Morpho-Taxonomical Studies on the Genitalia and Salivary Glands of some Pentatomoidea

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Introduction

The present paper deals with the study of genitalia and salivary glands of six families of Pentatomoidea and their bearing on the classification of the group.

The external male genitalia have been studied by a number of workers notably Pruthi (1925) who studied them throughout the Heteroptera and revealed their taxonomic importance. However, many taxonomic conclusions of Pruthi (1925) have become questionable in the light of subsequent researches of Baker (1931), Leston (1952, 1953 b, 1954 b, 1954 c, 1955 a, 1956, etc.) and Ashlock (1957). The main drawback with Pruthi's (1925) work as realized now is his study of almost all conjunctival aedeagi in an unexpanded state. In this state conjunctival processes lie collapsed and to study them as such has led to many taxonomic errors, for there are great differences in the expanded and unexpanded states of conjunctiva. In the present study expanded aedeagi have been studied and where expansion was not possible, the conjunctiva was dissected out mechanically.

The Heteropteran ovipositor has not been adequately studied by morphologists. An attempt has been made here to furnish additional information on it. The most recent work of Scudder (1959) in this connection has also been considered here.

Besides, internal genitalia and salivary glands have received little attention. Only a few publications concerning them have appeared after Pendergrast (1957) and Southwood (1956 b). These structures have also been dealt with in the present work.

These studies form a part of the major investigations on the genitalia and salivary glands of Heteroptera which were completed last year.

Material and Methods

Mostly Indian forms have been studied

For the study of external genitalia, the terminal portion of the abdomen was removed and boiled in 10 % KOH, passed through glacial acetic acid, cleared in methyl salicylate and mounted in the usual way.

Systematic Consideration of the Genitalia and Salivary Glands of Pentatomoidea

Ovipositor

Cydnidae: Cydninae

Aethus indicus Westw (Figs. 1, 2);
Geotomus apicalis Dall (Figs. 3, 4);
Macroscytus expansus (Figs. 5, 6, 7).

First valvifers large and very broad, their anterodorsal region produced greatly like an apodeme, posterior region round, major portion of the valvifer deeply sclerotized and black in comparison to the remaining membranous and transparent region; first valvulae small triangular flap like, outer ramus faintly marked, inner ramus sclerotized, arch shaped and ridged for the reception of the ramus of second valvula, first valvulae joined by a sclerotized anterior inter-valvular membrane, the latter remains folded over the first valvifers in natural condition as indicated in the diagrams, anterior intervalvular membrane cone shaped in *A. indicus* Westw, funnel like in *G. apicalis* Dalls, greatly elongated and more sclerotized towards the central regions in *M. expansus,* a vertical suture present in the centre of the anterior intervalvular membrane, inner ramus of first valvula joined to an anterior extension of ninth tergum; second valvulae deeply sclerotized, discoidal and connected by a posterior intervalvular membrane, the latter being sclerotized to the same intensity as second valvulae, posterior inter-valvular membrane rudimentary in *M. expansus,* arched convex ramus of second valvula slides into the grooved inner ramus of first valvula as said above; second valvifers club like, clubbed ends in the normal position applied against each other but not fused, devoid of any ornamentation excepting sparsely distributed tubercles, second valvifers produced into a finger like projection distally in *M. expansus.*

Similar projection of second valvifers has been figured in *Sehirus luctuosus* Muls. and Rey (Fig. 3, p. 411) by Scudder (1959) and he also states its presence in *Geotomus punctulatus* (Costa) but no such projections were noted in *G. apicalis* Dalls of the present study.

Stibaropus callidus Schiödte (Fig. 8)

First valvifers large and membranous anteriorly, not produced into an apodeme antero-dorsally; first valvulae large, triangular and somewhat membranous, devoid of an outer ramus; anterior inter-valvular membrane large but less sclerotized; second valvulae fused in the middle without any posterior inter-valvular membrane, arched ramus of second valvula flattened like that of Brachyplatidae; second valvifers unique (Fig. 8), just like their Pyrrhocorid counterparts, very broad and hairy distally, elongate, slender and curved proximally.

Remarks

From the foregoing account it would be apparent that a very characteristic feature of Cydninae is the development of a sclerotized membrane between the first valvulae. This anterior inter-valvular membrane has a

definite shape and varies greatly (vide supra) and it would be interesting
to investigate its variation at specific level. Nothing can be said about its
homology; a consistent vertical suture in its centre indicates that it is formed
by fusion of two flaps possibly belonging to the opposite first valvulae.

Brachyplatidae

Brachyplatys vahlii (Fig. 9), *B. radians* Voll (Fig. 10),
B. subaenus (Figs. 11, 12), *Coptosoma siamica* (Figs. 13, 14).

First valvifers triangular and highly sclerotized; first valvulae almost
round in *B. vahlii* and *B. radians* Voll (Fig. 10) but produced downwards
like an apodeme in *B. subaenus* West (Fig. 11); first valvulae bear a curved
and highly sclerotized outer ramus and a similar sclerotized flattened sabre
shaped inner ramus, anterior inter-valvular membrane in *B. subaenus* West
cylindrical and slightly sclerotized and bears a vertical suture in the centre;
second valvulae sabre shaped (as in *Dysdercus,* personal observations) and
bear an arched outer ramus. Second valvulae in *C. siamica* egg shaped,
sclerotized and pierced with many holes; second valvifers in *B. vahlii* (Fig. 9)
meet at their distal ends and appear to be partly fused; second valvifers
in *C. siamica* long, curved, slender and closely approximating (Fig. 14);
second valvifers fused to ninth paratergites; flask shaped sclerite (Fig. 13)
present on the vaginal wall in all cases.

Remarks

Scudder (1959) states the absence of rami in first valvulae in the *Liby-
aspis* sp. of Brachyplatidae that he examined. In all the four species of
Brachyplatidae examined in the present work distinct rami have been found.
Even the outer ramus of first valvula is present which elsewhere is fully
developed only in Dinidoridae. Scudder (1959) has even doubted the pres-
ence of the wall developed second valvulae for he states "a flat sclerotiza-
tion attached to anterior end of second gonocoxae is presumably the second
gonapophysis".

Scutelleridae

Chrysocoris stolli (Wolff) (Figs. 15, 16, 17)

First valvifers triangular and densely hairy; first valvulae triangular, its
outer ramus U-shaped, the area in the vicinity of the latter bears many small
holes (Fig. 15), anterior inter-valvular membrane not sclerotized but greatly
folded; second valvulae detached from their rami and fused in their middle,
from their middle a pair of curved rami issue to give attachment to second
valvifers (Fig. 16); second valvifers very broad and fused into a vase shaped
structure (Fig. 16); ninth paratergites deeply sclerotized, their postero-ventral
regions membranous; tergal apodeme present, a complicated set of vaginal
thickenings present around the spermathecal duct as figured (Fig. 17).

Scutellera perplexa (Fig. 18)

First valvifers quadrilateral shaped and beset with numerous hairs
throughout; first valvula membranous and elongated, inner ramus arched,
sclerotized and grooved as usual; second valvulae discoidal and bear an

arch like sclerotized interlocking ramus; second valvifers fused distally to form a trappa shaped structure (Fig. 18), the latter bears certain intriguing dark patches (Fig. 18); ninth paratergites pear shaped, their posterior ventral margins ring like and membranous, curving first downwards and then upwards to make connection with the inner ramus of second valvula.

Poecilocoris latus Dall. (Fig. 19)

First valvifers large and oval, slightly hairy and bear a irregular black area towards the distal end; first valvulae membranous, anterior intervalvular membrane highly folded; second valvulae discoidal bear an arched ramus as in *C. stollia* and *S. perplexa*; second valvifers fused into a vase like structure (Fig. 19) as in *Chrysocoris*, vaginal sclerotizations figured (Fig. 64).

From Scudder's (1959) descriptions of ovipositor in Scutellerinae, Eurygastrinae, Pachycorinae, Canopidae and present studies it would appear that there is a tendency for the fusion of first valvulae in Scutelleridae which reaches its extreme in *Anoplogonius nigricollis* where the first valvulae are united (Scudder, 1959). Similar fusion is noticed in respect of second valvulae which in *Chrysocoris* approaches the condition of Oncomerinae (Tessaratomidae).

Tessaratomidae

Musgraveia sulciventris (Figs. 20, 21, 22)

First valvifers large, very broad (Fig. 20), strongly sclerotized posteriorly but membranous anteriorly, posteriorly the valvifers bear a sclerite the basivalvifer; first valvulae highly sclerotized and attached to the first valvifer by their knob like distal ends which may be considered to represent the outer ramus, in the vicinity of the latter few holes may be observed, three long hairs present towards the tapering portion of the valvula, a highly folded anterior inter-valvular membrane present; second valvulae completely fused and have lost their connections with the second valvifers, a suture in the middle of the former indicates the fusion, also present on the second valvulae appears a continuous sclerotic rod which probably represents the fused rami of second valvulae, just above the second valvulae another sclerotized piece of uncertain homology can be seen, proximal ends of valvifers connected by a vaginal fold (Fig. 22); second valvifers fused into a cup shaped structure, tergal apodeme abuting in the second valvifer present.

Lyramorpha rosea (Fig. 23)

First valvifers irregular in outline, hairy and sclerotized distally; first valvulae membranous, broad proximally, gradually narrowing distally, the two joined by a inter-valvular membrane and devoid of any rami whatever, second valvifers and valvulae almost similar to *R. sulciventris* (Fig. 23).

Stilida sp (Fig. 24)

First valvifers sub-circular; first valvulae triangular, membranous and devoid of an outer ramus but inner concave arched ramus present; second valvifers very broad, fused together, and possess a verticle suture in their centre; second valvulae seem to have been lost, but immediately above the

fused second valvifers a sclerotized plate can be seen which may be the remnant of second valvulae, three sclerotized pieces present on the vaginal wall.

Dinidoridae

Coridius (=Aspongopus) janus (Figs. 25, 26, 27)

First valvifers triangular, highly sclerotized and bear ornamentations at several places; first valvulae membranous, in intimate contact with the valvifers and difficult to separate, outer ramus present, both outer and inner ramus of first valvulae highly sclerotized and of similar size and shape, inner ramus has almost fused to the outer ramus of second valvula so that in separation of Ovipositor components inner ramus of first valvula is carried with the ramus of the second valvula; second valvulae large, discoidal, membranous and bear a sclerotized arch shaped ramus of the same size and shape as the ramus of first valvula; second valvifers fused into a ridge like structure as in Pentatomidae and possess a highly sclerotized posterior inner-valvular membrane between their arms, second valvifers fused to ninth paratergites; ninth paratergites larger than eighth and gain contact to form a pseudosternum (Fig. 25).

Scudder (1959) in his account of Ovipositor of Coridius janus overlooked the outer ramus of first valvula, did not notice the partial fusion of inner ramus of first valvula and outer ramus of second valvula and missed the fusion of second valvifers to ninth paratergites.

Pentatomidae: Holyinae

Dalpada versicolor (Figs. 28, 29, 30)

First valvifers rectangular and hairy (Fig. 28); triangulum bell shaped, a suture in the middle shows it to be formed by the fusion of two parts, one from either side, central portion highly sclerotized in comparison to the rest (Fig. 29); second valvifers flattened and hairy distally, narrow and tapering proximally (Fig. 30), a pair of small curved appendages present at the distal ends, (it is to be wondered if they represent styloids of Pyrrhocorids that may have migrated a little away from the distal end in this case due to the latter coming in contact); second valvulae curved having lost their connections with second valvifers; a pair of oval rings touching second valvulae present.

In Dalpda all sorts of variations of second valvifers can be seen, in some cases they have inseparably fused without even a trace of suture, in others they are wide apart, and in still other cases they are just in contact, the latter being the frequently occurring case and is figured (Fig. 30).

The ovipositor of Dalpada is important in understanding the ovipositor of Pentatomoidea for it clearly shows that reduction of second valvula and valvifers begins at the point where they meet and the gap between the two then gradually increases resulting in the loss of proximal parts of both second valvifers and valvulae. Second valvulae consequently are either represented by small fragments on vaginal wall or may be wanting altogether and sometimes second valvifers are often much reduced. But it may be noted that remnants of the second valvulae vary greatly in their shape and

position and in many cases their homologies may be doubted. Evidently, there is a great need for embryological studies on the ovipositor of Pentatomidae and a study of them in some common Indian forms such as *Bagrada cruciferarum, Agonoscelis nubila* should be interesting and instructive.

Pentatominae

Nezara antennata (Figs. 31, 32, 33)

First valvifers hairy and of characteristic shape (Fig. 31); triangulum broad anteriorly and narrow posteriorly (Fig. 32); second valvulae represented by small oval structures; vaginal thickenings figured (Fig. 33).

In one abnormal case (Fig. 34) the presence of an arched ramus on second valvula was observed; it once again clearly indicates that the structures labelled as second valvulae in this study are no other structure than the remnants of second valvulae; second valvifers trough shaped with thick spines.

