

COMPARATIVE MORPHOLOGY OF SALDIDAE AND MESOVELIIDAE (HETEROPTERA)  
AND ITS BEARING ON CLASSIFICATION

by

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## ABSTRACT

On the basis of his study of the female genitalia, Scudder (1959) suggested that in the Heteroptera-Hemiptera, the families Saldidae and Mesoveliidae might be closely related; the present morphological study was undertaken to determine whether a study of other characters also supports their inclusion in a natural group.

In these two families, comparison of the head structures revealed that they are quite distinct. The thorax revealed two types:- a Saldula type, and a Mesovelgia type, and since it is shown that the structure of the thorax is of little taxonomic value in distinguishing the suprafamilial categories, it was considered that the differences between the Saldidae and the Mesoveliidae need not necessarily indicate a fundamental taxonomic difference. In the abdomen, the presence of the clasping organ in the Saldidae completely separates this family from the Mesoveliidae.

The present study shows that the Saldidae and the Mesoveliidae are not closely related as might be inferred from comparisons of the female genitalia; they are quite distinct morphologically.

The taxonomic position of the two families was also considered. Most authorities believe that the Mesoveliidae are appropriately placed in the Amphibicorisae, and this is supported

by the present study. The position of the Saldidae, on the other hand, has heretofore been very uncertain since this family shows some Pentatomomorph features as well as some Cimicomorph features.

Two alternatives have been suggested in this thesis regarding the systematic position of the Saldidae. According to the first, the Saldidae may be considered a Cimicomorph, which branched off from the main stem of Cimicomorpha, and subsequently developed Pentatomomorph characters- an assumption which presupposes that parallel evolution has occurred. Alternatively, the Saldidae may be considered a branch of the Pentatomomorpha, which arose after the evolution of some Pentatomomorph characters, but before the evolution of the complete Pentatomomorph complex of characters. This latter alternative takes cognisance of the fact that the Pentatomomorph complex of characters evolved gradually and not by a single 'saltation'. It has been concluded, however, that the data available at present are not sufficient to enable one to state which of the two alternatives mentioned above is the correct one, although I am inclined to consider the former as the more plausible.

In addition to the foregoing, two general aspects of the morphology of the Heteroptera were considered, namely the interpretation of the head sclerites and the variation in the thoracic structure between apterous and macropterous forms of the two families.

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## I- INTRODUCTION:

On the basis of his studies of the female genitalia of the Heteroptera, Scudder (1959) suggested that the Mesoveliidae might be closely related to the Saldidae. The present morphological study was undertaken to determine whether a study of other characters supports the inclusion of these two families together in a natural group. Both the alate and the apterous forms of the two families were studied and their morphology is compared and discussed .

## 2- MATERIAL AND METHODS:

Saldula sp.\* was collected from the beach at Point Grey, Vancouver, British Columbia. Aepophilus bonnairei Sign. from Jersey (Channel Islands) was kindly supplied by Dr. G.G.E. Scudder of the University of British Columbia, and Mesovelgia mulsanti White from England and Holland were obtained from Mr. I. Lansbury (Hope Department of Entomology, Oxford) and Dr. R.H. Cobben (Wegeningen, Netherlands). The alate specimens of Mesovelgia vittigera Puton were obtained from the Musee Royal de L'Afrique Centrale, Turvuren, Belgium, and were originally collected in the Congo.

The external anatomy was studied both from dried and preserved specimens. The material was boiled in 10% potassium hydroxide, was passed through glacial acetic acid, stained in acid fuchsin, and cleared in creosote. Observations on the cephalic muscles of Saldula were made in preserved specimens. This material, which had been preserved in 70% alcohol, was passed through different grades of alcohol, cleared in xylene and examined under polarised light. Specimens of other families of the Heteroptera were collected locally, and were used for comparative study.

All drawings were made by using a squared graticule eye piece, and are not to the same scale.

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\* The specific name of this species has not yet been decided on by the experts.

## 3- MORPHOLOGY:

## I- HEAD:\*

## A- DESCRIPTION:

I- Saldula sp. (Figs. I-3)

Head short, but broad; vertex well developed; coronal and ecdysial cleavage lines distinct in nymph, but not in adult; frons not extensive; frontoclypeal sulcus absent; two invaginations present on each side of vertex; clypeal region relatively extensive, and differentiated into postclypeus, anteclypeus and paraclypeus; cephalic portion of postclypeus with two lateral unpigmented lobes (absent in nymph); paraclypeal lobes with unpigmented areas; bucculae well developed; postgenal bridge short; mandibular plate absent; mandibular lever well developed and triangular(in nymph and adult); postocciput in the form of thin ring around occipital foramen, and apparently differentiated into dorsal and lateral elements, the lateral parts bearing paired condyles; labrum broad and flap-like, reaching distal end of second labial segment; epipharyngeal process absent; labium four-jointed, first segment the thickest, third the longest, being swollen proximally and tapering distally; antennae four-segmented with small intersegmental sclerites, first segment much thicker than rest, the whole beset with hairs, the third and fourth segments also bearing stout bristles; eight to ten pairs of trichobothria present, scattered over vertex, frons, and postclypeus(nymph with four pairs, one pair on frons, two pairs on the postclypeus, and the fourth pair

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\* The terminology of parts follows that of Snodgrass (1960).

on the anteclypeus); compound eyes conspic<sup>u</sup>ous; two ocelli present; two unpigmented areas present laterad of the ocelli.

2- Aepophilus bonnairei Sign. (Fig. 4)

Similar to Saldula in essential parts, but differing in the following features:

Cephalic portion of the postclypeus without two lateral unpigmented areas; paraclypeal region not as well defined as in Saldula, and restricted to the upper two thirds of the anteclypeus; maxillary plate area well developed; bucculae not well developed; labrum reaching the distal end of the first labial segment, and not the second as in Saldula; compound eyes not conspicuous; ocelli absent; postocciput not divided into dorsal and lateral elements; postgenal bridge longer than in Saldula; four pairs of trichobothria - one pair on frons, two pairs on postclypeus and one pair on anteclypeus.

3- Mesovelgia mulsanti White. (Figs. 5-7)

Head longer than in Saldula; vertex well developed, and overlapped by prothorax; coronal and frontal ecdysial cleavage lines indistinct in nymph and adult; fronto-clypeal sulcus absent; clypeal region well developed, and differentiated into postclypeus, anteclypeus and paraclypeus; maxillary plate region well developed and separated from the paraclypeal region by the short

genal sulcus; lower limit of maxillary plate area delimited by an indistinct line; bucculae not well developed; mandibular plate absent; mandibular lever well developed and roughly rectangular; labrum flap-like, with an epipharyngeal process extending almost to the distal end of the second labial segment; postgenal bridge longer than in Saldula; postocciput indistinguishable from occiput, and bearing two dorso-lateral condyles; labium four-jointed, first segment the thickest, third the longest, being swollen on the inner side proximally and tapering distally; antennae four-jointed with small intersegmental sclerites; first antennal segment thicker than rest, and bearing a stout bristle latero-mesally; three pairs of trichobothria, one pair on the frons laterad of the ocelli, and two pairs on the postclypeus (in the nymph one pair on the anteclypeus as well); compound eyes not very conspicuous; ocelli rudimentary.

4- Mesovelgia vittigera Puton.

Similar to Mesovelgia mulsanti White but ocelli well developed.

B- DISCUSSION AND INTERPRETATION:

Saldula sp.:

In the adult insect, on the antero-dorsal part of the head capsule, the position of the frontal ecdysial cleavage line

can be recognized by the position of two pits; these are found on each side of the vertex along the frontal ecdysial cleavage line in the nymph. These two lateral pits are not homologous with the pretentoria of Homoptera (Cicadellidae) (Spooner, 1938). They have no counterparts in other Heteroptera as far as is known, and the name epicranial pits is here suggested for these structures. It should be mentioned that the frons is not always delimited laterally by the ecdysial cleavage line, for Snodgrass (1960) states that, "they vary greatly in their extent and position in different insects." He suggests the name cephalic apotome for the part cut out at ecdysis by the ecdysial cleavage line.

In Saldula the fronto-clypeal sulcus is absent, and consequently there is no external demarcation between the frons and the clypeus. The positions of the antafossae or the mandibular levers are often used as landmarks to delimit the frontal and the clypeal areas (Spooner, 1938). However, in Saldula sp., they are situated cephalad and so are perhaps unreliable. These areas can be distinguished, however, by muscle attachment; the dilator muscles of the sucking-pump are attached to the clypeus internally (Snodgrass, 1935). Snodgrass (1960) states that the cibarium has often been called the 'pharynx' although it lies outside the mouth. He further states that this cibarium has become the sucking-pump of the liquid-feeding insects. It is evident, therefore, that the term 'pharyngeal pump' is inaccurate. In Saldula the criterion of the muscle attachment has been used to delimit the frontal and the clypeal areas, although it is realized that this

procedure is open to some criticism. For example, Ferris (1944), DuPorte (1946) and Parsons (1959) have criticised the criterion of muscle attachment for the identification of the sclerites, the latter in her account of Gelastocoris used the frontal ganglion as the landmark to delimit the point of attachment for the dilator muscle of the food-pump. She recognizes two sets of muscles - cibarial, which lie anterior to the frontal ganglion and attach on the clypeus, and pharyngeal muscles, which lie posterior to the frontal ganglion and attach on the frons. In this she follows Marks (1959). Parsons (1959), however, suggests," that the muscle posterior to the frontal ganglion could come to insert on a cibarial portion of the food pump, or that cibarial muscles might shift their insertions to the pharyngeal portion." She further quotes Marks (1959) and states that the position of the frontal ganglion also varies relative to the muscles from one species to another. It is evident then that an interpretation based on the position of the frontal ganglion is also not reliable. In the present study, therefore, in the absence of any alternative, the criterion of muscle attachment has been adopted to delimit the frontal and the clypeal portions of the head capsule. Examination shows that the dilator muscles of the sucking-pump attach to a definite part of the head capsule, and so it is probably correct to interpret this area as the clypeus. Ekblom (1926) states that in Saldula saltatoria(Lat.), " the forehead forms in front a transverse ridge where it limits the clypeus." This ridge would appear to be merely the posterior margins of the unpigmented postclypeal areas. In Saldula sp., therefore, as in other Heteroptera,

the clypeus appears to be differentiated into a postclypeus, which is united with the frons, a distinct anteclypeus, and two paraclypeal lobes.

The anteclypeus is a clearly defined area, and appears externally as a convex lobe, its internal concavity together with its lateral invaginations forms a supporting base for the food pump. To the cephalic margin of the anteclypeus is attached the flap-like labrum.

The paraclypeal lobes are well defined areas on each side of the anteclypeus, and extend caudad upto half the length of the latter. They are clearly visible in both the nymph and the adult. and appear to have no internal muscle attachment. The homology of the paraclypeal lobes in the Hemiptera is very controversial, and has been the subject of much debate. Smith (1892) and Weber (1929) considered them to be homologous with the mandibular plates. Snodgrass (1935) also mentions, " that these paraclypeal lobes appear to be the mandibular plates of the Homoptera," but he himself doubts their mandibular origin in the Homoptera in the absence of any embryological evidence. Ekblom (1926) and Cobben (1960) designate these lobes in Saldula - saltatoria (Lat.) as ' laminae maxillare ' and 'maxillare plattes ' respectively. Parsons (1959) states that the paraclypeus in Gelastocoris is wholly inflected within the head. However, most authors consider the paraclypeal lobes as parts of the clypeus. . Muir and Kershaw (1911, 1912) regard them as ' extensions of the clypeus',

and confirm that," they have no relation to the mandibles". Spooner(1938) states that the paraclypeal lobes are undoubtedly parts of the clypeus. However, MacGill (1947) refers to these two lobes in Dysdercus-intermedius Distant as juga.

