunctival appendages very long and membranous, divided into a dorsal and ventral appendages. The present studies also separated the elvisurine *Solenostethium* from the rest of the Scutellerini on the basis of characters of the scent gland ostioles and male and female genitalia as noted in the Tables 3-5. Similarly the scutellerine genera are also separated on the basis of these characters. *Chrysocoris* and *P(P) interruptus* appear to be more advanced than Scutellera, *Poecilocoris* and *Cantao* of the tribe Scutellerini and *Solenostethium* of Elvisurini as noted above in the characters of the median dilation of spermatheca clearly having pentomid type of sclerotized rod and convex form of venter of abdomen without furrow or sulcation.

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Explanation of Abbreviations

al	anterior laterale
an	antenniferoustubercle
anc	antecoxale
anp	anterior notal wing process
ap	apodeme
b	bucculae
bcs	basicostal suture
bl	blade
bp	basal plate
bst	basisternum
cas	circum antennal sulcus
cc	clypeal clefts
cf	claval furrow
cls	claws
cly	clypeus
co	corium
conx	connexivum
cos	circum ocular sulcus
cox	coxa
C+Sc	costosubcostal vein
Cu	cubitus
cvl	clavus
cxc	Prothoracic coxal cavitity
cxc_1	meso coxal cavity
cxc_2	metacoxal cavity
dmca	dorsal membranous conjunctival appendages
dsf	distal flanges
ds sp.d	distal spermathecal duct
dt.ap	dorsal thecal appendage
em	epimeron
em_1	epimeron of mesothorax.
em_2	epimeron of metathorax
emb	embolium
ep	episternum
ep_1	episternum of mesothorax
ep_2	episternum of metathorax.
ev	evaporatoria
eye	eye
f	frons
f_1	first fold
f_2	second fold
fam	furcal arm
fe	femur
frt	furcasternum
fur	furca
1st gcx	1st gonocoxae
ge	genae
gp	gonopore
gu	gula
ip	inflatory pump
lbg	labial groove
lbr	labrum
M	median
map	mandibular plates
mb	membrane
mdms	mandibulo-maxillary suture
mf	mesofurca
mnd	stylet base
mnl	mandibular lever
mnst	mandibular stylets
mtf	metafurcae
mxl	maxillary lever
mxp	maxillary plate
mxst	maxillary stylets
o	ostiole
oc	occiput
occ	occipital condyles
ocf	occipital foramen
ocl	ocelli
p	pygophore
par	paramere
per	peritreme
pnt	post notum
po	post occiput
pos	post occipital sulcus
pp	prepectus
pps	parapsidal sulcus
pr	pleural ridge
pra	prealar arms
prr	proctiger
ps	pleural sulcus
psc	prescutum
8th pt	eighth paratergites
9th pt	ninth paratergites
pul	pulvillus
pxf	proximal flanges
px. sp.d.	proximal spermathecal duct
px.s.sp. d.	swelling of the proximal spermathecal duct.
py	pivot
R	radius

R+M	radio-median vein
sc	sterna costa
scf	semi-circular furrow
scl	supra coxal lobes
sct	scutum
sctl	scutellum
sg 1-4	labial segment 1 to 4
sm. sp.d.	sclerotized median spermathecal duct.
sp	spiracle
spb	spermathecal bulb
sp.d.	spermathecal median dilation
sp.p	spermathecal pump
8th. spr.	eighth spiracle
sss	scuto-scutellar sulcus
st	stem
tap	terminal funnel-shaped apodeme
tar	tarsus
tb	trichobothria
th	theca
tib	tibiae
tibs	tibial spine
tr	triangulin
trc	trochanter
trr	transverse ridge
trs	tarsal spines
ugt	unguitractor plate
ves	vesica
vet	vestibule
vlt	veinlets
vt.ap.	ventral thecal appendage
wng	wing

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