There is a great difference in shape of the different components of the ovipositor even at specific level. Second valvifers in *Eusarcocoris inconspicuus* appear to be separate but are held together by a powerful posterior inter-valvular membrane. Extreme reduction of the second valvifers in Asopinae has been noted in the present work (Figs. 35, 36, 37) which shows that Amyoteinae are highly specialized. Southwood (1956 a) also came to the same conclusion on the basis of the structure of eggs.

Remarks on the Ovipositor of Pentatomidae

Scudder (1959) has completely misinterpreted the first valvifers and valvulae of Pentatomidae. Though his description is not accompanied with illustrations, it is quite clear that he has taken the first valvifers as first valvulae and the fused first valvulae — the triangulum Verhoeff (1893) — he calls a large triangular membrane joining the first valvulae. It may be mentioned here that the shape of this so-called triangulum varies very greatly even from species to species and is rarely triangular and the name triangulum is inappropriate. It may be recalled that in Cydnidae sclerotized anterior inter-valvular membranes of various shapes are present (vide supra) and the condition of Pentatomidae can be easily attained by the loss of first valvulae and retention of these inter-valvular membranes. Therefore it is difficult to decide the nature of these intervalvular membranes in absence of any embryological data, they may be anterior inter-valvular membranes or the fused first valvulae, more likely the former.

External male genitalia

Cydninae

Aethus indicus Westw. (Fig. 38)

Basal plates produced into struts dorsally; phallotheca more or less barrel like, conjunctiva has three pairs of distinct processes, those lying immediately below the vesica being the broadest and slightly sclerotized (Leston, 1954 c, states them to be membranous in *Sehirus*); ejaculatory reservoir kidney shaped; vesica highly sclerotized, thrown into a loop at its proximal end, distal region whip like, a pair of small highly sclerotized patches present

Entomol. Ts. Årg. 83. H. 1—2, 1962

4

about the middle of vesica; ventral connectives highly sclerotized in comparison to Pentatominae (noted also by Leston, 1954 c, in *Sehirus*), parameres narrow in the proximal and flattened in the distal region, inner margin serrated.

Geotomus apicalis Dist. (Fig. 39)

More or less similar to *A. indicus,* conjunctival processes below the vesica small; parameres different than in *Aethus* (Fig. 67).

Macroscytus expansus Sign. (Fig. 40)

On the same plan as *Aethus* and *Geotomus,* phallotheca however, very long and cylindrical; ejaculatory reservoir greatly elongated and tubular; parameres characteristic as figured (Fig. 40).

Leston (1954 c) states the presence of a median conjunctival sheath investing the vesica in *Sehirus*. No such sheath was observed in *M. expansus* Sign; but these are in different subfamilies.

Brachyplatidae

Brachyplatys subaenus Westw. (Fig. 41)

Basal plates stout and not produced dorsally; phallotheca very long, broad and highly sclerotized; ejaculatory reservoir curved, vesica completely enclosed in a vesical covering which probably represents the fused median vesical processes, conjunctiva bears two pairs of processes, a pair in the dorsolateral region and the other pair in ventro-median position free distally but fused proximally; parameres curved in the distal region.

Pruthi (1925) noted only one pair of conjunctival processes in *B. pasittus* which he studied in an unexpanded condition.

Coptosoma siamica

The aedeagus was studied in an unexpanded state and the number of processes cannot be said with certainty.

Pruthi (1925) in his study of unexpanded aedeagus of *Coptosoma cribarium* noted three pairs of conjunctival processes which is unlikely.

Scutelleridae

Chrysocoris stollii (Wolff) (Fig. 42)

Basal plates slightly produced dorsally; vesica bent proximally and enclosed in a large swan shaped chitinous covering; three pairs of conjunctival processes present, the first pair long, slender and distal half highly sclerotized but proximal half non-sclerotized, second pair longest of the three pairs and curve in the distal region into sclerotized apices, third pair flattened and highly sclerotized; parameres hook like in the distal region.

Pruthi (1925) in his account of *Chrysocoris stocherus* stated that its genitalia were similar to that of *Cantao ocillatus* and there he states that the apex of the vesica is trilobed, which is not the case in *C. stollii* Wolff where the swan shaped covering of vesica gives it a false trilobed appearance.

Poecilocoris latus Dall. (Figs. 43, 44)

Basal plates very long and greatly flattened; phallotheca highly sclerotized, uniformly broad and barrel like, ejaculatory reservoir round and

lies near the distal end of phallotheca; vesica long, U-shaped with characteristic convolution, its distal half enclosed in a duck shaped sclerotized covering; third pair of conjunctival processes flattened, highly sclerotized and each bears a dark sclerite, second pair slender and rod like, first pair appears to be represented by two small sclerotized rods attached to the distal ends of vesica, it may be that first pair of processes have migrated from their normal position and have fused with the distal part of vesica; parameres characteristic, straight and hook like in the distal region (Fig. 44).

Dinidoridae

Coridius janus (Fig. 45)

Basal plates large, thick and flattened on the sides (cf. Pruthi, 1925); phallotheca highly sclerotized; three pairs of conjunctival processes present, the first pair small and membranous, second pair large, slightly sclerotized while the third pair are highly sclerotized for most of their lengths and enclose a spongy organ, the latter represents the fused vesica and ejaculatory reservoir which swells proximally but slightly tapers distally; parameres same as described by Pruthi (1925).

Pruthi (1925) guessed that there were two pairs of conjunctival processes in Dinidoridae. In the present work it was not possible to obtain an expanded condition of conjunctiva which was, however, dissected out without injury and three pairs of processes are clearly seen (Fig. 45).

Pentatomidae

Dalpada versicolor (Figs. 46, 47)

Basal plates produced dorsally for a distance; phallotheca highly sclerotized and pitcher shaped, ejaculatory reservoir somewhat egg shaped, median vesical processes fused and rest against the ejaculatory reservoir (Fig. 46); two pairs of conjunctival processes present, first pair in dorso-median position free distally but fused proximally, the second pair in the dorso-lateral region long slender and rest against fused dorso-median pair (Fig. 47); parameres bent in the proximal region.

Pruthi (1925) studied the unexpanded aedeagus of Dalpada oculata and guessed the presence of only one pair of conjunctival processes.

Nezara antennata (Fig. 48)

Basal plates long and produced dorsally into long thick struts; phallotheca wide and highly sclerotized and its lateral walls greatly thickened; ejaculatory reservoir of moderate size, vesica fairly long and enclosed in a median vesical covering; in an expanded condition (Fig. 48). The conjunctiva has three pairs of conjunctival processes, one pair in dorso-median position, second pair (highly sclerotized and fused proximally but free distally) in dorso-lateral region, third pair in ventro-lateral region; parameres like a human foot.

Pruthi (1925) in his studies on unexpanded aedeagi of N. graminea and N. viridula noted only one pair of conjunctival processes.

Dorpius indicus Westw. (Fig. 49)

Basal plates produced dorsally for a short distance; phallotheca globose; ejaculatory reservoir elliptical, vesica thick, median vesical processes fused for a distance; three pairs of conjunctival processes present, those in dorso-median region bifurcate distally and correspond to process No. 1, a pair in the dorso-lateral region correspond to No. 2 and third unpaired in the medio-ventral region correspond to No. 3; parameres C-shaped with a median hairy projection.

Agonoscelis nubila Fabr. (Figs. 50, 51)

Basal plates produced dorsally; ejaculatory reservoir very big, more or less round and continues into a long curved and very thick vesica, no vesical lobes; three pairs of conjunctival processes present in dorsal, dorso-lateral and ventro-lateral regions; parameres curved and flattened (Fig. 51).

Agonoscelis rutila was studied in an unexpanded state and there appear to be only two pairs of conjunctival processes.

Aeliomorpha pusana Dist. (Fig. 52)

Basal plates slightly produced dorsally; phallotheca globular; ejaculatory reservoir big, vesica short, median vesical processes fused proximally but free distally; conjunctiva exposed permanently and bears one pair of conjunctival process; parameres L-shaped with a median projection.

Eusarcocoris inconspicuous H.-S. (Fig. 53)

Basal plates very thick and produced dorsally; phallotheca like an inverted beaker and very wide; ejaculatory reservoir round, median vesical processes not united; one pair of conjunctival processes present; parameres very characteristic (Fig. 53) being bent on themselves, distal portion flattened, proximal portion narrow.

Bagrada cruciferarum (Fig. 54)

Basal plates produced dorsally into small struts; phallotheca round; ejaculatory reservoir sub-globular; endosoma permanently exposed, vesica bears median and lateral vesical processes; two pairs of conjunctival processes present in dorso-lateral and ventro-lateral position (Fig. 54); parameres curved, genital capsule bears a pair of parandria.

Pruthi (1925) in his description of the male genitalia of *B. cruciferarum* did not note the vesical processes and stated that conjunctival flaps were bilobed, his figure 21 shows, however, that he has mistaken the median vesical processes as conjunctival flaps.

Stenozygum speciosum Dist. (Fig. 55)

Basal plates moderate and produced dorsally; phallotheca highly sclerotized; ejaculatory reservoir round; vesica enclosed in median vesical processes; a pair of conjunctival processes present; parameres biramus (Fig. 55); parandria present (Fig. 55).

Biramous parandria have been noted in *Podops inuncta* by Leston (1953 b).

Adria parvula Dall. (Fig. 56)

Basal plates produced dorsally; phallotheca oval, highly sclerotized and of characteristic shape; ejaculatory reservoir long and oval, median vesical

processes as in *A. pusana* and *D. versicolor*; a pair of conjunctival processes present in dorso-lateral position; parameres as figured (Fig. 56) — somewhat C-shaped with a hairy projection in the centre.

Morna florens (Fig. 57)

Basal plates of moderate size; phallotheca not sclerotized; ejaculatory reservoir large and sub-globular; vesica small and curved but without processes; conjunctiva bears a pair of indistinct processes; parameres broad in the middle and tapering at the two ends (Fig. 57).

Spermathecae

Cydnidae

The spermatheca of *Aethus indicus* Westw. *Geotomus apicalis* Dall. (Fig. 59), *Macroscytus expansus* Sign., *Stibaropus callidus* Schiodte (Fig. 59) were studied. The spermatheca of *G. apicalis* is interesting for the spermathecal duct below and above posterior dilation is thrown into several circular coils. The spermathecal duct of *Stibaropus* swells into a big dilation posteriorly just like many Scutelleridae but is devoid of any thickenings or ornamentations, while in all other Cydnidae studied so far the dilation is formed by invagination of the basal parts of spermatheca.

Brachyplatidae

In *Brachyplatys radians* Voll (Fig. 60), *Brachyplatys subaenus* (Fig. 61), *Coptosoma sp* (Fig. 62) there is a small pumping region and tubular spermathecal duct of varying length. In *B. subaenus* the duct is enclosed in a chitinous covering marked into numerous small segments.

Scutelleridae

Chrysocoris stollii (Wolff) (Fig. 63)

Long tubular apical bulb, short pumping region, posterior part of the duct enclosed in a broad cylindrical covering, the latter being formed by the invagination of the basal portions of spermathecal duct. A projection rises from the proximal portion of this cylindrical structure and into it fits a long projection from the top (Fig. 63). In *Scutellera perplexa* the spermathecal duct expands into a very big, globular and sclerotized swelling, bearing characteristic ornamentation in its centre (Fig. 63). Similar spermathecal dilations have been figured by Pendergrast (1957) in *Cryptacrus comes, Scutiphora pedicellata,* etc.

In *Poecilocoris latus* Dall. (Fig. 64) the spermathecal duct is thin walled and bears some ornamentations.

Dinidoridae

Coridius janus

Similar to *C. viduatus* as described by Pendergrast (1957) but spermathecal diverticulum in *C. janus* is extremely long.

Tessaratomidae

Lyramorpha rosea (Fig. 65)

Apical bulb spherical, short pumping region, spermathecal duct swells into a huge balloon like structure.

Pentatomidae

In all the twelve species of Pentatominae, one Holyinae and one of Asopinae examined in the present work, Pentatominae type of spermatheca as demonstrated by Pendergrast (1957) was found. It is interesting to note that the complex dilation covering the spermathecal duct is filled with watery fluid so that if a spermatheca is examined from fresh specimens the dilation appears to be huge, the fluid is, however, lost during progressive dehydration. Attention may be paid here to the spermatheca of *E. inconspicuus* (Fig. 66) where the spermathecal duct dilation bears posteriorly three pairs of small sclerotizations of unknown significance.

Ovaries and accessory glands

Female internal genitalia of *A. indicus* Westw, *M. expansus* Sign, *C. stollii* (Wolff), *C. janus*, *D. versicolor*, *N. antennata*, *D. indicus*, *A. nubila*, *E. inconspicuous*, *S. speciosum*, *B. cruciferarum* have a pair of ovaries each composed of seven ovarioles; there are no accessory glands.

Internal male genitalia

Cydnidae

In *Aethus indicus* Westw. (Fig. 67) the testes consist of seven testes follicles. The vas deferens is long and bear numerous small mesadene tubules posteriorly. There are a pair of ectadene sacs on the sides and a single median globular sac at the centre of the anterior end. There are numerous ectadene glands on the lower side of the bulbus. The bulbus is flattened side ways at the anterior end.