It is usually not possible to trace the mandibular plates in the Heteroptera since there is no sulcus between the mandibular plate area and the gena. It is, therefore, advisable to consider the whole area of the head capsule between the eye and the points of attachment of the mouthparts as the genal area; if mandibular plate areas need to be recognized, it is suggested that they be defined as the ventro-anterior area of the gena to which the mandible articulates.

In mandibulate insects the maxillae are usually attached to the ventral area of the occiput and the labium to the ventral area of the postocciput (Snodgrass, 1935). It does not appear to be necessary to recognize a maxillary plate area despite the fact that such an area is usually described in the hemipterous head; maxillary plates are absent in the primitive orthopteran type of the head, and they cannot usually be defined by sulci in the hemipterous head(MacGill,1947).

The origin of what is herein termed the postgenal bridge has been a problem in the past. Many authors claim that the ventral region of the head is formed by the fusion ventrally of the maxillary plates, the area considered to be equivalent to the postero-ventral

part of the gena anterior to the point of articulation of the labium. MacGill (1947) refers to the ventral area of the head in Dysdercus intermedius Distant as "a large median ventral sclerite interpolated between the labium and the foramen magnum". However, she makes no comment regarding its origin. Parsons (1959), like most earlier authors, adopts the term 'gula' but notes that perhaps it is not a true gula. Snodgrass (1960) has recently considered the ventral sclerites of the head in insects, and has concluded that they are not homologous in all groups, and thus cannot in all be termed a 'gula'. He states that there are three distinct processes which may result in the formation of ventral sclerites in the head of insects: in the first, a hypostomal bridge may be formed between the occipital foramen and the base of the labium by the ventral fusion of two hypostomal lobes as in the Diptera. The hypostomal bridge, he states is continuous dorsally with the post-occiput. The second modification, according to Snodgrass, is the ventral fusion of two postgenal lobes to form a postgenal bridge between the occipital foramen and the base of the labium, as in Vespula maculata. When this is the case, the hypostomal bridge is replaced by the postgenal bridge, which differs from the former in not being continuous dorsally with the postocciput. He thus regards the ventral plate in Notonecta and Naucoris as the postgenal bridge since it is continuous with the postgenae and not with the postocciput. The third process described by Snodgrass is the ventral fusion of the lower ends of the postocciput to form a median plate, which may become extended distally as in the Coleoptera. This median plate is the true gula, and is continuous proximally with the postocciput.

In Saldula sp., as in Notonecta and Naucoris, the ventral plate seems to be formed by the fusion ventrally of the postgenae. However, a developmental study of this region is badly needed to determine whether or not the homology accepted in this thesis is really the correct one. This study should include a consideration of the origin of the bucculae. These structures, which apparently serve to support the rostrum during feeding, are interpreted as the ventral extensions of the areas anterior to the point of attachment of the labium. Since they often extend posterior to the rostrum, this interpretation is perhaps incorrect.

#### C- COMPARISON:

On comparing the head structures of the two families, it is found that Saldula and Mesovelgia resemble each other in a number of features, namely, the well developed vertex, the indistinct coronal and frontal ecdysial cleavage lines in the adults, well developed clypeal regions, the absence of the fronto-clypeal sulci, the four-jointed labium, the antennae, and in possessing four pairs of cephalic trichobothria in the nymphs. However, these similarities are not in characters of great taxonomic importance in the group. There are a number of important features in which they are quite distinct (Table I ). It should be mentioned here that although Aepophilus bonnairei appears to resemble Mesovelgia more than Saldula, in respect of the most important taxonomic characters (ie, the shape of the mandibular lever, presence of epicranial pits, and the absence of epipharyngeal process), Aepophilus

is exactly like Saldula. It is evident that the two families, the Saldidae and the Mesoveliidae, show more differences than resemblances in their head structures, and thus it is concluded that in the head structure they are distinct taxonomically. The epicranial pits are a feature which appear to be confined to the Saldidae and can thus be regarded as a character by which this family can be separated from all other Heteroptera.

TABLE I  
DIFFERENCES IN HEAD STRUCTURES

Parts of Head	Saldidae	Mesoveliidae
I- Postclypeus.	I- Cephalic portion of postclypeus with two lateral unpigmented areas(absent in nymph); absent in <u>Aepophilus</u> .	I- No such unpigmented areas present.
2- Paraclypeal region.	2- Well defined in <u>Saldula</u> ; not so in <u>Aepophilus</u> .	2- Not well defined.
3- Bucculae.	3- Well developed in <u>Saldula</u> ; not so in <u>Aepophilus</u> .	3- Not well developed.
4- Postgenal bridge.	4- Short in <u>Saldula</u> ; longer in <u>Aepophilus</u> .	4- Longer than in <u>Saldula</u> .
5- Mandibular lever.	5- Triangular both in <u>Saldula</u> and <u>Aepophilus</u> .	5- Roughly quadrangular.
6- Postocciput.	6- Differentiated into dorsal and lateral portions in <u>Saldula</u> , not so in <u>Aepophilus</u> .	6- Not so differentiated.
7- Maxillary plate area.	7- Not developed dorsally in <u>Saldula</u> ; developed dorsally in <u>Aepophilus</u> .	7- Developed dorsally.

Table I continued....

Parts of Head	Saldidae	Mesoveliidae
8- Labrum.	8- Without epipharyngeal process both in <u>Saldula</u> and <u>Aepophilus</u> .	8- With epipharyngeal process.
9- Cephalic trichobothria.	9- Eight to ten pairs in adult <u>Saldula</u> ; four pairs in <u>Aepophilus</u> .	9- Three pairs in the adult.
10- Compound eyes.	10- Conspicuous in <u>Saldula</u> ; not so in <u>Aepophilus</u> .	10- Not so conspicuous as in <u>Saldula</u> .
II- Ocelli.	II- Present in <u>Saldula</u> ; absent in <u>Aepophilus</u> .	II- Rudimentary in <u>Mesovelgia mulsant</u> ; present in <u>M. vittigera</u> .
12- Epicranial pits.	12- Present both in <u>Saldula</u> and <u>Aepophilus</u> .	12- Absent.

## 2- THORAX:

## A- DESCRIPTION:

I- Saldula sp. (Figs. 8-13, 30-34)

## PROTHORAX:

Pronotum large, with anterior collar, and posteriorly overlapping base of forewings; pronotum with a wide dome-shaped callal area; the latter triangularly depressed in middle; epimeron broader than episternum, with part of latter forming a precoxal shelf; pleural sulcus and pleurodema distinct but short; trochantin present, and very distinct in nymph; sternum differentiated into a transversely elongated presternum, a triangular basisternum, and a sternellum; furcal arms rather elongate, extending laterally to meet pleurodema.

## MESOTHORAX:

Mesonotum differentiated into scutum and scutellum, with the dividing suture incomplete; scutum secondarily divided into a median and two lateral areas; scutellum extending posteriorly over second abdominal segment, and apically pointed; parascutellum also present, extending antero-laterally into soute-scutellar region, the latter being unequally sclerotised; postscutellum present and visible laterally; anterior notal wing process lying antero-laterally to posterior notal wing process; pleural sulcus distinct but short; pleurodema short and pointing anteriorly; trochantin short; episternum ventrally fused with basisternum, the posterior part of the former forming precoxal shelves; epimeron divided into a dorsal anepimeron

and a ventral katepimeron, the latter produced into a point at the lower limit of coxal cleft; pleural wing process very distinct; basalar and subalar sclerites not distinguishable; sternum well developed, and divided into a presternum, a basisternum, and a sternellum, the latter extending posteriorly over metasternum; furca well developed, with furcal arms extending laterally and meeting pleurodema; phragma well developed.

#### METATHORAX:

Metanotum in the form of fused metascutum and scutellum; postscutellum well defined; pleural sulcus horizontal, and dorsal in position; pleurodema short; trochantin comparatively long; episternum broad, forming a large precoxal shelf, the two precoxal shelves being approximated mesially; epimeron small and dorsal in position; orifices of scent-apparatus located laterally; basalar and subalar sclerites not distinguishable; metapleural wing process lying forward in the region of mes-epimeron, and reinforced by processes from the postscutellum and epimeron of mesothorax and the postscutellum of the metathorax; metasternum reduced to a small plate underneath the mesoscutellum; furcal arms short, not reaching pleurodema; phragma very large.

#### THORACIC APPENDAGES:

##### WINGS: (Figs. 30, 31 )

Forewings differentiated into clavus, corium,

embolium, and a membranous area; posterior end of clavus produced mesially into a narrow triangular area along inner margin of membrane; membranous area with four cells.

Hindwings with distinct vanal and jugal folds; Costa, Subcosta and base of Radius fused ; Radius and Media distally fused; base of Media and Cubitus in contact with distal median plate; two Vanal veins in the vanal area; 2V with a thickened base; jugal lobe with single Jugal vein; humeral plate well developed; first and second axillaries reduced; third axillary articulated both with proximal median plate and second axillary; two median plates (proximal and distal) present.

#### LEGS: (Figs. 32-34)

Coxae, especially those of hind leg, well developed, and having only pleural and trochantinal articulations; articular surface of hind coxa inflected probably to give leverage to muscles; a coxal suture present on proximal half of outer surface of hind coxa, the internal ridge of the suture being continuous with inflection of articular surface; coxal suture absent in fore and middle coxae; distally coxae bearing anterior and posterior articular surfaces for articulation with trochanter; trochanter immovably articulated with base of femur; femora flattened laterally; hind tibia longer than hind femora, and bears stout bristles; proximal end of tibia with a distinct head bent toward femur; tarsi with three tarsomeres, the basal the smallest; tarsomeres with bristles; pretarsus in the form of two claws.

2- Aepophilus bonnairei Sign. (Figs. 15-17)

## PROTHORAX:

Pronotum large with a pronotal collar;  
epimeron broader than episternum, precoxal shelf formed by both; pleural sulcus short; pleurodema short; coxal cleft prominent; trochantin present; sternum differentiated into a basisternum and sternellum; furcal arms short.

## MESOTHORAX:

Mesonotum a triangular piece; pleural sulcus short (shorter than that of prothorax); trochantin present; sternum differentiated into a presternum, basisternum and sternellum, latter extending over metasternum (as in Saldula); furca not well developed.

## METATHORAX:

Metanotum undifferentiated, and shorter than pronotum and mesonotum; pleural sulcus dorsal in position; epimeron dorsal; pleurodema very short; episternum broad, forming a large precoxal shelf.

## THORACIC APPENDAGES:

## LEGS:

Coxae more or less like those of Saldula;  
no outer suture and inflection; anterior and posterior articular processes present in coxae (as in Saldula); femora flattened laterally; hind tibia longer than hind femora (as in Saldula); tibiae with stout bristles at

their distal ends; tarsi with three tarsomeres.

Two rudimentary mesothoracic wings present.

3- Mesovelgia mulsanti White. (Figs. 18-23)

PROTHORAX:

Pronotum large, with a short collar; epimeron broader than episternum; precoxal shelf formed by both episternum and epimeron; pleural sulcus not visible; a very short pleurodema present; trochantin present, and very distinct in nymph; sternum differentiated into a basisternum and a sternellum; furcal arms (apophyseal apodemes) small, and pointing ventro-posteriorly.

MESOTHORAX:

Mesonotum undifferentiated; pleural sulcus not visible; very short pleurodema present; trochantin present; episternum mesially fused basisternum; precoxal shelf formed by both the episternum and epimeron; sternum differentiated into basisternum and sternellum; furcal arms (apophyseal apodemes) short, and pointing posteriorly.

METATHORAX:

Metanotum undifferentiated; pleural sulcus not visible; coxal cleft absent (present in prothorax and mesothorax); apophyseal apodemes short and pointing laterally; episternum fused with basisternum, and forming a part of precoxal shelf; metasternum

differentiated into basisternum and sternellum, the latter fused with the first abdominal sternum; single median orifice of scent-apparatus present.

#### THORACIC APPENDAGES:

Coxae well developed, the fore and middle ones being swollen; articulation both pleural and trochantinal; hind coxa without coxal suture on its outer surface; trochanter immovably attached to base of femur; femora flattened laterally; fore and middle femora with more stout bristles than hind femora; hind tibiae with stout bristles; middle tibiae with combs at their distal ends; three tarsomeres; pretarsus in the form of claws, latter provided with pseudo-aroliae (parempodium).

#### 4- Mesovelgia vittigera Puton. (Figs. 24-29 )

##### PROTHORAX:

Pronotum with anterior collar, and posteriorly overlapping the bases of fore and hind wings; pronotum with a wide callal area, the latter with two laterally located depressions; epimeron broader than episternum; pleural sulcus short; pleurodema very short; trochantin present; sternum as in Mesovelgia mulsanti.

##### MESOTHORAX:

Mesonotum differentiated into scutum and

scutellum, the latter not extending posteriorly over the second abdominal segment as in Saldula; anterior notal wing process lying antero-laterally to posterior notal wing process; postscutellum present; sterno-pleural region same as in Mesovelgia mulsanti.

#### METATHORAX:

Metascutum and scutellum fused, the median part extending over the second abdominal segment; postscutellum distinguishable; pleuro-sternal region same as in Mesovelgia mulsanti.

#### THORACIC APPENDAGES:

##### WINGS: (Figs. 28, 29 )

Fore wings with clavus, corium and an indistinct embolium; bases of Costa, Subcosta and Radius fused; distal ends of fused Costa, Subcosta plus Radius, and Media and Cubitus form a stigma; rest of wing membranous, but without cells.

Hind wings without jugal fold; vanal fold present; bases of Costa, Subcosta, Radius and Media fused; Radius and Media distally fused; two vanal veins present.

##### LEGS:

As in Mesovelgia mulsanti.

## B- DISCUSSION AND INTERPRETATION:

The prothorax in Saldula is more or less of a generalised type seen in other Heteroptera in that it shows no differentiation into separate sclerites. The presence of the dome-shaped callal area is not a constant feature in the Saldidae, for Drake and Chapman (1958) state that a callus is absent in the genus Saldoida.

Of the three thoracic segments, the mesothorax in Saldula is the most developed. This agrees with Weber's (1930) thesis that in the Hemiptera the fore wings are the principal organs of flight. Both the mesoscutellum and mesosternum are well developed. Taylor (1918) states that in the Heteroptera the mesothoracic sternum is indistinguishably fused with the pleura. This is true in Saldula, and it is because of this fusion that the limits of the pleural and sternal sclerites cannot be clearly defined. The fusion of the sterno-pleural sclerotizations is also seen in the metathorax. Brindley (1934) figures the thorax of Saldula pilosella (Thomson), and labels the anterior and posterior areas of the mesosternum BS2 (basisternum of mesothorax) and BS3 ( basisternum of metathorax), and leaves the middle area unnamed. If the location of the apophyseal pits is taken as the landmark in delimiting the sternal plates, her interpretation appears to be inaccurate with respect to the mesosternum. According to the interpretation given, the area which she has left unnamed is the basisternum of the mesothorax, and the areas which she calls BS2 and BS3 are merely the mesothoracic presternum and the sternellum respectively. The basisternum of the metathorax in

Saldula is a small plate, and lies underneath the mesosternellum, with the metasternal apophyseal pits lying on each side of it. This can be seen if the mesothorax and the metathorax are pulled apart. This structure is most clear in the nymph. Thus what Brindley considers as the basisternum of the metathorax is evidently the sternellum of the mesothorax.

The pleural sulcus of the metathorax is horizontal, and lies on the upper margin of the pleura, so much so that the epimeron occupies a dorsal position, and is attached to the lateral margin of the metascutellum. According to Taylor (1918), the horizontal position of the pleural sulcus seems to be a general feature in the Heteroptera. Brindley (1934) states that this horizontal position is characteristic of the aquatic bugs because of the enlarged coxae, which extend behind rather than from beneath the thorax. Larsen (1945) mentions a horizontal pleural ridge in Salda muelleri (Gmelin). The upper forward margin of the metapleuron extends forwards beneath the posterior margin of the mesopleuron, and terminates in the metapleural wing process in the region of the mesepimeron. Taylor (1918) mentions that similar condition is seen in the Nabidae, Gerridae and Berytidae. However, the metapleural wing process in Saldula is peculiar in that it is also supported by processes from the mesepimeron and the metascutellum, and lies in the region of the mesothorax. The large precoxal shelves of the metapleuron seem to be associated with the greatest development of the hind coxae.

In the fore wing, the corium is secondarily divided into a marginal embolium. Drake and Chapman (1958) also mention an embolium in the genus Saldoida. In the interpretation of the veins of the hind wing of Saldula the criterion of the axillaries and their association with particular veins has been adopted. Thus the veins in association with the distal median plate have been designated as the Media and Cubitus, the former together with the Radius seems to be very much approximated toward the Costa and Subcosta. It may be mentioned here that different degrees of fusion of the Costa, Subcosta, and Radius occur also in the Miridae, Lygaeidae, Phymatidae, Mesoveliidae, and Piesmidae (Hoke, 1926). Drake and Davis (1958) have figured the hind wing of the piesmid Miespa splendida Drake, and have shown the Cubitus in the same position as in Saldula. Hoke (1926) has studied the venation of the hind wings of the Heteroptera in detail. She follows the Comstock-Needham system, and divides the wing into four areas- the costal area with Costa, Subcosta, Radius and Media I and 2; medial area with Media 3 and 4; cubital area with Cubitus and first Anal, and the anal area with the remaining anal veins. On comparison, it becomes obvious that her Cubital area in Salda bouchervillei Prov.(=coriacea Uhler) and Saldula pallipes (F.)(=separata Uhler) should really be interpreted as the vanal area, and thus it appears that the vein which she designates as Cubitus is probably one of the vanal veins (Table II). Although she has omitted the consideration of the axillaries in her interpretation, she has figured them in the two saldids she studied, and it is evident that her Cubitus is not in association with the distal median plate, which it should be according to the interpretation (Snodgrass,1935) adopted in this thesis. Since many of the veins of the adult wing

in Heteroptera are without a corresponding trachea (Hoke, 1926), the interpretation of the adult veins seems to be more reliable if based on the associated axillaries. Very little information is obtained by studying the position of the trachea in the nymph. A reinterpretation of the wing venation of the Heteroptera based on the association of veins with axillaries is thus required.

TABLE II  
INTERPRETATION OF THE VEINS OF HIND WING

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Hoke	Gupta
I- Costa	I- Costa
2- Subcosta	2- Subcosta
3- Radius	3- Media
4- r-m	4- m-cu
5- Media I plus 2	5- Cubitus
6- Cubitus	6- Vanal I
7- Anal I	7- Vanal 2
8- Anal 2	8- Jugal I

---

## C- COMPARISON: :

on comparing the two families, we find that they show certain resemblances, particularly in the pronotal collar, callal area with its median or lateral depressions, precoxal shelf, trochantin, and fused metascutum and scutellum, well developed coxae, flattened femora, and three tarsomeres, etc., but they exhibit distinct differences (Table III): these differences outweigh the resemblances. A preliminary examination of some of the families of Pentatomomorpha, Cimicomorpha, Amphibicorisae and Hydrocorisae revealed that the structure of the mesonotum and the metasternum in the various families are of either Saldula-type ( the mesosternum projects over the metasternum) or Mesovelgia-type ( the mesosternum not projecting over the metasternum). Examination also revealed that, with the exception of Amphibicorisae, both the Pentatomomorpha and the Cimicomorpha as well as the Hydrocorisae possess both types (Table IV). This indicates that if the above mentioned taxa are natural groups, the structure of the thorax is of little value in distinguishing the suprafamilial categories.

TABLE III  
DIFFERENCES IN THE THORAX

Parts of thorax	Saldidae	Mesoveliidae
1- Scutellum(mesoth.)	1- Extends over second abdominal segment in <u>Saldula</u> ; not so in Aepophilus.	1- Does not extend over the abdomen.
2- Parascutellum (mesothorax)	2- Present in <u>Saldula</u> ; absent in Aepophilus.	2- Absent.
3- Pleural sulcus (mesothorax)	3- Distinct but short in both.	3- Absent in both(not visible externally)
4- Epimeron(mesoth.)	4- Divided into dorsal anepimeron and ventral katepimeron.	4- Not so divided in both.
5- Sternum(mesoth.)	5- Sternellum extending over metasternum in both.	5- Sternellum not extending over metasternum.
6- Coxal cleft (metathorax)	6- Present in both.	6- Absent in both.
7- Pleural sulcus (metathorax)	7- Present and dorsal in both.	7- Absent in both.
8- Orifice of Scent-apparatus.	8- Two, located laterally.	8- One, median in position.

Table III continued.....

Parts of thorax	Saldidae	Mesoveliidae
9- Fore wings	9- Differentiated into clavus, embolium and membranous part.	9- Mostly membranous.
IO- Hind wing	IO- With jugal fold.	IO- Without jugal fold.
II- Base of media	II- Not fused to Costa, Subcosta and Radius.	II- Fused to Costa, Subcosta and <sup>R</sup> radius.
I2- Tibial comb	I2- Absent in both.	I2- Fore and middle tibiae with combs at their distal ends.
I3- Pseudo-aroliae (par-empodium)	I3- Absent.	I3- Present.

## 3- ABDOMEN:

## A\* DESCRIPTION:

I- Saldula sp. (Figs. 35-39,45,46,50)

Abdomen with ten segments.

## TERGA:

Terga of segments two to eight differentiated into dorsal median plates, and lateral paratergites; tergum of first segment not complete medially; in the male, posterior margin of second paratergite modified into a granulated convex lobe; conjunctiva between second and third paratergite forming, underneath the anterior margin of third paratergite, a fold with a concave anterior margin, the latter being beset with stout setae; this together with the convex lobe of second paratergite forms, during copulation, the grasping mechanism in the male; remnants of orifices of abdominal scent-glands present at posterior margin of third tergite.

## STERNA:

Sternum of first segment rudimentary and indistinguishably fused with the partially membranous sternum of second segment; seven pairs of spiracles present on lateral margins of the sterna two to eight.