In *Macroscytus expansus* Sign (Fig. 68) the testes are very big and of characteristic shape which is similar to Brachyplatid testes as figured by Pendergrast (1957, Fig. 122, page 43). The vas deferens is extremely long but less longer than Brachyplatid vas deferens. There are wide masses of tubular mesadene glands. Small tubular ectadene glands are confined to the middle of bulbus ejaculatorius. Ectodermal sacs as in *A. indicus* Westw, but the median sac is strap like and bears two projections on either side.

Pendergrast (1957) in his studies on the bulbus of Cydnidae stated their similarity to Pentatominae, but at the same time he said, "The most obvious difference being the lack of tubules comprising the accessory glands, these having the form of swollen sacs". It seems that these generalizations hold good only for *Sehirus bicolor* which Pendergrast studied. The ectadene glands (e.g. 1 and e.g. 2, page 43, Fig. 121) of Pendergrast (1957) are as a matter of fact the ectadene sacs, for the present studies on *A. indicus* Westw and *M. expansus* show that there are distinct tubular ectadene glands and serial sections reveal that the structure of the paired sacs is similar

to the median ectodermal sac. From the present study it would appear that internal genitalia of Cydnidae show remarkable similarity to those of Brachyplatidae.

Bulbus ejaculatorius consists of an outer layer of investing epithelium which is composed of narrow cells, the inner border of these cells is characteristically fringed (Fig. 71). The investing epithelium secretes a chitinous intima which lies within it. The middle layer of bulbus is composed of tall and secretory cells (Figs. 69, 70). The central or lining epithelium is highly folded and secretory in nature. A unusual feature is the extension of the middle and lining epithelial layers of the bulbus into the ductus ejaculatorius (Figs. 69, 70). This tube is generally empty but in some cases e.g. *Nezara viridula* (Pendergrast, 1957), *Coridius janus* (vide infra), *Dalpada versicolor* (vide infra), *Liorhyssus rubicundus* (Kumar, in press) processes extend back from lining epithelium of the bulbus and obscure the lumen of ductus which is then hard to make out. It may be that in Cydnidae these processes have become arranged regularly thereby giving the impressions of the presence of two layers. Another noteworthy feature of Cydnid bulbus is the arrangement of muscle fibres in the form of a cap at the top of the bulbus (Fig. 74). The muscle fibres in other Pentatomoidea are arranged at the back of the bulbus i.e. on the ventral side.

Dinidoridae

In *Coridius janus* the testes consist of seven follicles (Fig. 72). Vesicula seminalis is posteriorly placed. Mesadene glands are tubular and numerous (represented diagramatically in Fig. 72). Bulbus ejaculatorius is covered dorsally by a big sac like investment. The single layered epithelium of which (the investing epithelium of Pendergrast, 1956, 1957) is thrown into numerous folds. Ventral and lateral sides are covered by a thick layer of muscle fibers. The epithelium of the bulbus proper (the middle epithelial layer of Pendergrast, 1956, 1957) is composed of tall columnar secretory cells (Figs. 73, 74) and is restricted to antero-dorsal aspect only. The central cavity of the bulbus is surrounded by a spongy epithelium (the lining epithelium of Pendergrast, 1956, 1957). The lumen of the ductus ejaculatorius is obscured by the processes from lining epithelium (Fig. 75).

From the description it is clear that bulbus of Dinidoridae shows resemblances to bulbus of Pyrrhocoridae and Acanthosomidae.

Pentatomidae

The internal male genitalia of *Dalpada versicolor* (Figs. 76, 77, 78), *Dorpius indicus* (Fig. 79), *Agonoscelis nubila* (Fig. 80), *Eusarcocoris inconspicuus* (Fig. 81), *Stenozygum speciosum* Dist (Fig. 82), *Bagrada cruciferarum* (Figs. 83, 84) are on typical Pentatominae plan. There are a pair of testes of deep red colour. There are usually six testes follicles but in the present work as few as two testes follicles in *B. picta* and three in *E. inconspicuus* were recorded. Bulbus ejaculatorius is a complex organ of the same type as described in *M. expansus* (Cydnidae) and *C. janus* (Dinidoridae). The structure of bulbus in *D. versicolor* and *B. cruciferarum* is figured. There are a pair of laterally placed ectadene sacs into which open numerous ectadene glands. Mesadene glands are present. In *Dalpada* there is in addition

an apically placed ectadene sac and a single pair of ectadene glands which open at about the middle of ductus ejaculatorius.

The reproductive organs of *Rhynchocoris humeralis* (Fig. 85) are very different from the usual Pentatominae type. There are four pair of ectadene sacs, a very big pair situated laterally and there are other small pairs situated round the anterior region of the bulbus, ectadene glands are wanting. Mesadenes appear to be represented by a pair of long tubular glands swollen at their apices. Number of testes follicles was not determined.

Salivary glands

Cydnidae

Salivary glands of *Aethus indicus* Westw. and *Macroscytus expansus* Sign. (Fig. 86) consist of an anterior undivided lobe while the posterior lobe is sub-divided into three long tubular lobes; accessory duct of salivary glands thrown into convolutions.

Scutelleridae

In *Chrysocoris stollii* Wolff (Fig. 87) salivary glands consist of an anterior and posterior lobe, each of which is further sub-divided into numerous tubular sub lobes, the number of which varies greatly even in the two glands of the same insect and therefore their number should not be taken as a taxonomic guide; duct of accessory salivary gland thrown into several convolutions.

Dinidoridae

In *Coridius janus* (Fig. 88) each salivary gland is divided into anterior and posterior lobes, the former is subdivided into several small lobes, and the latter into many very long and tubular ones. The number of sub lobes in both anterior and posterior lobes varies very greatly as in *Chrysochoris stoollii* Wolff. Accessory salivary duct is thrown into many convolutions. Rastogi (1961) erroneously states that salivary glands of *C. janus* show no differentiation into anterior and posterior lobes. He states at the same time that these glands are plurilobed. It must be borne in mind that the term plurilobed as applied to Pentatomoidea means that there are distinct anterior and posterior lobes, each of which may be further sub-divided. In case it is meant that there is no distinction between anterior and posterior lobes, term multilobed should be used.

Pentatominae

Salivary glands of *Agonoscelis nubila, Dorpius indicus* (Fig. 89), *E. inconspicuus, Stenozygum speciosum, Andrallus spinidens* Fabr. (Asopinae) are bilobed, consisting of an anterior and posterior lobe, and none of these lobes is further sub-divided, accessory salivary duct is thrown into typical Pentatomid convolutions.

Sarel-Whitefield (1929) states the presence of trilobed salivary glands in majority of the *A. versicolor* that he examined, but in present studies on two species of *A. nubila* and *A. rutila*, a trilobed condition was never observed.

Status of the families and sub-families of Pentatomoidea

Cydnidae

Cydnidae now consists of Sehirinae, Cydninae and Coriomelaeinae. Unfortunately, it was not possible to study Coriomelaeinae for no material could be secured of the same. Little information exists about Coriomelaeinae, only ovipositor (Scudder, 1959) and spermatheca (Pendergrast, 1957) having been studied. In the present work Sehirinae have been treated as one of the Cydninae. It seems that Cydninae and Coriomelaeinae should be raised to family level. Cydninae are unique in having sclerotized anterior inter-valvular membranes of characteristic shapes. Amongst Pentatomoidea there is a tendency for these anterior inter-valvular membranes to become progressively non-sclerotized and in highly specialised groups like Tessaratomidae these are membranous and greatly folded (in Pentatomidae, however, nature of triangulum remains to be investigated, vide supra). Cydninae appear to be the only group in Pentatomoidea (other than Brachyplatidae) where the second valvifers are free from each other.

Cydninae as Leston (1954 c) showed have three pairs of conjunctival processes and in this respect show affinities to Scutelleridae, Dinidoridae and Tessaratomidae. Pruthi (1925) in his studies on *Geotomus* and *Sehirus* noted only two pairs of conjunctival processes and considered Cydnidae to bridge the gap between Pentatominae and Scutellerinae. But studies of Leston (1954 c) and present work show that three pairs of processes are present.

Spermatheca of Cydninae do not seem to be very helpful in determining the affinities of the group although its affinities to Pentatominae are indicated as pointed out by Pendergrast (1957). The spermatheca of *Stibaropus* of the present study shows similarity to the spermatheca of Scutelleridae. Male reproductive organs are very interesting, they indicate its affinities to Brachyplatidae. The vas deferens of *Macroscytus* is extremely long but less longer than those of Brachyplatidae.

The shape of testes in *Macroscytus* is strikingly similar to the testes of *Coptosoma* (Brachyplatidae). Further there is similarity between Cydninae and Brachyplatidae in the shape of mesadene glands as well. In Cydninae muscle fibers are arranged on the top of the bulbus in the form of a cap which is peculiar. Pendergrast (1957) stated that the reproductive organs of Cydnidae appear to be even more complex than those of Pentatominae and indicated its affinities to the latter group. However, his conclusion is not tenable for he studied only *Sehirus* and did not interpret its ectadene sacs correctly.

Salivary glands of Cydninae are important for they indicate that plurilobed glands are a specialized rather than a primitive condition. In Cydninae anterior lobe of these glands is undivided while posterior lobe is subdivided into three long lobes and plurilobed condition could be attained by the sub-division of anterior lobes. Brachyplatid salivary glands are unfortunately unknown, otherwise they would have been a valuable comparison.

Ovipositor of Coriomelaeinae as described by Scudder (1959) shows that Coriomelaeinae are highly specialized in having lost rami and possessing unrecognizable second valvulae and in this respect show affinities to certain Tessaratomidae and Pentatominae. Pendergrast (1957) in his studies in *Galgupa atra* noted that its spermatheca did not show affinities to Cydninae

and suspected it to be aberrant. Both Scudder (1959) and Pendergrast (1957) have noted that *Thyreocoris* does not show affinities to Cydninae which clearly indicates that *Thyreocoris* is placed in a wrong subfamily as suggested by Scudder (1959). Thus it can be concluded that Cydninae and Coriomelaeinae should be raised to family status within the group Pentatomoidea.

Brachyplatidae

It is usual to give it a family status these days. The ovipositor in Brachyplatidae is on the same lines as in Cydninae. However, it is more specialized, the anterior intervalvular membranes have become totally non-sclerotized, the first valvulae have developed an complete arch like outer ramus which is elsewhere fully developed only in Dinidoridae. There is a tendency for the second valvifers for becoming fused. The male genitalia are more specialised than Cydnids in having two pairs of conjunctival processes, the vesica is enclosed in a sclerotized median vesical covering just like many Pentatomidae and Scutelleridae.

The male genitalia taken as a whole appear to be closely allied to Pentatominae. Pruthi (1925) considered the Brachyplatid male genitalia to be Cydnid type which is erroneous for in his studies on unexpanded aedeagus of Cydnidae, he guessed only two pairs of conjunctival processes.

Pendergrast (1957) noted that the Brachyplatid spermatheca showed similarity to the spermatheca of Berytidae, Pyrrhocoridae and Urolabidae. But latter two have a proximal pump flange, while only a distal pump flange is present in Berytidae. Both pump flanges are present in Brachyplatidae and the spermathecal duct may be short or extremely long (vide supra). Brachyplatidae is thus the only family in Pentatomoidea where both pump flanges are present and there is simple a narrow tubular spermathecal duct.

While considering male reproductive organs, Pendergrast (1957) noted that extreme length of vas deferens and form of accessory glands was unique amongst Trichophora. In the present study, great length of vas deferens and Brachyplatid shape of mesadene glands has been noted in Cydnids (vide supra) which suggests that Brachyplatids and Cydnids are closely related.

From the present work it would appear that Brachyplatidae are a specialized group exhibiting close resemblances to Cydnids but differences in the two are sufficient to suggest that Brachyplatidae should be given a family status within the group Pentatomoidea.

Scutelleridae

The ovipositor of Scutelleridae is at once different from that of other Pentatomoidea. There is tendency for the fusion of various parts of Ovipositor particularly the first valvulae (vide supra). In complete fusion of second valvulae in some cases they show similarities to certain Tessaratomidae. The ovipositor of Scutelleridae can be easily derived from Pyrrhocorid ovipositor by the fusion of second valvifer and loss of styloids when a condition similar to that of *Scutellera* or *Poecilocoris* will result.

Similarity of the aedeagus in Scutelleridae and Tessaratomidae in respect of conjunctival processes has been noted by Leston (1952) and the present

studies are in agreement with him. However, it may be noted that position and shape of ejaculatory reservoir in Scutellerinae is very similar to that of Cydninae. Leston (1958) on chromosomes puts the 3 families close together. Leston (1952) generalizes that in Scutelleridae the vesica and reservoir like Tessaratomidae merge imperceptibly into one another but such condition was not noted in the present work.

Pendergrast (1957) from his studies on spermatheca generalized that spermatheca of Scutelleridae are characterised by a spermathecal duct which has "very large, ovoid or spherical heavily sclerotized and deeply pigmented dilation of the spermathecal duct" and in this respect differed from that of Pentatomidae; however, in one case in the present study the spermathecal duct was found to be of Pentatomid type.