FEMALE GENITALIA: (Figs. 36-39)

Previous Description: Ekblom (1926); Leston (1956); Scudder (1959).

First gonapophyses joined by membrane, elongate, tapering and split longitudinally with serrate dorsal tips; rami sclerotized; first gonocoxa fused with ventral part of eighth paratergite; ninth tergum without separate paratergite; gonangulum triangular, its anterior limbs being fused with first ramus, and the posterior side with ninth tergum; ventral angle of posterior side articulating in a notch on mid-dorsal side of second gonocoxa, thus forming a fulcrum on which the latter pivots; second gonapophyses broader than first, sclerotized and united except at the apices, the latter being truncate; second gonocoxa elongate and thickened dorsally; gonoplares broad, curved and free distally, and united proximally by partially sclerotized membrane; spermatheca single, with an oval bulb or receptacle, and an elongated spermathecal tube, the latter communicating with the vagina; a muscular pump with a single flange present between the receptacle and the main part of the duct; wall of vagina lined internally with wrinkled chitinous intima, and strengthened by a sclerotized ring.

MALE GENITALIA: (Figs. 45, 46, 50)

Previous Description: Ekblom (1926); Marks (1951); Pruthi (1925).

Aedeagus differentiated into phallosoma and endosoma, the latter being further divisible into conjunctiva and vesica; proximal part of phallosoma wide and membranous, the distal part being narrow, heavily sclerotized and bent over the proximal part; mouth of phallosoma located ventro-laterally and confined to its distal half; two minute

posteriorly directed appendages located one on each side of the anterior end of the mouth; base of phallosoma supported by a inverted Y-shaped sclerite, with its upper limb fused with the junction of the basal plates; dorsal half of the conjunctiva sclerotized, forming a curved sclerite with its two ends produced into lateral 'wings' on either side of mid-dorsal line; distal end of conjunctiva containing two pairs of dorso-laterally located appendages, the anterior pair smaller than the posterior one; ventral wall of conjunctiva containing, near the mouth of phallosoma, a V-shaped structure with two pairs of processes projecting anteriorly from the inner angle of V, the inner pair being smaller than the outer; vesica narrow, coiled, and in close contact with the ejaculatory duct; ejaculatory reservoir located at the junction of conjunctiva and vesica; basal plates completely fused in the middle line, forming a horse-shoe-shaped structure; capitate processes attached on to the ends of basal plates; parameres long, sickle-shaped, and pointed at apices, the proximal ends being broader and curved for muscle attachment.

2- Aepophilus bonnairei: (Fig. 47)

Abdomen with ten segments.

TERGA:

Terga two to eight differentiated into median tergites and lateral paratergites; first tergum fused with second; clasping organ present in the second and third segments.

## STERNA:

First sternum rudimentary and indistinguishably fused with partially membranous second sternum; seven pairs of spiracles on segments two to eight.

## FEMALE GENITALIA:

More or less as in Saldula.

## MALE GENITALIA: (Fig. 47)

Aedeagus differentiated into a phallosoma and endosoma, latter with two appendages projecting out of the mouth of phallosoma; base of phallosoma membranous, distal part narrow and heavily sclerotized and bent over the proximal part; base of phallosoma supported by an L-shaped sclerotized structure, the horizontal limb being fused with the junction of the basal plates; dorsal part of endosoma presents a sclerotized structure; basal plates completely fused and like those in Saldula.

3- Mesovelgia mulsanti : (Figs. 40-44, 48, 49, 51)

Abdomen with ten segments.

## TERGA:

Terga of segments two to eight in the female and two to seven in the male differentiated into dorsal median tergites and lateral paratergites; orifice of abdominal scent gland in the middle of fourth tergum; clasping organ in the male absent.

## STERNA:

First sternum indistinguishably fused anteriorly with metasternellum and posteriorly with second sternum; seven pairs of spiracles present on segments two to eight; anterior margin of the seventh sternum produced antero-laterally, in mid-line, as a long apodeme; two circular patches of black setae present on the eighth sternum in the male.

## FEMALE GENITALIA: (Figs. 41-44)

Previous Description: Ekblom (1926); Neering (1954); Pendergrast (1957); Scudder (1959).

First gonapophyses joined by membrane, elongate, tapering and split longitudinally, with serrate tips; rami sclerotized and interlocking; first gonocoxa fused with eighth paratergite; gonangulum triangular, its posterior side also fused with an inflection between the eighth and ninth terga; second gonapophyses elongate, sclerotized, and laciniate, united except at the tips; second gonocoxa elongate; gonoplace triangular, sclerotized, curved and attached to second gonocoxae; spermatheca single with an accessory fecundation canal.

## MALE GENITALIA: (Figs. 48, 49, 51)

Previous Description: Ekblom (1926); Pruthi (1925).

Aedeagus differentiated into phallosoma and endosoma, the latter being further divisible into conjunctiva and vesica; proximal part of phallosoma membranous, distal part heavily sclerotized and bent over the proximal part; a triangular sclerotized area present in the mid-dorsal part of the conjunctiva; proximally conjunctiva produced into

sclerotized appendages projecting from the mouth of the phallosoma; vesica narrow and short and in close contact with ejaculatory duct; two ejaculatory reservoirs distinguishable; basal plates completely fused in the middle line, forming a horse-shoe-shaped structure; capitate processes attached laterally; parameres hook-like, pointed at the apices, the proximal ends being broader for muscle attachment.

#### 4- Mesovelgia vittigera :

Abdomen very similar to that of Mesovelgia mulsanti.

#### B- DISCUSSION AND INTERPRETATION:

Drake and Hottes (1951) state that the "hardened and plate-like and roughened lobe of the first paratergite together with the 'peg-like' or 'spine-like' organs" of the second paratergite form the stridulatory organ in the Saldidae. Leston (1957), however, established that the granulated plate and the pegs were actually situated on the second and third paratergites respectively, and not on the first and second as indicated by Drake and Hottes. Leston also states that the organ functions not as a stridulator but as a clasping mechanism in the male during copulation. Examination of the organ in Saldula has revealed, however, that one small modification is needed in Leston's description; the pegs are located actually on a fold of the conjunctiva underneath the anterior margin of the third paratergite and not on the anterior margin of the paratergite itself.

In the male genitalia, the sclerotized curved structure in the base of the conjunctiva probably acts as a guiding mechanism for the vesica, which passes along the ventral surface of this sclerite; the vesica is then directed on to the V-shaped structure in the ventral wall of the conjunctiva and is thus everted out. Pruthi (1925), in his account of the male genitalia of Chiloxanthus pilosus (Fall.) and Salda littoralis (L.) does not mention the conjunctival appendages, the ejaculatory reservoir, and the capitate processes, the latter according to Marks (1951), are secondary developments in the Heteroptera, and mark the original point of attachment of the parameres to the basal plates. Ekblom (1926) also failed to notice the ejaculatory reservoir and the capitate processes.

Pruthi (1925) mentions that the aedeagus in Mesovelgia is not differentiated into phallosoma and endosoma, but examination of Mesovelgia mulsanti has shown that the phallosoma, conjunctiva and vesica are distinguishable. Ekblom (1926) figures a drawn-out endosoma with its two appendages in his account of Mesovelgia furcata.

#### C- COMPARISON:

On comparing the structure of the female genitalia, the aedeagus, the presence of ejaculatory reservoir, paratergites, and the seven pairs of abdominal spiracles, the two families are found to be very similar, but it is evident that other characters indicate that they are taxonomically distinct (Table IV).

TABLE IV  
DIFFERENCES IN THE ABDOMEN

Parts of abdomen	Saldidae	Mesoveliidae
1- Apodeme in sternum VII.	1- Absent.	1- Present.
2- Clasp ing organ.	2- Present.	2- Absent.
3- Aedeagus.	3- Differentiated into phallosoma, conjunctiva and vesica in <u>Saldula</u> ; in <u>Aepophilus</u> , into phallosoma and endosoma only.	3- Differentiated into phallosoma, conjunctiva and vesica.
4- Base of phallosoma.	4- Supported by an inverted Y-shaped structure in <u>Saldula</u> ; by L-shaped structure in <u>Aepophilus</u> .	4- Absent.
5- Conjunctiva.	5- Dorsal half sclero- tized into a curved structure in both.	5- Present.
6- Ejaculatory reservoir.	6- Present(one).	6- Present (two).
7- Parameres.	7- sickle-shaped.	7- Hook-like.

#### 4- INTERNAL ANATOMICAL CHARACTERS:

To supplement the characters obtained from a study of the external morphology, information on the internal anatomy and other important features of the insects has been obtained from the literature. Studies on the mandibular lever (Spooner, 1938), accessory salivary glands (Baptist, 1941; Southwood, 1954), wing venation (Hoke, 1926), testes (Pendergrast, 1956), ovary (Carayon, 1950; Miyamoto, 1957), sex-determining mechanism (Makino, 1950), accessory fecundation canal (Pendergrast, 1957), eggs (Southwood, 1956) were consulted, and the information obtained is included in Table V.

TABLE V  
TAXONOMIC CHARACTERS OF PENTATOMOMORPHA, CIMICOMORPHA, AMPHIBICORISAE AND  
HYDROCORISAE

Parts	Pentatomomorpha	Cimicomorpha	Amphibicorisae	Hydrocorisae
I- Labrum (Spooner, 1938).	I- Not broad, longer.	I- Broad, flap- like or longer.	I- Broad, flap- like, with epipharynge- al process.	I- Broad, flap- like.
2- Mandibular lever (Ekblom, 1926).	2- Triangular.	2- Triangular.	2- Quadrangular.	2- Three branched or triangular.
3- Accessory sali- vary gland Baptist, 1941; Southwood, 1955)	3- Tubular.	3- Vesicular.	3- Vesicular (Gerridae).	3- Vesicular.
4- Mesoscutellum (person. observ.)	4- Projects or does not project over abdomen.	4- Does not project over abdomen.	4- Does not pro- ject over abdomen.	4- Does or does not project over abdomen.
5- Mesosternum (person. observ.)	5- Saldula plus Mesovelgia type.	5- Saldula plus Mesovelgia type.	5- Mesovelgia type.	5- Saldula plus Mesovelgia type.
6- Orifice of Scent- gland (pers. obs.)	6- Lateral.	6- Lateral.	6- Median or absent.	6- Lateral or absent.
7- Metacoxal cleft (person. observ.)	7- Present.	7- Present or absent.	7- Absent.	7- Present or absent.
8- R and M in hind wing (Leston, Pen- dergrast, South- wood, 1954; pers.	8- Dis- tally separated.	8- Distally fused.	8- Distally fused (Gerridae)	8- Distally fused.

Table V continued.....

Parts	Pentatomomorpha	Cimicomorpha	Amphibicorisae	Hydrocorisae
9- Male genitalia (Pruthi,1925).	9- Pentatomid type or related thereto.	9- Reduvid type or related thereto.	9- Reduvid type.	9- Reduvid type.
10- Female genitalia (Scudder,1959).	10- Pentatomid type.	10- Cimicomorph type.	10- Cimicomorph type or rel- ated thereto.	10- Cimicomorph type or related thereto.
11- Testicular folli- cles(Pender- grast,1956).	11- Usually seven.	11- Usually seven.	11- Usually one.	11- Usually seven.
12- Male sex Chrom. (Makino,1950).	12- XY or XO type.	12- XY or XO type.	12- XO type.	12- XY or XO type.
13- Eggs (Southwood, 1956)	13- With microp- ylar processes,	13- With micr- pylar appa- ratus.	13- ****--	13- -----
14- Accessory fecu- ndation canal (Pendergrast, 1957)	14- Absent.	14- Absent.	14- Present except in Ochteridae.	14- Absent.

## 5- COMPARISON OF ALATE AND APTEROUS (AND BRACHYPTEROUS) FORMS IN

## SALDIDAE AND MESOVELIIDAE:

From comparative morphology of the alate and the apterous forms in both the Saldidae and the Mesoveliidae, it is evident that these two forms show distinct structural differences, particularly in the thorax (Tables VI and VII). Insects with flight possess well developed flight muscles and correlated with this an elaborate thoracic structure, while those with limited or no flight have reduced flight muscles, and consequently less developed thoracic structure. Flight in insects is effected by two sets of muscles, the direct and the indirect. The indirect muscles include the dorsal longitudinal muscles and the dorso-ventral muscles. The direct muscles are attached to wing bases or wing sclerites and include principally the basalar, the subalar and the muscles of the axillaries.

According to Larsen (1945), the principal muscles are present in Saldula, and accordingly, as one would expect, the apodemes and the internal margin of the pronotal collar are well developed in the prothorax. The longitudinal muscles, running from the first phragma to the second phragma in the pterothorax, mainly produce the arching of the nota, and thus raising the notal processes relative to the pleural processes, act as depressors of the wings. And since these muscles are important in flight, the phragmata in Saldula are well developed. Similarly the development of the furca seems to be correlated with the development of the direct muscle, M. furca-pleuralis (of Larsen).

By the same token, the absence of another direct muscle, *M. coxa-subalaris* (of Larsen) both in the mesothorax and the metathorax is correlated with the absence of the subalar sclerite in the pterothorax. The lateral oblique muscle, *M. mesonoti secundus* (of Larsen) is well developed in the mesothorax of *Saldula*, but is absent in the metathorax. This can be explained on the basis of Weber's thesis that in the Heteroptera the fore wings are the principal organs of flight, and thus the mesothorax is more developed than the metathorax. It is evident from the foregoing that the morphological differences are the reflections of the functional differences in the alate and the apterous forms. Unfortunately, no account of the musculature of *Mesovelgia* is available for comparison, but the structural differences in the thorax of *Mesovelgia vittigera* and *Mesovelgia mulsanti* could also be explained on a functional basis. This study has also revealed that the sternal region in the alate and the apterous forms shows very little difference, and thus perhaps the dorso-ventral muscles are not of great importance in the flight of these insects.

On comparing the alate and the apterous forms of both families, it is found that the ocelli are rudimentary or absent in the apterous forms, but are present in the alate forms. Accompanied with this presence of the ocelli in the alate forms, are the well developed compound eyes, which are not so conspicuous in the apterous forms. Such correlated presence or absence of certain structures has also been reported in the Lygaeidae (Scudder, personal communication). It is likely that perhaps an alate insect needs more perfect visual

apparatus than an apterous one, and probably the ocelli supplement the compound eyes in the latter's visual perception. It is also possible that the presence of the ocelli in the alate forms and its absence in the apterous ones may be due in part to a genetic linkage with some other character effected by loss of flight.

TABLE VI  
DIFFERENCES IN ALATE AND APTEROUS FORMS IN THE SALDIDAE

Parts	<u>Saldula</u> <u>sp.</u>	<u>Aepophilus</u> <u>bonnairei</u>
1- Callal area.	1- Present.	1- Absent.
2- Furcal arms.	2- Well developed.	2- Not well developed.
3- Mesoscutellum.	3- Extends over the abdomen.	3- Does not extend over the abdomen.
4- Ocelli.	4- Present.	4- Absent.

TABLE VII  
DIFFERENCES IN ALATE AND APTEROUS FORMS IN THE MESOVELIIDAE

Parts	<u>Mesovelgia</u> <u>vittigera</u>	<u>Mesovelgia</u> <u>mulanti</u>
1- Callal area.	1- Present.	1- Rudimentary.
2- Mesonotum.	2- Differentiated into meso- scutum and scutellum, the fo- rmer being overlapped by the posterior part of pronotum.	2- Mesonotum undifferentiated.
3- Metanotum.	3- Median part extending over abdomen.	3- Does not extend over abdomen.
4- Ocelli.	4- Present.	4- Rudimentary.

#### 6- RELATIONSHIP BETWEEN SALDIDAE AND MESOVELIIDAE:

From the foregoing study it is evident that the Saldidae and the Mesoveliidae are not closely related as suggested by the comparative morphological study of the female genitalia; they are quite distinct in gross morphology.

In order to ascertain or check the systematic position of the two families, it has been necessary to compile a table showing the differences between the four higher taxonomic groups usually recognized in the Heteroptera. This table (Table V) lists only the characters considered in recent works to be of real importance in the higher classification of the group.

If we also list these same characters in the Saldidae and Mesoveliidae (Table VIII), and compare Table V and Table VIII, we can work out the possible systematic position of the two families under consideration.

TABLE VIII

## TAXONOMIC CHARACTERS OF THE SALDIDAE AND MESOVELIIDAE

Parts	Saldidae	Mesoveliidae
I- Labrum.	I- Broad, flap-like.	I- Broad, flap-like, with epipharyngeal process.
2- Mandibular lever.	2- Triangular.	2- Quadrangular.
3- Accessory salivary gland.	3- Vesicular.	3- -----
4- Mesoscutum.	4- Projects over abdomen(exception in Cimicomorpha).	4- Does not project over abdomen.
5- Mesosternum.	5- Projects over metasternum(Saldula type).	5- Does not project over metasternum (Mesovelina type).
6- Orifice of scent gland.	6- Lateral.	6- Median.
7- Metacoxal cleft.	7- Present.	7- Absent.
8- R and M of hind wing.	8- Distally fused.	8- Distally fused.
9- Male genitalia.	9- Pantatomid type.	9- Reduvid type.
10- Female genitalia.	10- Cimicomorph type.	10- Cimicomorph type, with gonoplac.
II- Testicular follicles.	II- Seven.	II- One.

Table VIII continued.....

Parts	Saldidae	Mesoveliidae
I2- Male sex- chromosomes.	I2- -----	I2- XY type.
I3- Eggs.	I3- Operculum absent, egg burster present, pdeudo-micropyle absent.	I3- -----
I4- Accessory fecundation canal.	I4- Absent.	I4- Present.

## 7- SYSTEMATIC POSITION OF THE MESOVELIIDAE:

Pruthi(1925) and China (1933) included Mesoveliidae and Hydrometridae in Gerridae. Ekblom (1926) also maintained that, " Mesoveliidae shows perfect conformity with Hydrometra group". Handlirsch (1908) included both Mesoveliidae and Saldidae in Gymnocerata. He probably thought that Aepophilidae arose from Mesoveliidae. Reuter (1910), however, doubted if Mesoveliidae is a branch of Gerroidea. Leston, Pendergrast and Southwood (1954) placed Mesoveliidae in Amphibicorisae. It is thus evident from the foregoing that most of the authors agree that Mesoveliidae belongs to the present group of Amphibicorisae.

The present study of the morphology of Mesoveliidae shows that this family is correctly placed in the Amphibicorisae. On the basis of the epipharyngeal process, mandibular lever, mesoscutum, mesosternum, median scent-gland orifice, absence of metacoxal cleft, number of testicular follicles and the presence of accessory fecundation canal, Mesoveliidae distinctly belongs to Amphibicorisae. However, Scudder (1959) showed that the female genitalia of Mesoveliidae are of a primitive Cimicomorph type with a well developed gonoplac; gonoplacs are absent in all other Amphibicorisae as far as is known. It is probable that Mesoveliidae represents a primitive stage or separate branch of the Amphibicorisae stem- a branch which separated before the gonoplac was lost in the phylogeny(Fig.A).

## 8- SYSTEMATIC POSITION OF SALDIDAE:

There has been little agreement among the heteropterists on the probable position of the Saldidae in the higher classification of the Heteroptera, and this family, more than any other, has been variously moved from one group to another. Table IX shows in chronological order the views of different authors on the position of the Saldidae, and it is evident that the Saldidae has no recognized position to date.

It is evident that on the basis of the labrum, mandibular lever, mesoscutum, mesosternum, lateral scent-gland orifice, metacoxal cleft, the male genitalia and testicular follicles, the Saldidae cannot be included in the Amphibicorisae. The Hydrocorisae in general are almost identical with the Cimicomorph section of the Geocorisae, and so these groups can be considered as one. The position of the Saldidae is to be sought either among Pentatomomorpha or Cimicomorpha. On the basis of the labrum, accessory salivary gland and distally fused Radius and Media of the hind wing, Saldidae show affinity with Cimicomorpha, but in the structure of male genitalia and the eggs it clearly belongs to the Pentatomomorpha. Two alternative interpretations of this situation are possible, and these are pictorially illustrated in Figs. A and B. If we consider the Cimicomorph characters as the most important, and if it is accepted that parallel evolution can occur in the egg and male genitalia, it can be argued that the Saldidae is a Cimicomorph, which has branched off the main Cimicomorph stem and has evolved parallel to the Pentatomomorph line, having subsequently developed the Pentatomomorph type of male genitalia

and eggs. However, it should be noted that there is little evidence for parallel evolution. But its possibility cannot be discounted since so many cases are known elsewhere in the animal kingdom. The alternative systematic position can be determined by assuming that parallel evolution has not occurred. One must also state in this alternative scheme that the Pentatomomorph complex of characters has evolved gradually and not by a single 'saltation'. The alternative scheme shows the Saldidae as a side branch of the main Pentatomomorph stem, a branch which arose after the evolution of the male genitalia and eggs but before the evolution of the rest of the Pentatomomorph characters. The data that we have available at the present time are not sufficient to enable one to state which of the two alternatives mentioned in this thesis is the correct one although I am inclined to consider the Saldidae as a branch of the Cimicomorph line, which probably subsequently developed the Pentatomomorph male genitalia and eggs.

TABLE IX

## VIEWS OF VARIOUS AUTHORS ON THE SYSTEMATIC POSITION OF THE SALDIDAE

Authors	Dates	Views
1- Latreille	1825	Grouped Saldidae in Oculatae(Geocorisae).
2- Amyot & Serville	1843	Included Saldidae in Nudirostres (Geocorisae).
3- Osborn	1898	Allied Saldidae with Gerridae.
4- Kirkaldy	1908	included Saldidae in the superfamily Notonectoidea.
5- Handlirsch	1908	Included Saldidae and Mesoveliidae in Gymnocerata.
6- Distant	1902-1918	Associated Saldidae with Reduviidae.
7- Reuter	1912	Stated that Saldidae are closely allied to Nabidae.
8- Pruthi	1925	Put Saldidae in Pentatoma.
9- Ekblom	1926	Stated that Saldidae have affinities with Nabidae.
10- Esaki & China	1927	Put Saldidae and Leptopodidae in Hydrocorisae.
11- Börner	1934	Included Saldidae in superfamily Reduvioidea.
12- Spooner	1938	Grouped Saldidae, Anthocoridae, and Cimicidae together on the basis of flap-like labrum.

Table IX continued .....