Salivary gland of Scutelleridae seem to show variability, for, in the present study it has been observed that both anterior and posterior lobes are sub-divided into numerous lobes (same condition has been noted in *Eurygaster integriceps* by Vodjdani, 1954) which indicates its affinities to Dinidoridae and Acanthosomidae. Dufour (1833) figured salivary glands in some *Scutellera* species where anterior lobe remains undivided while posterior lobe is sub-divided into many lobes which would indicate its affinities to Cydninae.

In the end it may be said that the characters of genitalia and salivary glands, particularly those of ovipositor and spermatheca show that Scutelleridae deserve a family status within the group Pentatomoidea.

Dinidoridae

The ovipositor of Dinidoridae is very distinct and can be said to be unique in Pentatomoidea. The first valvulae have both outer and inner rami equally well developed. Outer ramus elsewhere is fully developed only in Brachyplatidae. All the three rami of Dinidoridae are highly sclerotized, equal in size and similar in shape. The second valvifers are fused into a ridge like structure like Pentatomidae, but they at the same time retain fully developed and highly sclerotized second valvulae whose ramus is partially fused to inner ramus of first valvulae. Ovipositor of Dinidoridae shows affinities to Scutelleridae but former are far more specialized.

The aedeagus of Dinidoridae consists of three pairs of conjunctival processes and in this respect shows similarity to Tessaratomidae, Scutelleridae and Cydnidae. The third pair of processes in Dinidoridae are highly sclerotized for most of their lengths while in Tessartomidae and Scutelleridae the third pair is sclerotized for the entire length (In Cydnidae, third pair is only slightly sclerotized). However, the first pair in Dinidoridae are totally membranous. The vesica of Dinidoridae like Tessaratomidae shows no differentiation between ejaculatory reservoir and vesica, whole structure is a small swollen spongy organ. Leston (1954 b) while commenting on male genitalia of Dinidoridae stated "Male genitalia of Dinidorinae are very different from those of Tessaratominae", however, from the present studies it would appear that Dinidoridae are close to Tessaratomidae at least in respect of conjunctival processes. Three pairs of conjunctival processes the presence of which is regarded as a primitive character, occur in groups like Coreidae, Alydidae, Pyrrhocoridae as well (personal observations). Further

spermatheca was noted by Pendergrast (1957) to be "unique" in Penta-
tomoidea and present observations are in agreement with it.

Internal male reproductive organs of Dinidoridae are of the same complex
type which is present in land bugs generally. The absence of ectadenes
clearly take it away from the typical pentatomid bulbus. Furthermore, the
bulbus has a very well marked dorsal sac. In the latter two features it re-
sembles Pyrrhocoridae and Acanthosomidae.

The salivary glands of Dinidoridae have both anterior and posterior lobes
divided into many sub lobes and in this respect show resemblances to Scutel-
leridae and Acanthosomidae (Salivary glands of Tessaratomidae are un-
known), of course much to latter than former. Nuorteva (1956) in his stu-
dies on salivary glands of *Elasmostethus interstinctus* (Acanthosomidae)
stated that they represented "a transitory stage between the usual bilobed
type and the plurilobed type represented by *Eurygaster integriceps*" (p. 53).
If that is so then Dinidoridae should also be regarded as such. However, it
may be stated in the light of present work that it appears more convincing
to take Cydnids as the transitory state (Cydnid salivary glands were un-
known to Nuorteva, 1956).

It is interesting to note that internal male reproductive organs of both
Dinidoridae and Acanthosomidae show resemblances to Pyrrhocoridae but
their salivary glands are very different, in the former two cases they are
of typical Pentatomid type while in the latter case they are typical Coreid
type which suggests that the Pyrrhocorid resemblances may be a matter
of parallel evolution only.

To sum up, it may be stated that Dinidoridae show affinities to Acantho-
somidae in respect of internal male reproductive organs and salivary glands,
but they are more or less distinct from other Pentatomoidea as regards ovi-
positor, male external genital and spermatheca. These findings show that
Dinidoridae undisputably deserve a family status. Leston (1958) does so
on cytological grounds.

Tessaratomidae

Considering the Ovipositor only, Tessaratomidae appear to be highly
specialised, second valvifers and valvulae have completely fused, the latter
having lost their connections with the former and in *Lyramorpha* they
approach the condition of Pentatominae. As in Pentatominae, first valvifers
are very well developed while the first valvulae have become highly mem-
branous and have lost their rami (excepting *Stilida*) and themselves appear
to be in the process of being lost and approaching the condition of Penta-
tominae. Similarly second valvulae are also in the process of being lost and
in *Stilida* almost Pentatominae condition can be seen.

Scudder (1959) states the presence of sclerotized and interlocking rami
in *Eusthenus, Phloea* and *Piezosternum*. Present observations are therefore
in contradiction to those of Scudder (1959). It may be that loss of rami and
gradual reduction of fused second valvulae is peculiar to tribe Oncomerini
(which have alone been examined in present work). It seems that sperma-
theca of Oncomerini is also peculiar and distinct in having an "apically
placed saccular diverticulum". It may be proved at a latter stage that tribe
Oncomerini merits a higher status within Tessaratomidae or it may have

been removed from it as in case of Thyreocorinae of family Cydnidae (vide supra). Above studies together with observations of Pendergrast (1957) appear to strengthen this view of the author. Affinities of the aedeagus of Tessaratominae have been pointed out by Leston (1954 b) and in the present work they have been dealt with already (vide supra).

At present there is no information about the internal male reproductive organs and salivary glands of Tessaratomidae. Evidently, further information is required on genitalia and salivary glands in more representative genera of the group before any decision on its status can be given. But it appears likely that Tessaratomidae is a heterogenous group in which Oncomerini is highly specialized and may have to be removed from Tessaratomidae altogether.

Pentatomidae

The female external genitalia are very constant in this group as has been pointed out by Scudder (1959), and the present studies are in agreement with it. Rami are always absent (except in one abnormal case in *Nezara antennata,* vide supra). First valvulae appear to have been lost so that first valvifers are joined by a membrane the triangulum. Triangulum has been regarded as representing the fused first valvulae (Verhöff, 1893). However, comparative studies suggest it to be a mere fused intervalvular membrane and the need for embryological data in this regard has been stressed earlier (vide supra); second valvulae and valvifers are extremely reduced.

Male external genitalia are however, very variable in the group, the variability being shown in respect of conjunctival processes which vary from one to three pairs (vide supra).

Internal male genitalia of Pentatomidae are almost constant in having ectadene sacs, ectadene glands and tubular mesadene glands. However, in the present studies in one case, ectadene glands were absent and mesadenes were represented by a single tubular gland. Variation in testes follicles was also recorded in Pentatominae.

Spermatheca (confirmed by Scudder, 1959 and present work after Pendergrast, 1957) and salivary glands in Pentatomidae are also very constant and they in addition to ovipositor and internal male genitalia strongly suggest that Pentatomidae is a homogenous and natural group.

The conclusion of Manna (1958) that Pentatominae includes heterogenous groups on the ground that chromosome number in them varies from 6 to 27 is not agreed upon from the present studies of ovipositor, internal male genitalia, spermatheca and salivary glands which indicates it to be a most homogenous group. However, variations in the conjunctival processes of the aedeagus are striking but difficult to account for in the present state of our knowledge.

Higher and Lower Pentatomoidea

Leston (1958) suggests a group of higher and lower Pentatomoidea. Present studies do not support such a division. Higher Pentatomoidea of Leston (1958) comprises Dinidoridae, Eumenotidae and Pentatomidae. Considering genitalia and salivary glands, Dinidoridae and Pentatomidae are wide apart. In Dinidoridae first and second valvulae are well developed and bear rami

while in Pentatomidae just reverse is the case; vesica and ejaculatory reservoir merge imperceptibly in Dinidoridae while in Pentatomidae the distinction between the two is very well marked; conjunctival processes in Pentatomidae are always membranous, while in Dinidoridae at least second and third pairs are sclerotized to varying extents; the internal male reproductive organs of Dinidoridae are Pyrrhocorid like quite different from Pentatomid type; spermatheca of Pentatomidae is entirely different from that of Dinidoridae; salivary glands of Pentatomidae have two simple lobes while in Dinidoridae the glands are plurilobed. Therefore, it would be seen that inclusion of Dinidoridae and Pentatomidae in the same group of higher Pentatomoidea is not justified, Dinidoridae although quite specialized appear to be a off-shoot from some Scutellerid stock.

Scutelleridae, Cydnidae and Tessaratomidae form the central group of lower Pentatomoidea of Leston (1958). Amongst these Cydnidae are very distinct in having sclerotized anterior inter-valvular membranes of definite shapes and possessing second valvifers which are free from each other while in Scutelleridae and Tessaratomidae there is a tendency for their fusion, Ovipositor of Oncomerinae (Tessaratomidae) is very nearly Pentatomid type. Inclusion of Tessaratomidae at least in lower Pentatomoidea is not justified. Male reproductive organs of Cydnidae are also very different from Scutellerid type.

In the present state of our knowledge of the structure of genitalia and salivary glands, the grouping of the families in two groups of Pentatomoidea is not supported. Scudder (1959) did not give any decision on such grouping of Pentatomoidea and merely stated "There is nothing in morphology of the female genitalia to support or disapprove the division of the superfamily into two groups".

Summary

Genitalia and salivary glands in six families of Pentatomoidea have been studied and their bearing on the classification is considered.

Family status for Brachyplatidae, Scutelleridae, Tessaratomidae, Dinidoridae and Pentatomidae has been supported. It has been suggested that Cydninae and Coriomelaeinae should be raised to family level; Oncomerini deserves a higher status than hitherto given.

Stress has been laid on the study of the inter-valvular membranes in ovipositors. Cydninae are unique in possessing highly sclerotized and characteristically shaped anterior inter-valvular membranes. It has been found that ovipositor of Oncomerini approaches the condition of Pentatomidae while Scutellerid ovipositor appears to be derived from the Pyrrhocorid type.

Conjunctival processes have been found in Pentatominae to vary from one to three and three pairs of processes have been shown to be present in the aedeagus of Dinidoridae.

Extreme length of vas deferens has been noted in Cydninae and variations in the testes follicles of Pentatominae have been recorded for the first time. Salivary glands in Cydninae have been suggested to be intermediate between bilobed and plurilobed glands.

On the basis of genitalia and salivary glands the division of Pentatomoidea into higher and lower groups has not been supported.

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Key to the Lettering of Figures

Female external genitalia

ANT.EXT.	=Anterior extension of ninth paratergite.
BAS.VF	=Basi-valvifer.
INT.VAV.ANT	=Anterior inter-valvular membrane.
INT.VAV.POST	=Posterior inter-valvular membrane.
INT.VAV.SCL.ANT	=Anterior inter-valvular sclerite.
R_1	=Outer ramus of first valvula.
R_2	=Inner ramus of first valvula.
R_3	=Ramus of second valvula.
SCL	=Sclerotic expansions.
ST	=Styloids.
TH.VA	=Vaginal thickenings.
V.F	=A fold of vaginal wall connecting second valvifers.
1st.VAL	=First valvula.
1st.VF	=First valvifer.
2nd.VAL	=Second valvula.
2nd.VF	=Second valvifer.
VIII	=Eighth paratergite.
IX	=Ninth paratergite.

Male external genitalia

B	=Body of ejaculatory reservoir.
B.P	=Basal plates.
B.P.B	=Basal plate bridge.
CON	=Conjunctiva.
CON.PR	=Conjunctival processes.
CP.PR	=Capitate process.
D.C.	=Dorsal connective.
DU.SM	=Ductus seminis.
EJ.RS	=Ejaculatory reservoir.
H	=Hinge.
HE.PR	=Helicoid process.
INF.PR	=Inferior process.
M.V.P.	=Median vesical process.
L.V.P.	=Lateral vesical process.
PR	=Paramere.
PTH	=Phallotheca.
S	=Stigma.
V	=Vesica.
V′	=A process of unknown homology arising out of vesica.
V.C.	=Ventral connective.
W	=Wings of ejaculatory reservoir.
I, II, III	=Conjunctival processes.

Spermatheca

B	=Bulb of spermatheca.
DF	=Distal pump flange.

DL   =Dilation of spermathecal duct.
DS   =Saccular dilation of spermathecal duct.
I   =Intima.
PF   =Proximal pump flange.
SP.D   =Spermathecal duct.

Male internal genitalia

B.EJ   =Bulbus ejaculatorius.
BL.GL   =Bulbus glands.
CE.EP   =Lining epithelium.
CO.DU   =Common duct of accessory glands.
D.EJ   =Ductus ejaculatorius.
DS   =Dorsal sac.
DU.VAS   =Duct of vas deferens.
EC.SC, EC.SC$_1$, EC.SC$_2$=Ectadene sacs.
EG   =Ectadene glands.
I   =Intima.
INV.EP   =Investing epithelium.
M   =Muscle fibers.
MD.EP   =Middle layers of epithelium.
MES   =Mesadene glands.
SV   =Seminal vesicle.
T   =Testes.