Authors	Dates	Views
I3- Larsen	I945	Differed in placing Saldidae intermediate between Cryptocerata and Gymnocerata.
I4- Leston	I953	Indicated a Trichophoran affinity of Saldidae on the basis of wing venation.
I5- Leston, Pendergrast, I954 & Southwood		Included Saldidae in Pentatomomorpha, although they stated that "Saldidae is far removed from the main Pentatomorph stem.
I6- China	I955	Put Saldidae at the base of Amphibicorisae on the basis of three pairs of cephalic trichobothria.
I7- Pendergrast	I957	Stated that Saldidae have the type of spermatheca found in most Trichophora.
I8- Leston & Scudder	I957	Included Saldidae in the Geocorisae.
I9- Scudder	I959	Included Saldidae in Cimicomorpha on the basis of the female genitalia.

FIGURE A

Cimicomorpha &  
Hydrocorisae

- E- 1- Labrum broad and flap-like.
- 2- Mandibular lever three branched or triangular.
- 3- Orifice of scent-gland lateral or absent.
- 4- Metacoxal cleft present or absent.
- 5- Testicular follicles usually seven.
- 6- Accessory fecundation canal absent.

Mesoveliidae

Amphibicorisae

Loss of gonoplac.

# Pentatomomorpha

Saldidae

Parallel evolution in  
♂ genitalia & eggs.

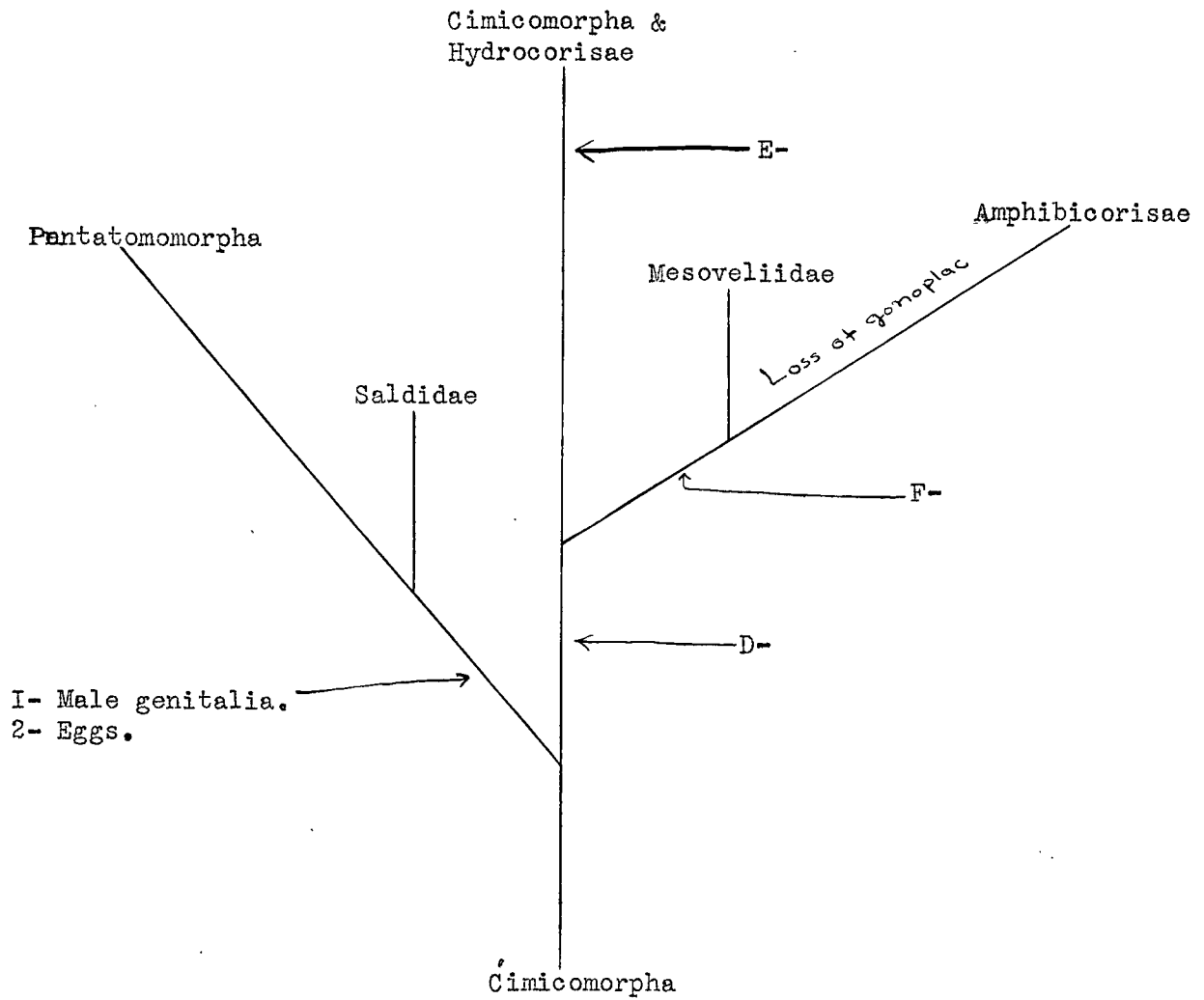
- 0- I- Labrum not broad,  
and flap-like.
- 2- Accessory salivary  
gland tubular type.
- 3- R and M in hind wing  
separate distally.
- 4- Male genitalia Pent-  
atomomorph type.
- 5- Female genitalia  
Pentatomomorph type.
- 6- Eggs with micropylar  
processes.

- ← D- 1- Labrum broad and flap-like.
- 2- Accessory salivary gland of vesicular type.
- 3- R and M of hind wing fused distally.
- 4- Female genitalia Cimicomorph type.
- 5- Eggs with micropylar apparatus.

- F- 1- Labrum, broad,  
flap-like with  
epipharyngeal  
process.
- 2- Mandibular lever  
quadrangular.
- 3- Orifice of  
scent-gland  
median or  
absent.
- 4- Metacoxal cleft  
absent.
- 5- Testicular  
follicles one.
- 6- Accessory  
fecundation  
canal present  
except in  
Ochteridae.

Cimicomorpha

FIGURE B



D,E,F as in Fig. A

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## KEY TO LETTERING OF FIGURES

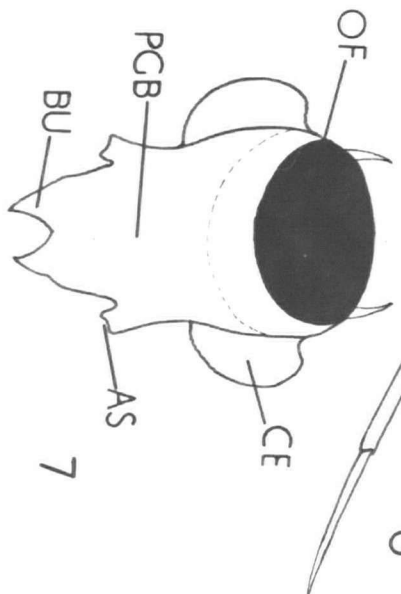
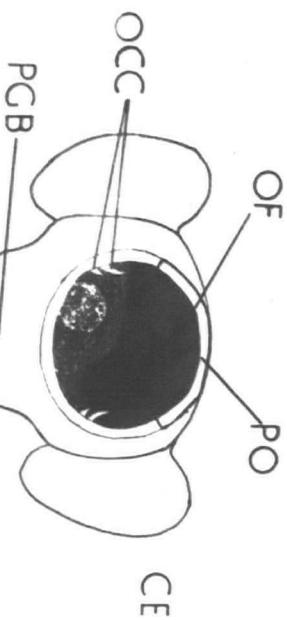
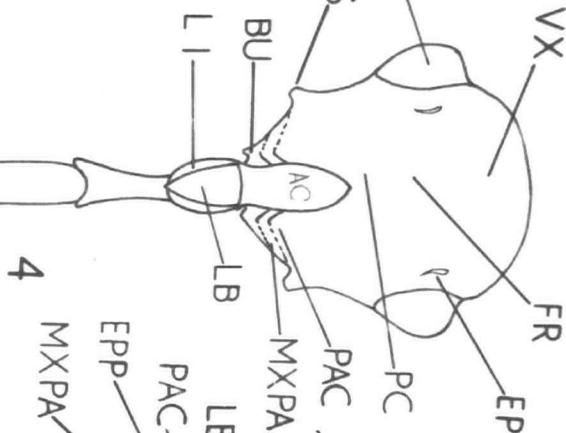
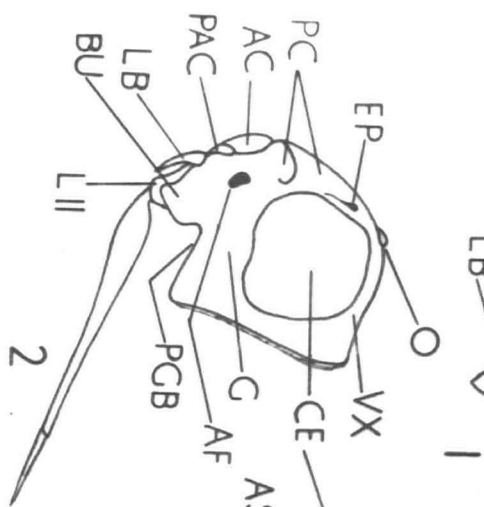
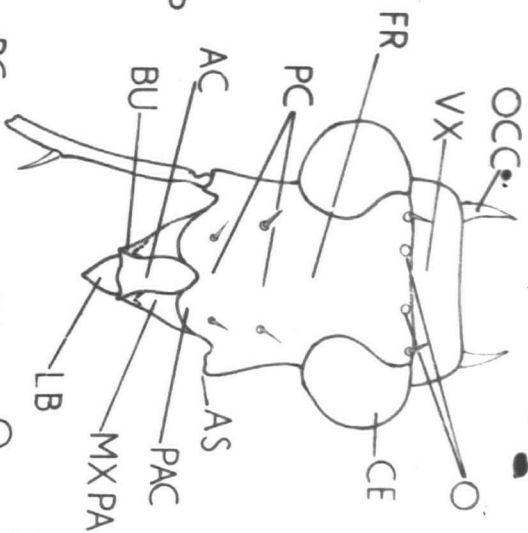
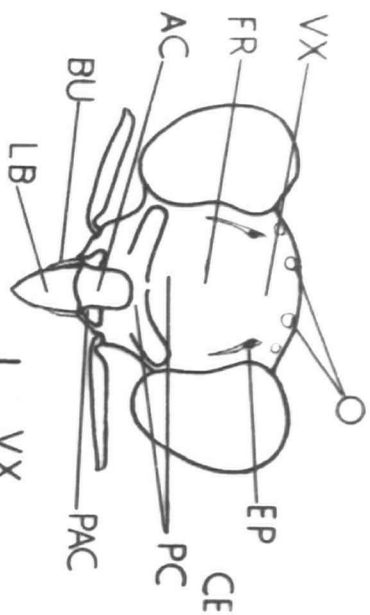
A	.....	anal vein.
AC	.....	anteclypeus.
AEM	.....	anepimeron.
AF	.....	antafossae.
ANP	.....	anterior notal wing process.
AP	.....	apodemes.
APP	.....	apophyseal pits.
AS	.....	antennal tubercle.
AT	.....	antenna.
I AX	.....	first axillary.
2 AX	.....	second axillary.
3 AX	.....	third axillary.
B	.....	spermathecal bulb.
BP	.....	basal plates.
I BS	.....	basisternum of prothorax.
2 BS	.....	" " mesothorax.
3 BS	.....	" " metathorax.
BU	.....	bucculae.
C	.....	costa.
CA	.....	callus.
CE	.....	compound eye.
CL	.....	clypeus.
CNJ	.....	conjunctiva.