Salivary glands

AD   =Accessory duct.
AG   =Accessory gland.
AL   =Anterior lobe.
LL   =Lateral lobe.
ML   =Median lobe.
PD   =Principal duct.
PL   =Principal lobe.

Entomol. Ts. Årg. 83. H. 1—2, 1962

5

Explanations of figures

Figs. 1—2. *Aethus indicus* Westw. (Cydninae): (1) First valvifers and associated parts; (2) Ovipositor (Dorsal view).

Figs. 3—4. *Geotomus apicalis* Dall. (Cydninae): (3) First valvifers and associated parts; (4) Ovipositor (Dorsal view).

Figs. 5—7. *Macroscytus expansus* Sign. (Cydninae): (5) First valvifers and associated parts; (6) Anterior inter-valvular membrane; (7) Ovipositor (Dorsal view).
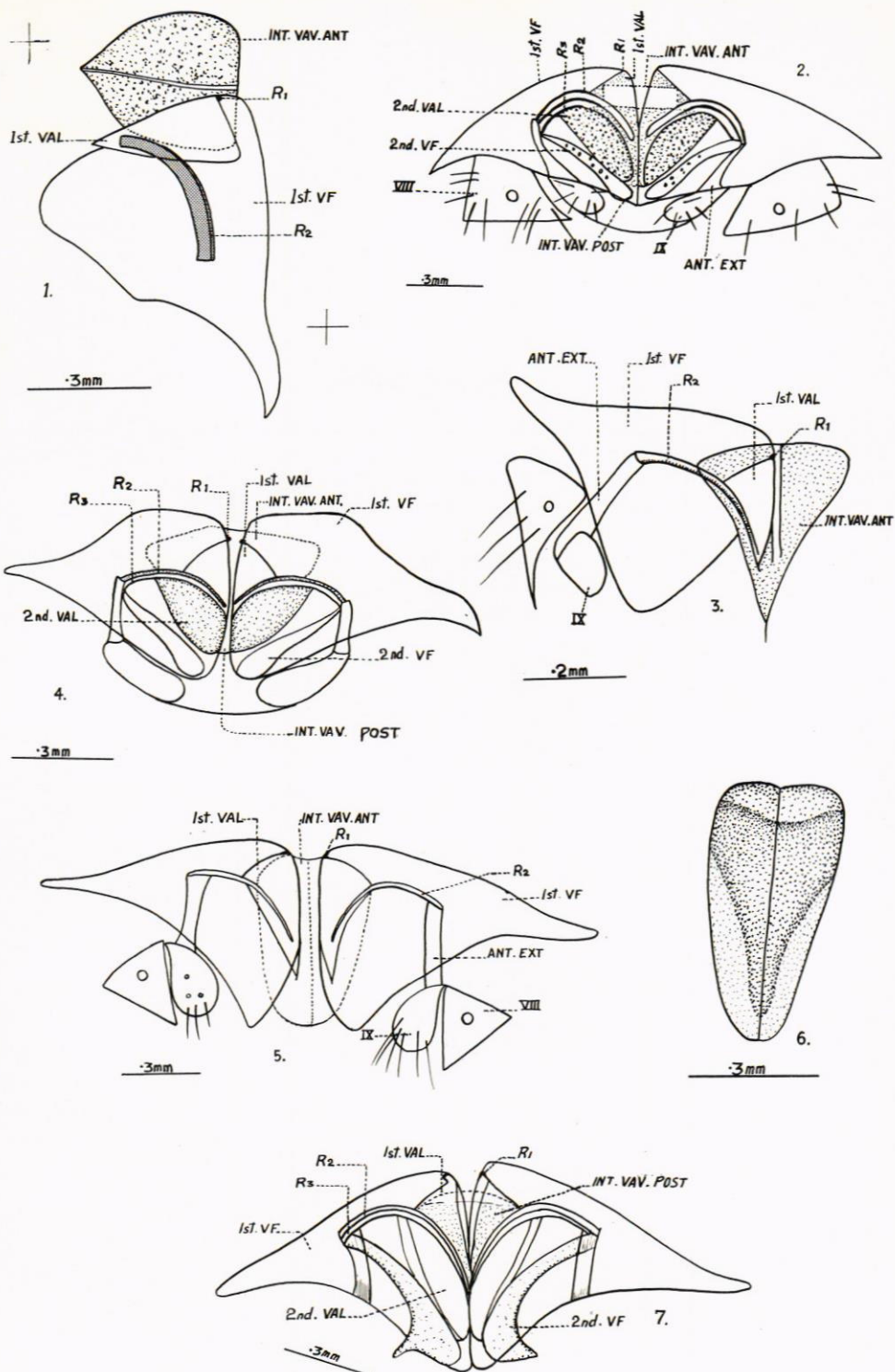
Explanations of figures

Fig. 8. *Stibaropus callidus* Schiödte (Cydninae): Ovipositor spread out (Dorsal view).
Fig. 9. Second valvifers and associated parts and first valvula of *Brachyplatys vahlii*.
Fig. 10. First valvula of *B. radians* Voll. (Brachyplatidae).
Figs. 11—12. *B. subaenus*: (11) Second valvifers and associated parts; (12) First valvula and anterior inter-valvular membrane.
Figs. 13—14. *Coptosoma siamica* (Brachyplatidae): (13) Sclerotic expansion present on vaginal wall; (14) Second valvifers and associated parts.
Fig. 15. *Chrysocoris stolli* Wolff (Scutelleridae): First valvifers and associated parts.
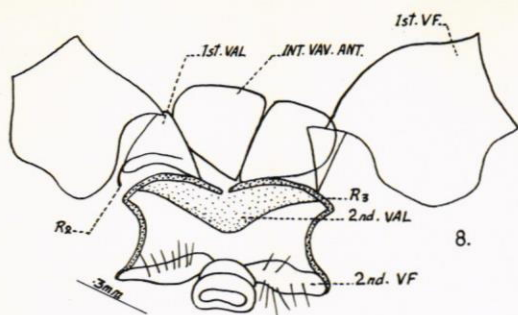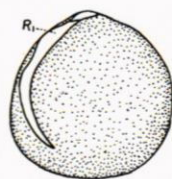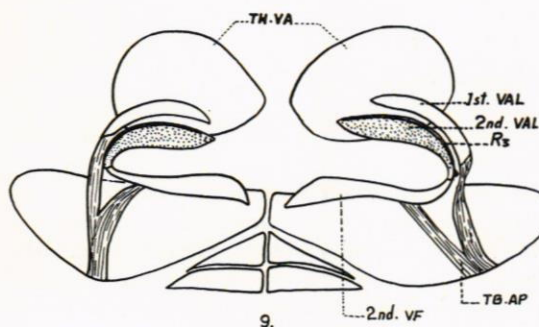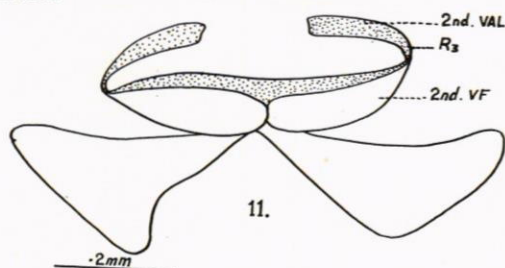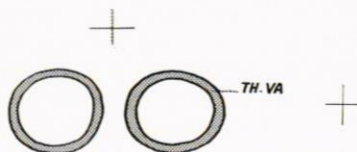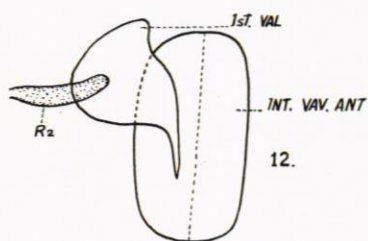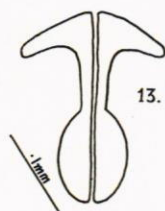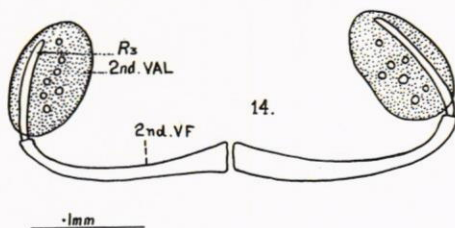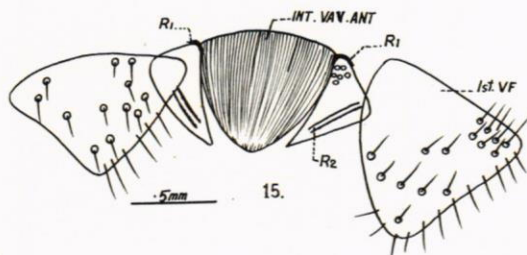
Explanations of figures

Figs. 16—17. *Chrysocoris stolli* (Scutelleridae): (16) Second valvifers and associated parts; (17) Sclerotizations around spermathecal duct.

Fig. 18. Second valvifers and associated parts of *Scutellera perplexa* (Scutelleridae).

Fig. 19. Second valvifers and associated parts of *Poecillocoris latus* Dall. (Scutelleridae).

Figs. 20—22. *Musgraveia sulciventris* (Oncomerini, Tessaratomidae): (20) First valvifers and associated parts; (21) First valvula; (22) Second valvifers and associated parts.

Fig. 23. *Lyramorpha rosea* (Oncomerini, Tessaratomidae): Second valvifers and associated parts.

R. KUMAR
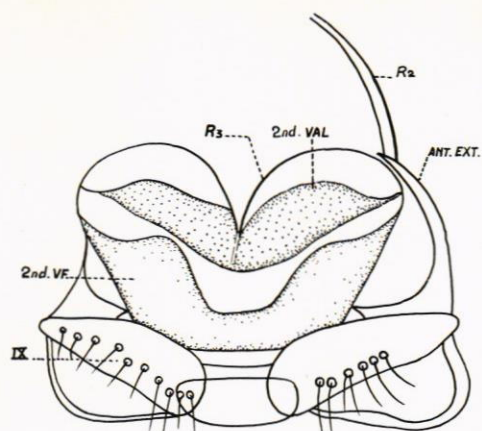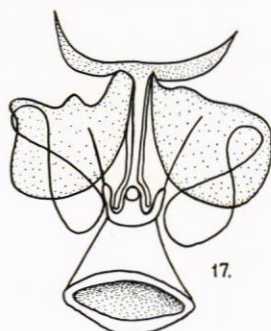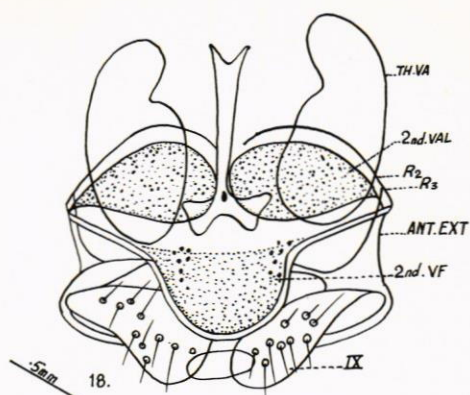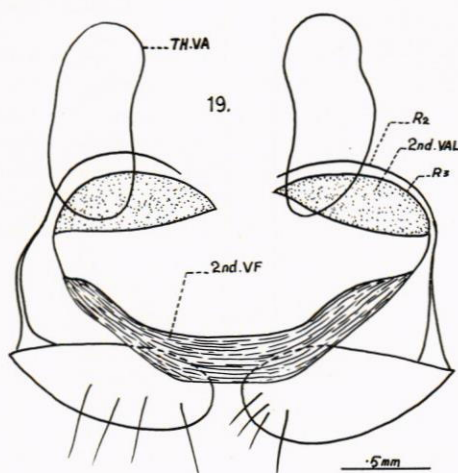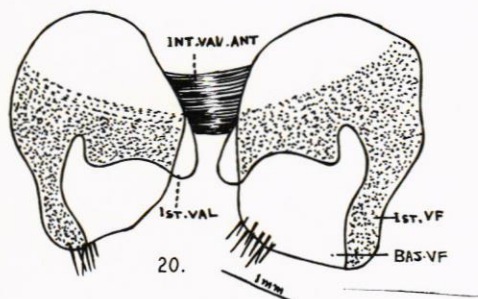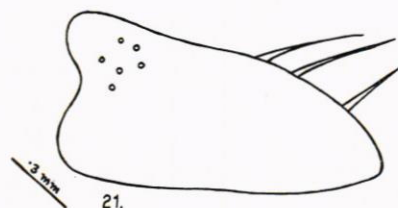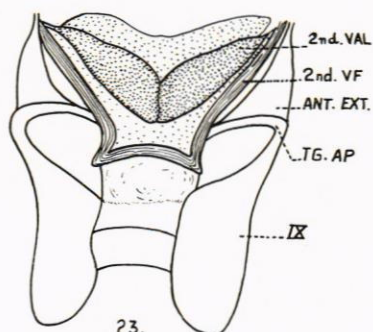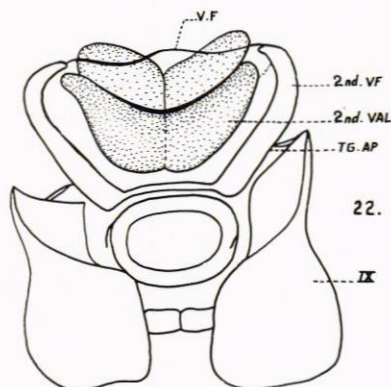
Explanations of figures

Fig. 24. *Stilida sp.* (Oncomerini, Tessaratomidae): Ovipositor spread out (Dorsal view).