CNJ APP	.....	conjunctival appendages.
CO	.....	corium.
CP	.....	capitate process.
CT	.....	coxal cleft.
CTY	.....	coxal cavity.
CU	.....	cubitus.
CV	.....	clavus.
CX	.....	coxa.
DMP	.....	distal median process.
EP	.....	epicranial pit.
EDS	.....	endosoma.
EDS APP	.....	endosomal appendages.
EJD	.....	ejaculatory duct.
EJR	.....	ejaculatory reservoir.
I EM	.....	epimeron of prothorax.
2 EM	.....	" " mesothorax.
3 EM	.....	" " metathorax.
EPP	.....	epipharyngeal process.
I ES	.....	episternum of prothorax.
2 ES	.....	" " mesothorax.
3 ES	.....	" " metathorax.
FC	.....	fecundation canal.
FL	.....	flange of pump.
FM	.....	femur.
FR	.....	frons.

FU	.....	furca.
FWP	.....	fore wing process.
G	.....	gena.
GA	.....	gonangulum.
GP	.....	granular plate of clasping organ.
GPC	.....	concavity of clasping organ.
GPL	.....	gonoplac.
I GPO	.....	first gonapophysis.
2 GPO	.....	..second "
I GX	.....	first gonocoxa.
2 GX	.....	second "
HP	.....	humeral plate.
HWP	.....	hind wing process.
J	.....	jugal vein.
JF	.....	jugal fold.
KEM	.....	katapimeron.
L	.....	labium.
LB	.....	labrum.
M	.....	media.
ME	.....	membrane.
MP	.....	median plate.
MSN	.....	mesonotum.
MTN	.....	metanotum.
MXPA	.....	maxillary plate area.

N	.....	notum.
O	.....	ocellus.
OC	.....	occiput.
OCC	.....	occipital condyle.
OF	.....	occipital foramen.
PAC	.....	paraclypeus.
PC	.....	postclypeus.
PCS	.....	precoxal shelf.
PG	.....	postgena.
PGB	.....	postgenal bridge.
2 PH	.....	phragma of mesothorax.
3 PH	.....	" " metathorax.
PHS	.....	phallosoma.
PHS APP	.....	phallosomal appendages.
PLA	.....	pleurodema.
PMP	.....	proximal median plate.
PN	.....	pronotum.
PNC	.....	pronotal collar.
PNP	.....	posterior notal wing process.
PO	.....	postocciput.
PR	.....	paramere.
1 PRS	.....	presternum of prothorax.
2 PRS	.....	" " mesothorax.
PRSC	.....	prescutum.
PS	.....	pleural sulcus.
PSCU	.....	parascutellum.
2 PSL	.....	postscutellum of mesothorax.

3 PSL	.....	postscutellum of metathorax.
PSN	.....	postnotum.
PT	.....	paratergite.
PTAR	.....	pretarsus.
R	.....	radius.
SC	.....	subcosta.
2 SCL	.....	mesoscutellum.
3 SCL	.....	metascutellum.
2 SCU	.....	mesoscutum.
3 SCU	.....	metascutum.
SGO	.....	scent-gland orifice.
SPCD	.....	spermathecal duct.
ST	.....	stigma.
1 STL	.....	sternellum of prothorax.
2 STL	.....	" " mesothorax.
T	.....	tergum.
TAR	.....	tarsus.
TB	.....	tibia.
TN	.....	trochantin.
TR	.....	trochanter.
1 V	.....	first vanal vein.
2 V	.....	second vanal vein.
VF	.....	vanal fold.
VG	.....	vagina.
VS	.....	vesica.
VX	.....	vertex.
WP	.....	pleural wing process.



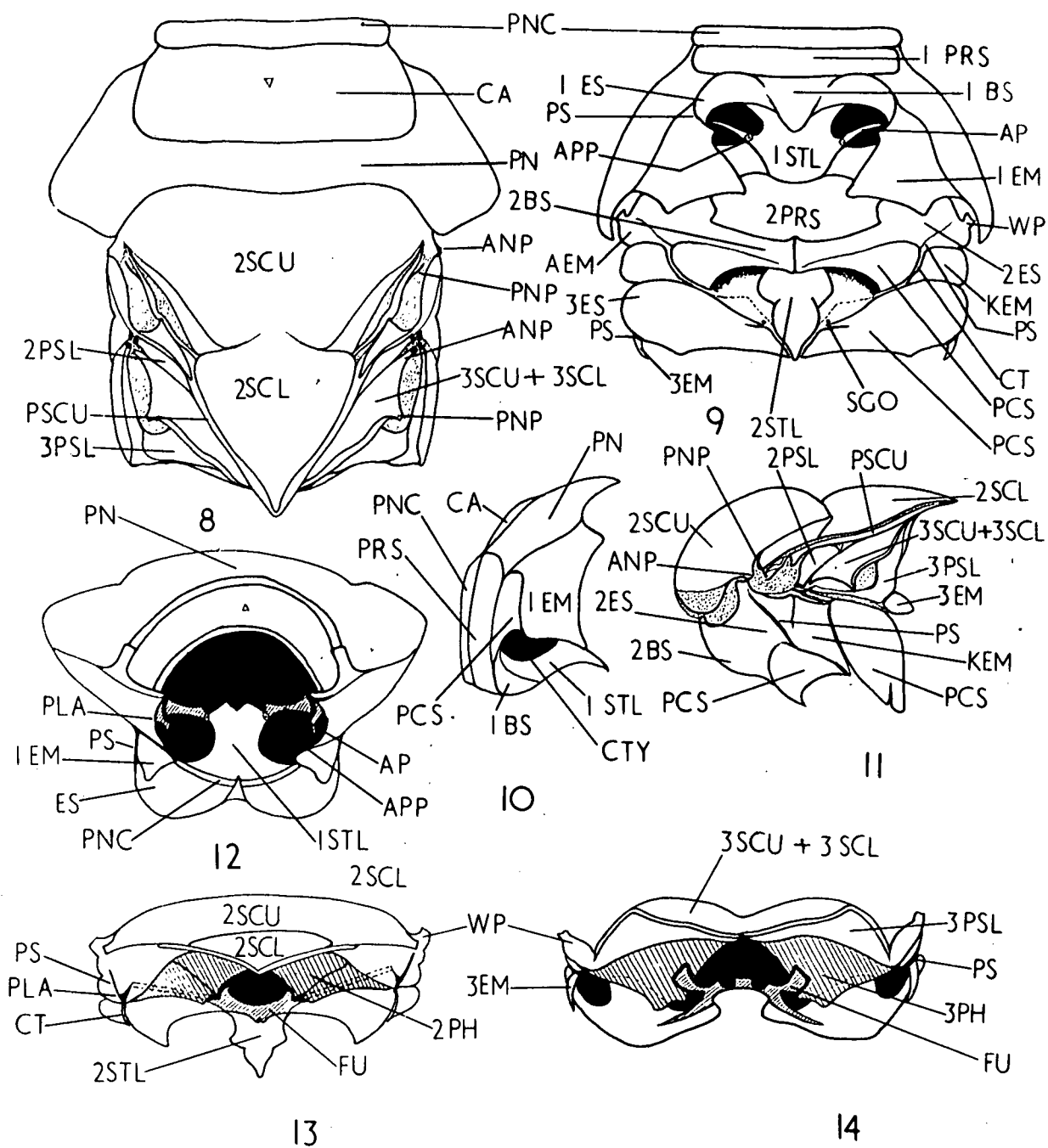
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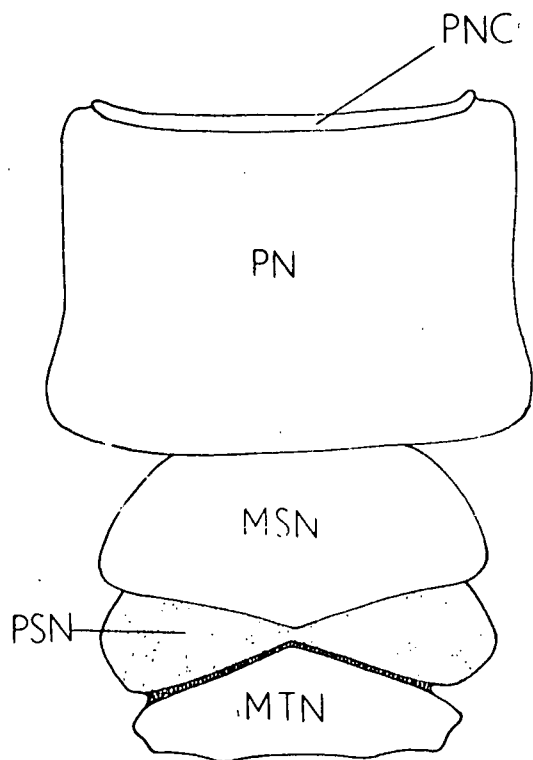
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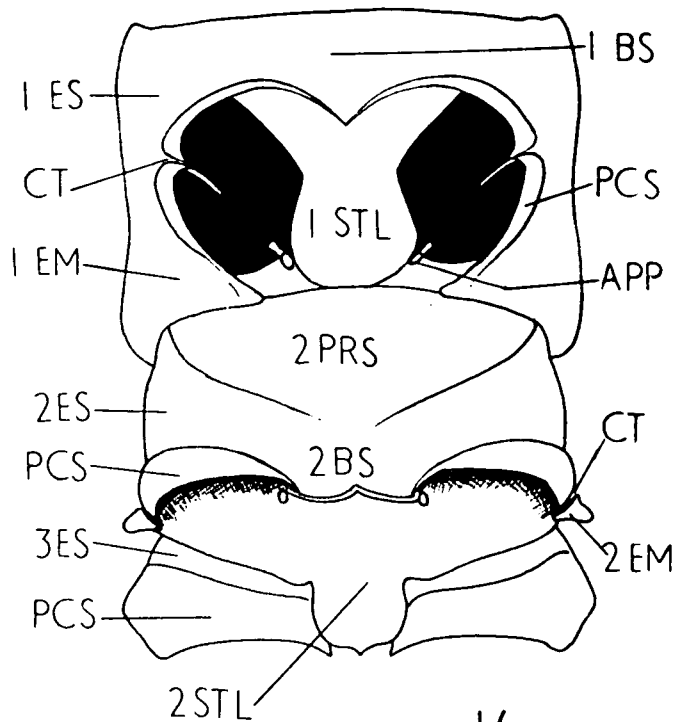
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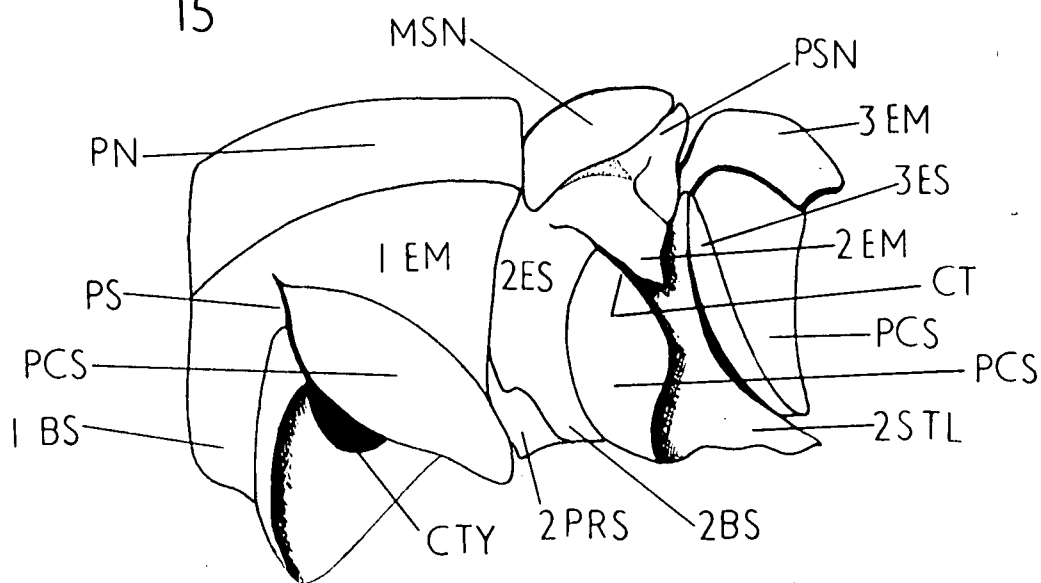