Figs. 25—27. *Coridius* (=*Aspongopus*) *janus* (Dinidoridae): (25) First valvifers, second valvula, associated parts, eighth and ninth paratergites; (26) First valvula (somewhat diagramatic); (27) Second valvifers and associated parts.

Figs. 28—30. *Dalpada versicolor* (Pentatominae): (28) First valvifer; (29) Triangulum; (30) Triangulum and associated parts.

Figs. 31—32. *Nezara antennata* (Pentatominae): (31) First valvifer; (32) Triangulum.
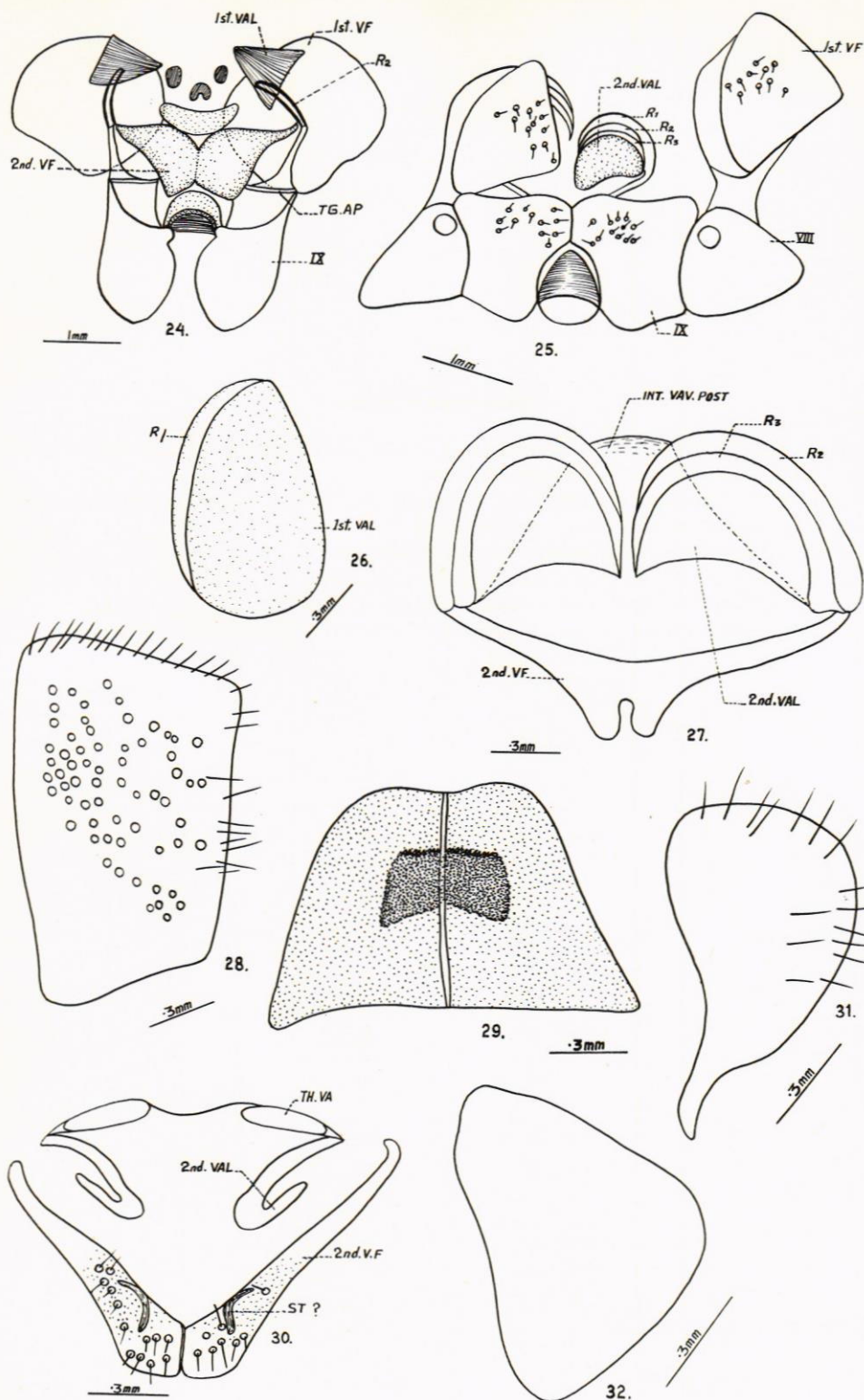
Explanations of figures

Figs. 33—34. *Nezara antennata* (Pentatominae): (33) Second valvifers and associated parts; (34) Abnormal case of presence of rami.

Figs. 35—37. *Andrallus spinidens* Fabr. (Asopinae): (35) First valvifer; (36) Triangulum; (37) Second valvifers and associated parts.

Fig. 38. Aedeagus of *Aethus indicus* Westw. (Cydninae).

Fig. 39. Aedeagus of *Geotomus apicalis* Dist. (Cydninae).

Fig. 40. Aedeagus of *Macroscytus expansus* Sign. (Cydninae).

Fig. 41. Expanded aedeagus of *Brachyplatys subaenus* Westw. (Brachyplatidae).

R. KUMAR
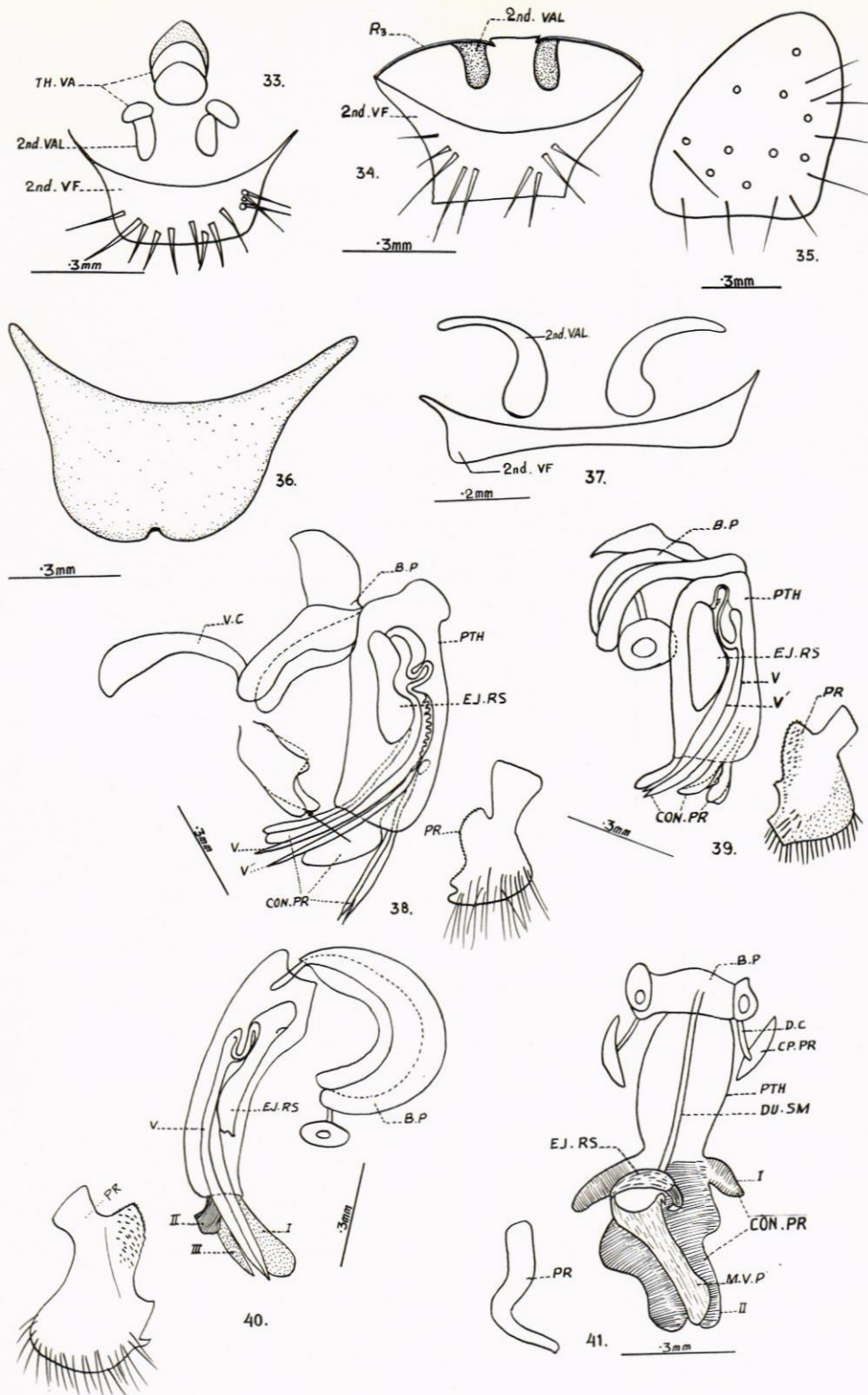
Explanations of figures

Fig. 42. Aedeagus of *Chrysocoris stollii* (Wolff) (Scutelleridae).

Figs. 43—44. *Poecilocoris latus* Dall. (Scutelleridae): (43) Aedeagus without third pair of conjunctival processes; (44) Phallus with third pair of conjunctival processes.

Fig. 45. A. Aedeagus of *Coridius janus* (Dinidoridae): Basal plates lifted upwards. Conjunctiva dissected out. B. Paramere.

Figs. 46—47. *Dalpada versicolor* (Pentatominae): (46) Vesica and one of the parameres; (47) Conjunctival processes dissected out.
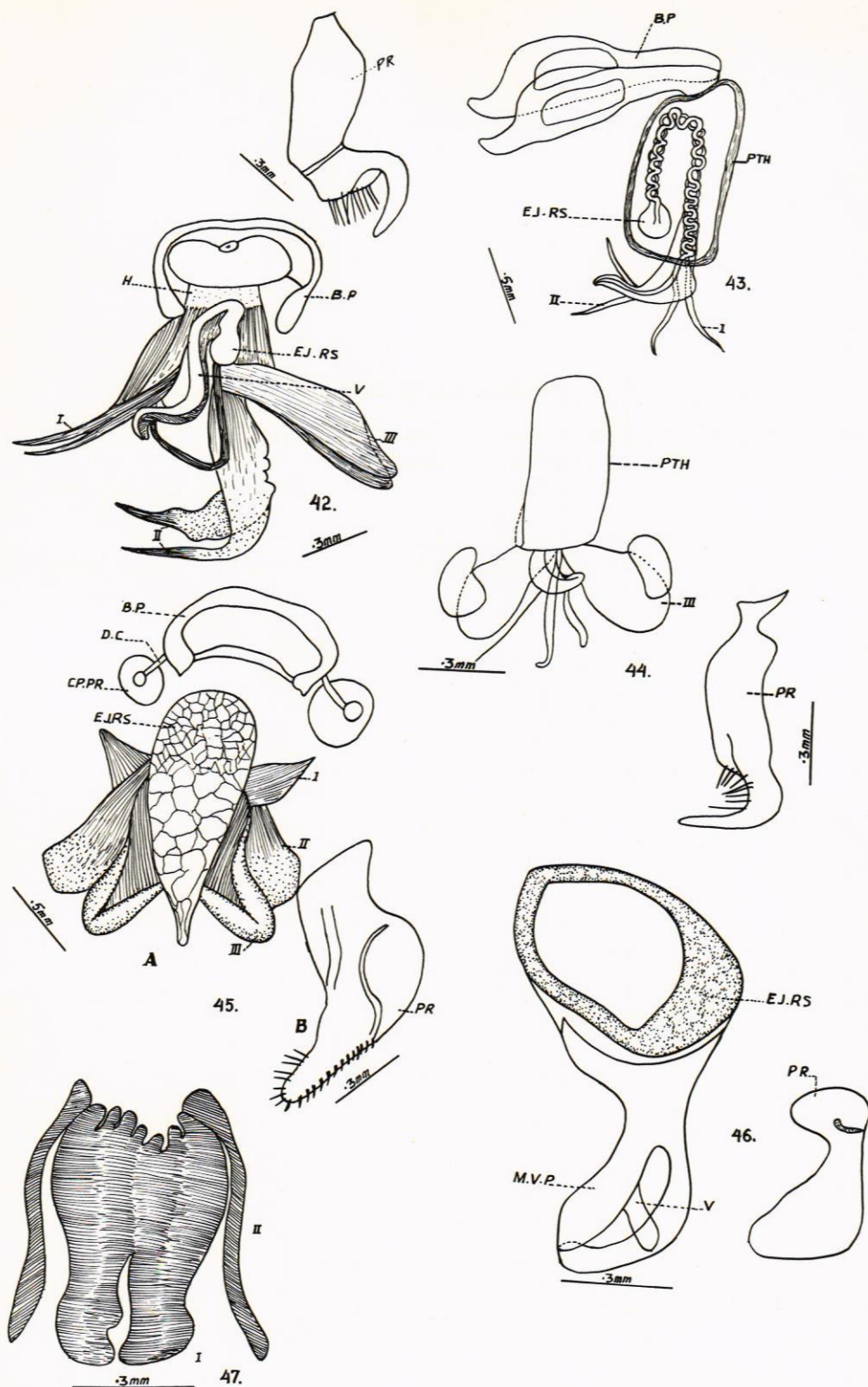
Explanations of figures

Fig. 48. Expanded aedeagus of *Nezara antennata* (Pentatominae).

Fig. 49. Expanded aedeagus of *Dorpius indicus* West.

Figs. 50—51. *Agonoscelis nubila* Fabr: (50) Expanded aedeagus, part of vesica removed; (51) Vesica.

Fig. 52. Aedeagus of *Aeliomorpha pusana* Dist.

Fig. 53. Aedeagus of *Eusarcocoris inconspicuus* H.S. (Pentatomidae) partly expanded.
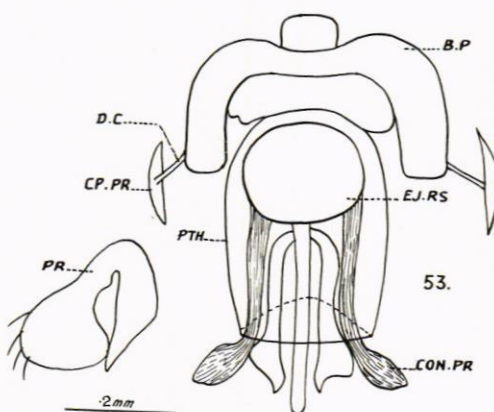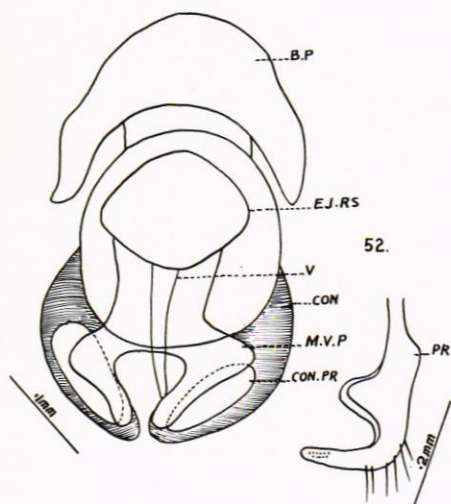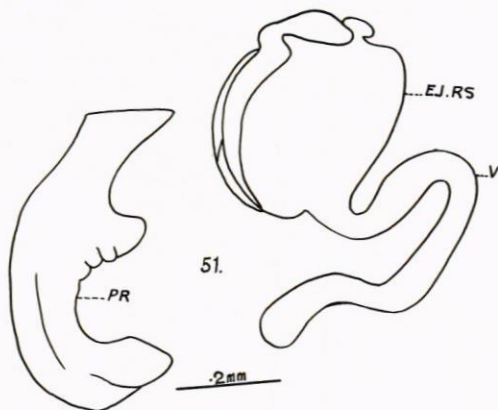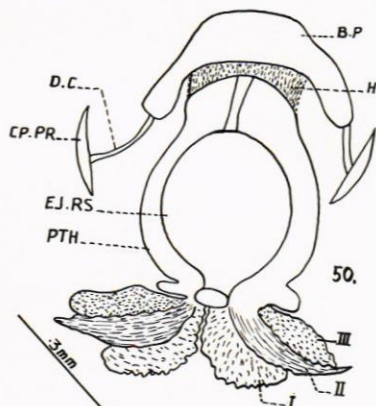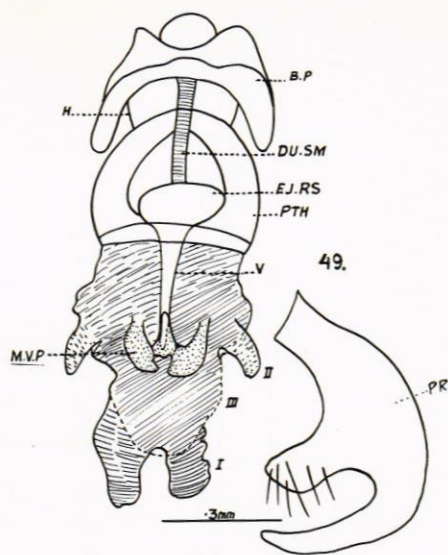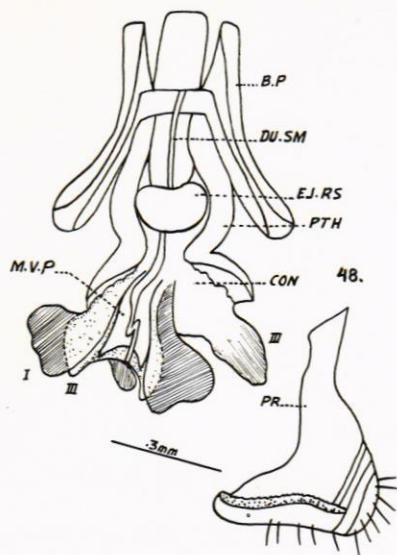
Explanations of figures

Fig. 54. *Bagrada cruciferarum* Fabr: A. Expanded aedeagus; B. Ejaculatory reservoir
as seen in lateral view; C. Paradria; D. Paramere.

Fig. 55. *Stenozygum speciosum* Dist. (Pentatominae): A. Aedeagus, basal plates lifted up-
wards; B. Ejaculatory reservoir in lateral view; C. Paramere.

Fig. 56. Aedeagus of *Adria parvula* Dall. (Pentatominae).

Fig. 57. Aedeagus and paramere of *Morna florens* Walker (Pentatominae) basal plates
lifted upwards. Ejaculatory reservoir drawn out of phallus.

Fig. 58. Spermatheca of *Geotomus apicalis* Dall. (Cydnidae).

Fig. 59. Spermatheca of *Stibaropus callidus* Schiödte (Cydninae).

Fig. 60. Spermatheca of *Brachyplatys radians* Voll (Brachyplatidae).

Fig. 61. Spermatheca of *B. subaenus*.

Entomol. Ts. Årg. 83. H. 1−2. 1962

6
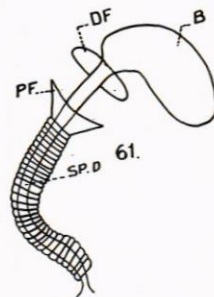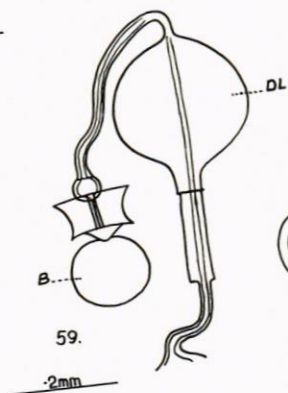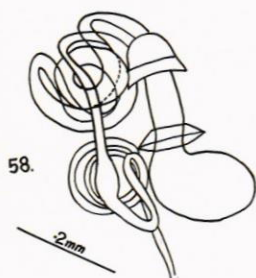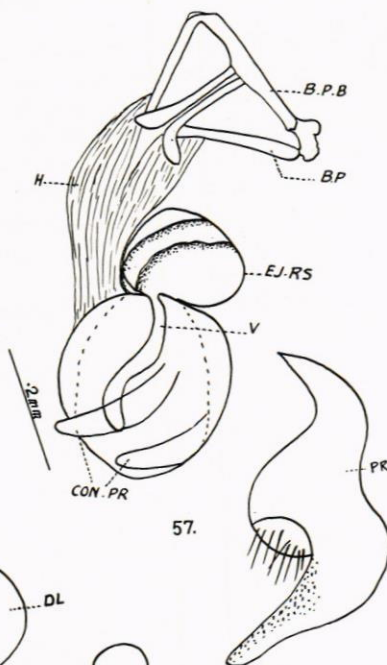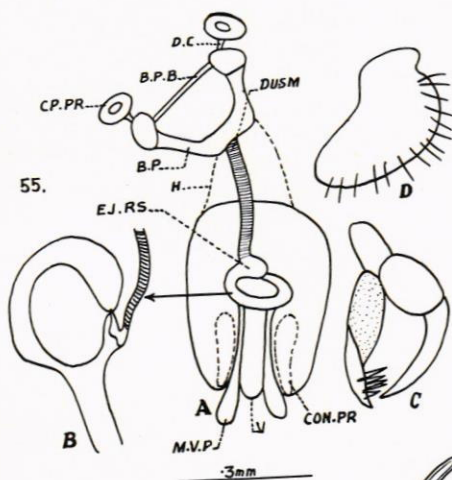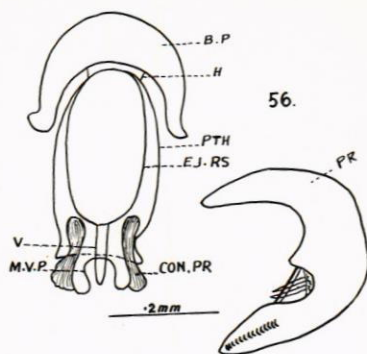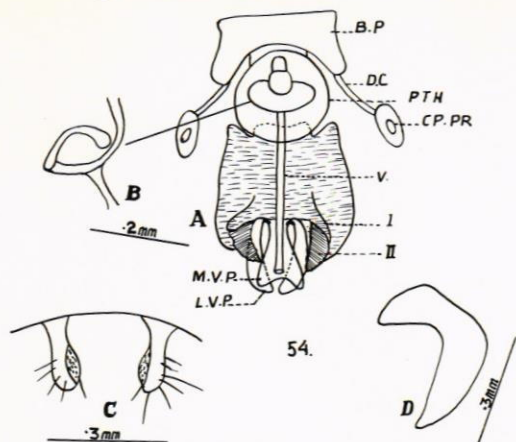
Explanations of figures

Fig. 62. Spermatheca of *Coptosoma sp* (Brachyplatidae).

Fig. 63. Spermatheca of *Chrysocoris stollii* (Wolff) (Scutelleridae).

Fig. 64. Spermatheca of *Poecilocoris latus* Dall. (Scutelleridae).

Fig. 65. Spermatheca of *Lyramorpha rosea* (Oncomerini, Tessaratomidae).

Fig. 66. Spermatheca of *Eusarcocoris inconspicuous* (Pentatominae).

Fig. 67. Male reproductive organs of *Aethus indicus* Westw. (Cydninae), testes and vas deferens on the right side omitted.

Fig. 68. Male reproductive organs of *Macroscytus expansus* Sign., testes and vas deferens on the right side not shown.

Fig. 69. *Aethus indicus* Westw. (Cydninae): T.S at about the middle of bulbus ejaculatorius.
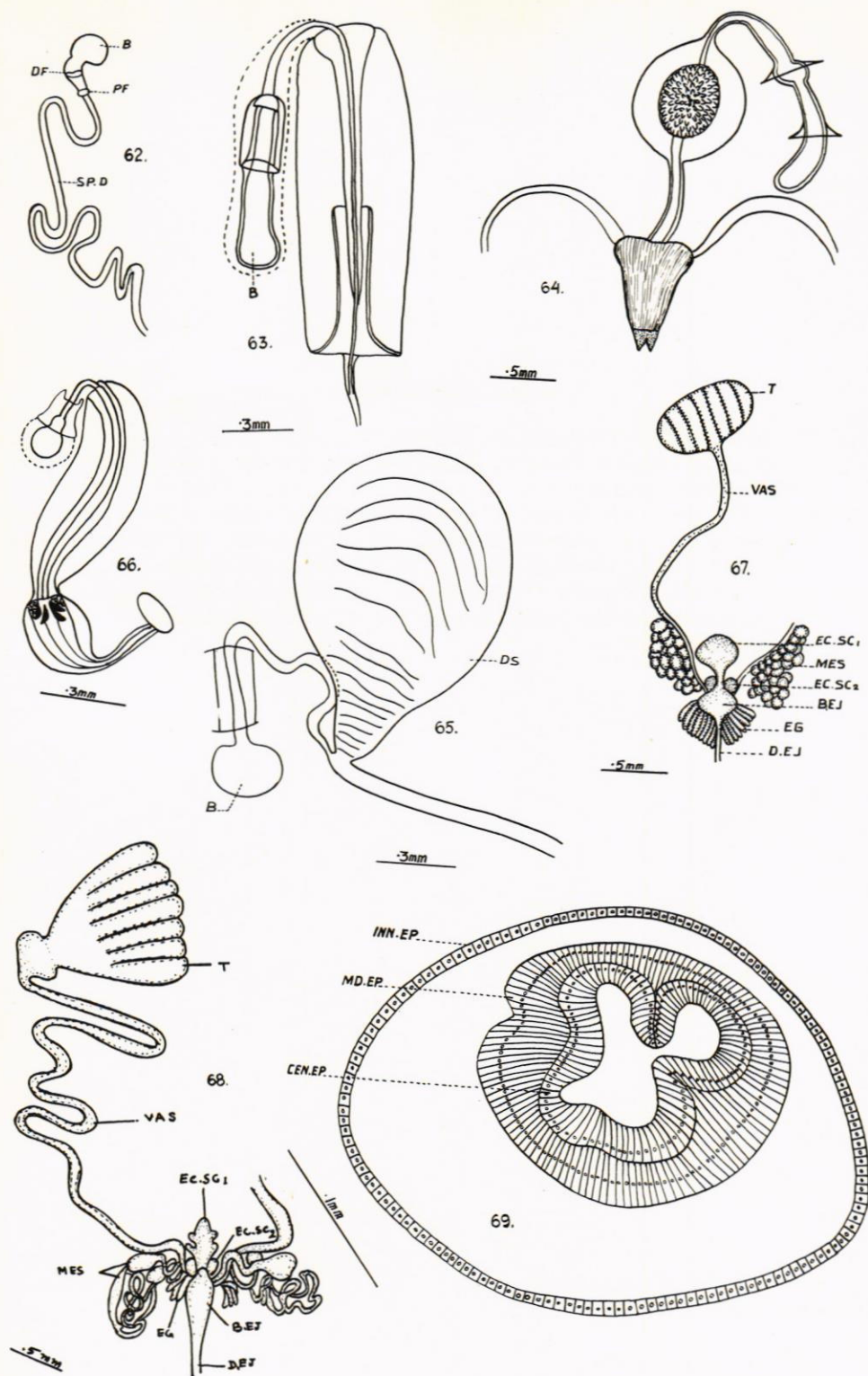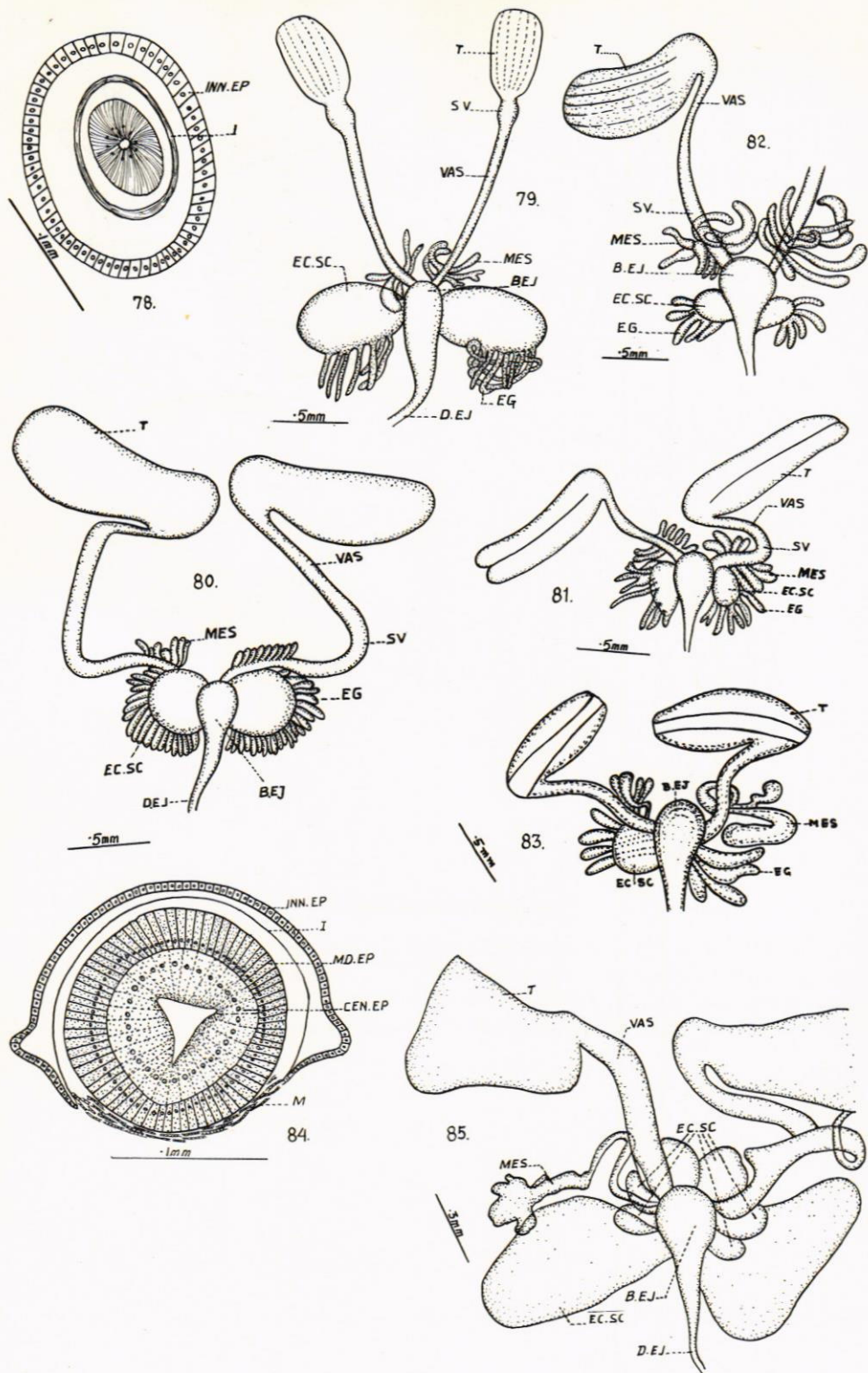
Explanations of figures

Fig. 70. *Aethus indicus*: T.S ductus elaculatorius.

Fig. 71. Frontal section (at about the middle) of bulbus ejaculatorius of *Macroscytus expansus* Sign (Cydninae).

Figs. 72—75. *C. janus* (Dinidoridae): (72) Male reproductive organs, testes on the right side omitted; (73) T.S bulbus ejaculatorius (anterior region); (74) T.S. bulbus ejaculatorius (at about the middle region); (75) T.S ductus ejaculatorius.

Figs. 76—77. *Dalpada versicolor* (Pentatominae): (76) Male reproductive organs (testes and vas deferens on the right side omitted); (77) T.S through anterior region of bulbus ejaculatorius.

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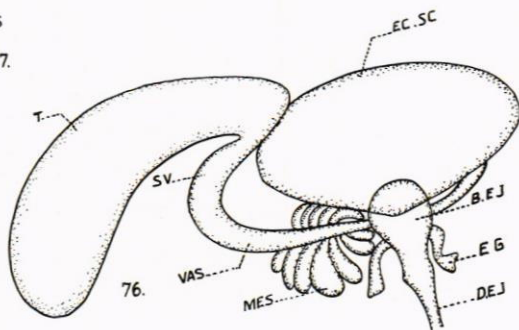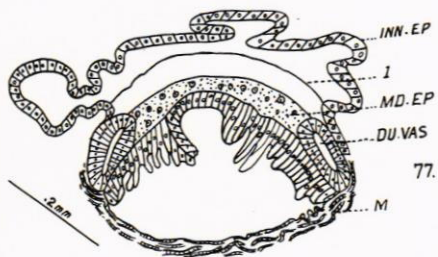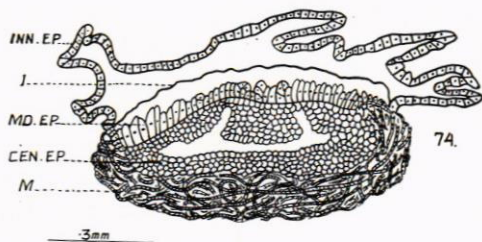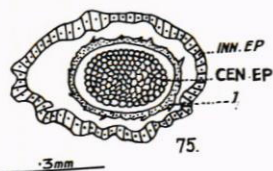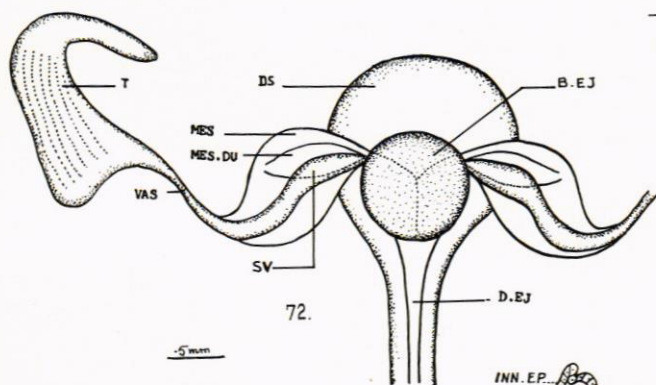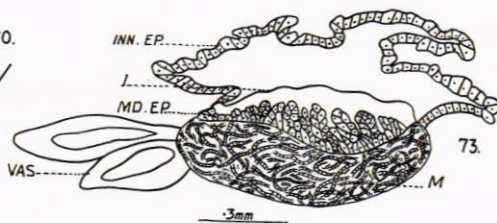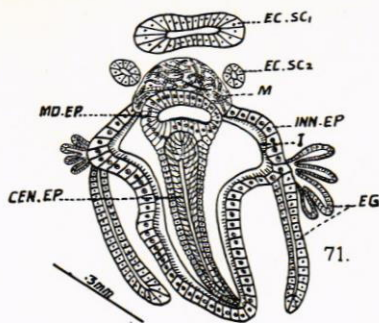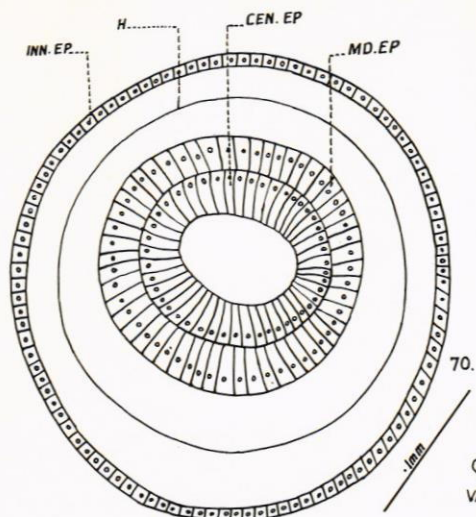
Explanations of figures

Fig. 78. *Dalpada versicolor*: T.S through ductus elaculatorius.
Fig. 79. Male reproductive organs of *Dorpius indicus* (Pentatominae).
Fig. 80. Male reproductive organs of *Agonoscelis nubila* (Pentatominae).
Fig. 81. Male reproductive organs of *Eusarcocoris inconspicuus* (Pentatominae).
Fig. 82. Male reproductive organs of *Stenozygum speciosum* Dist. (Pentatominae).
Figs. 83—84. *Bagrada cruciferarum* (Pentatominae): (83) Male reproductive organs;
         (84) T.S bulbus ejaculatorius middle region.
Fig. 85. Male reproductive organs of *Rhynchocoris humeralis*.
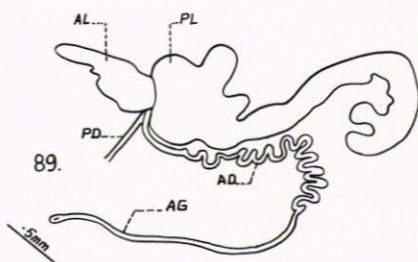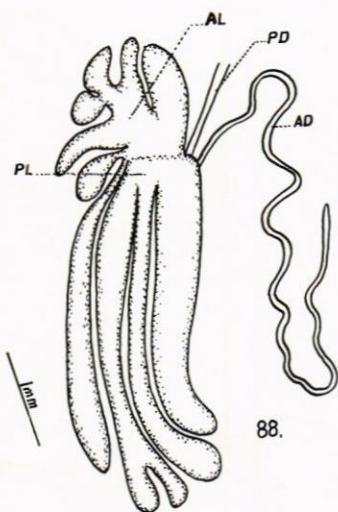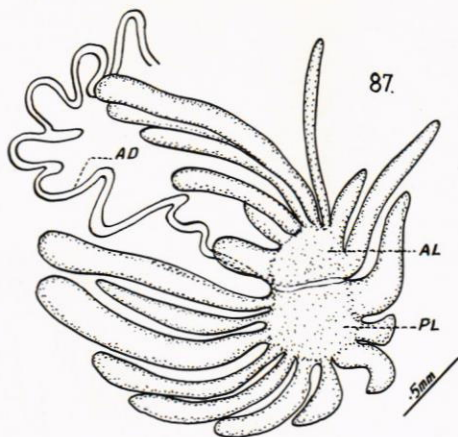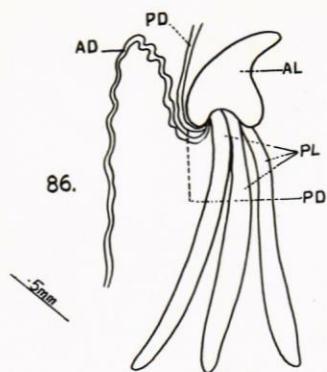
Explanations of figures

Fig. 86. Salivary gland of *Aethus indicus* Westw. (Cydninae).
Fig. 87. Salivary gland of *Chrysocoris stollii* Wolff (Scutelleridae).
Fig. 88. Salivary gland of *Coridius janus* (Dinidoridae).
Fig. 89. Salivary gland of *Dorpius indicus* (Pentatominae).