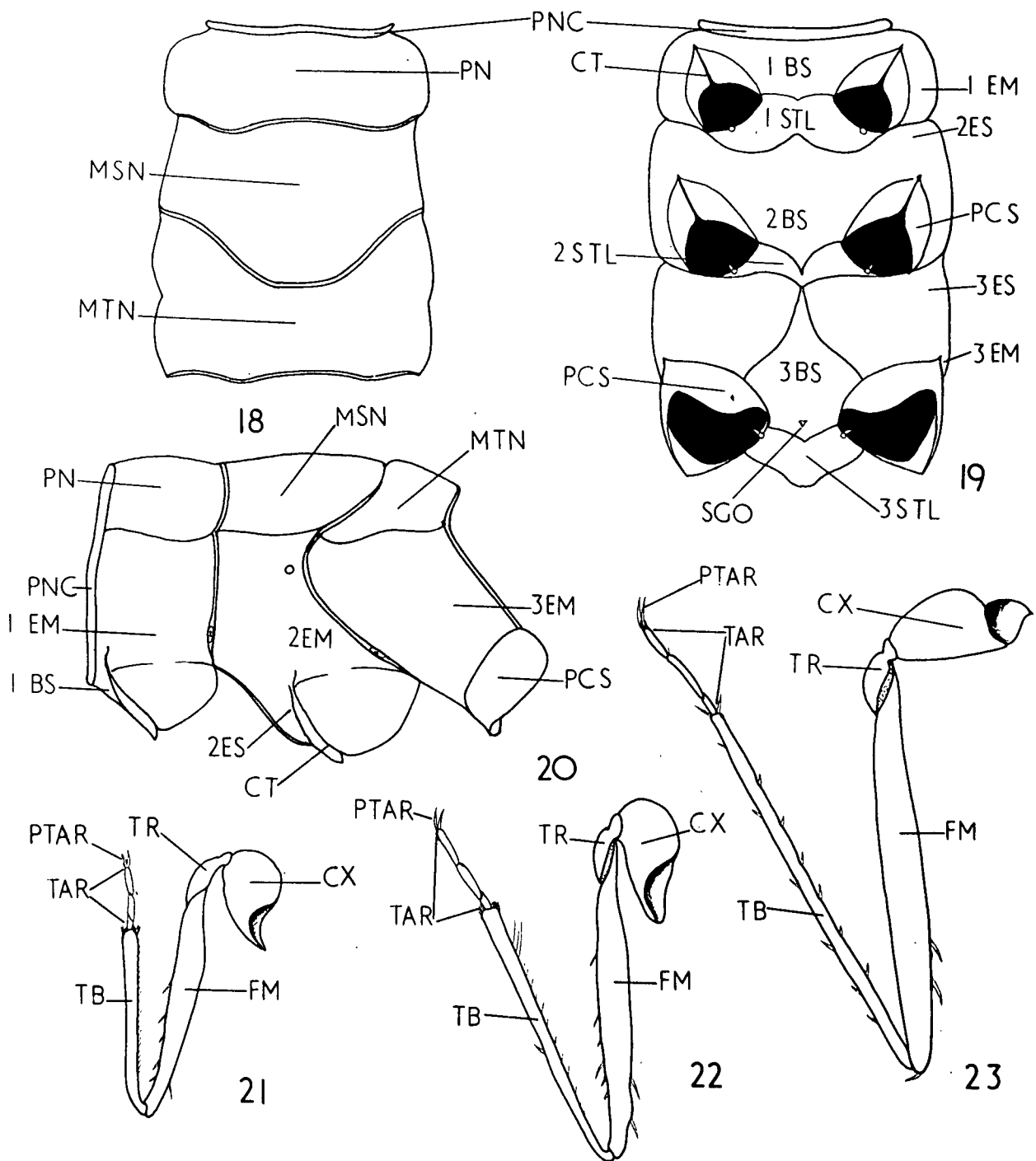
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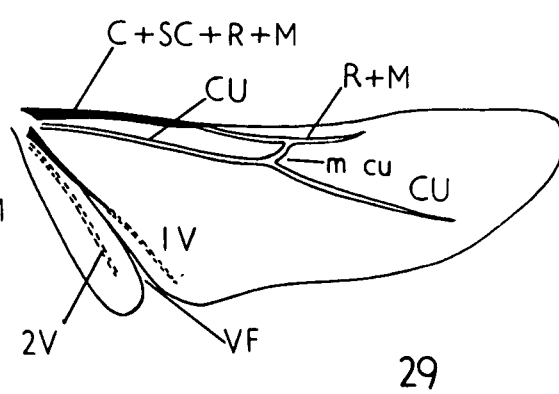
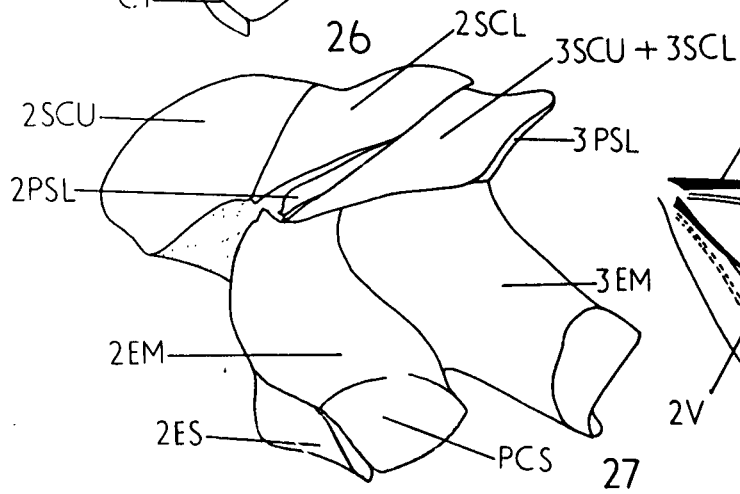
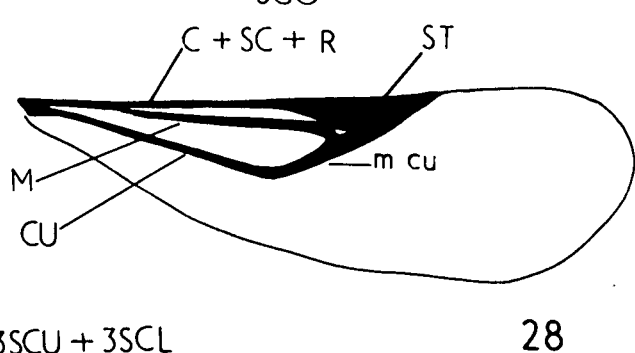
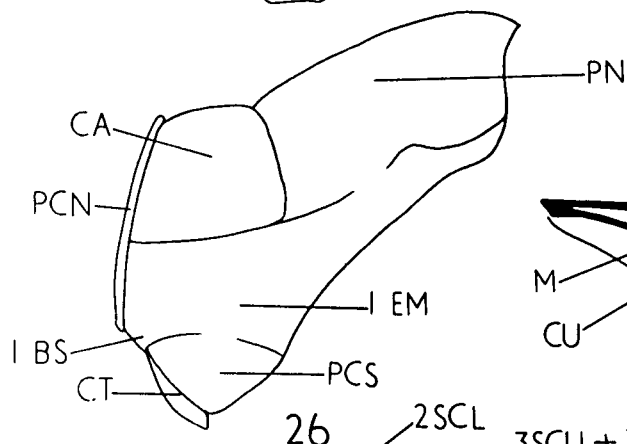
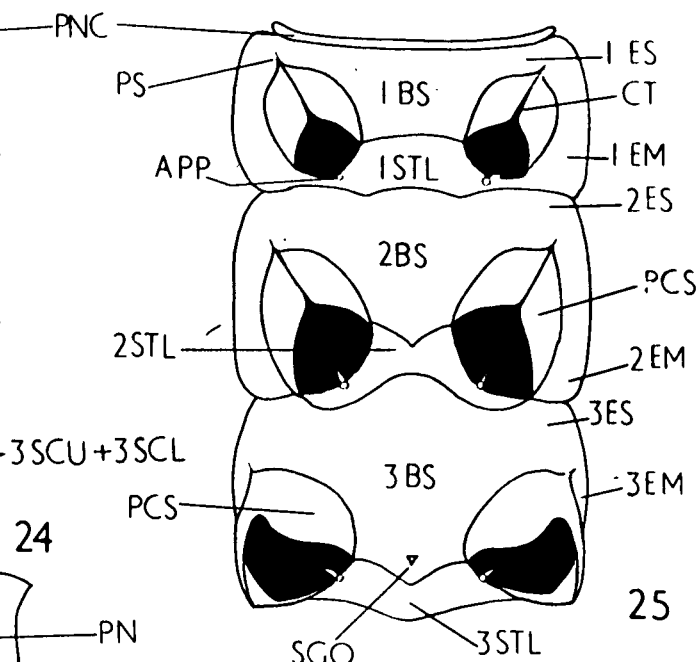
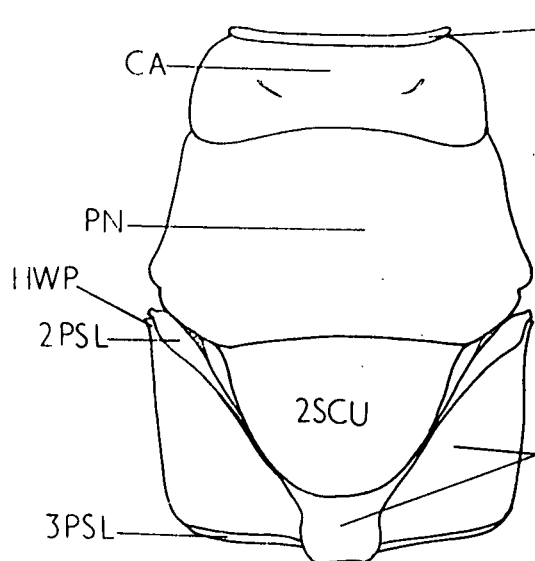


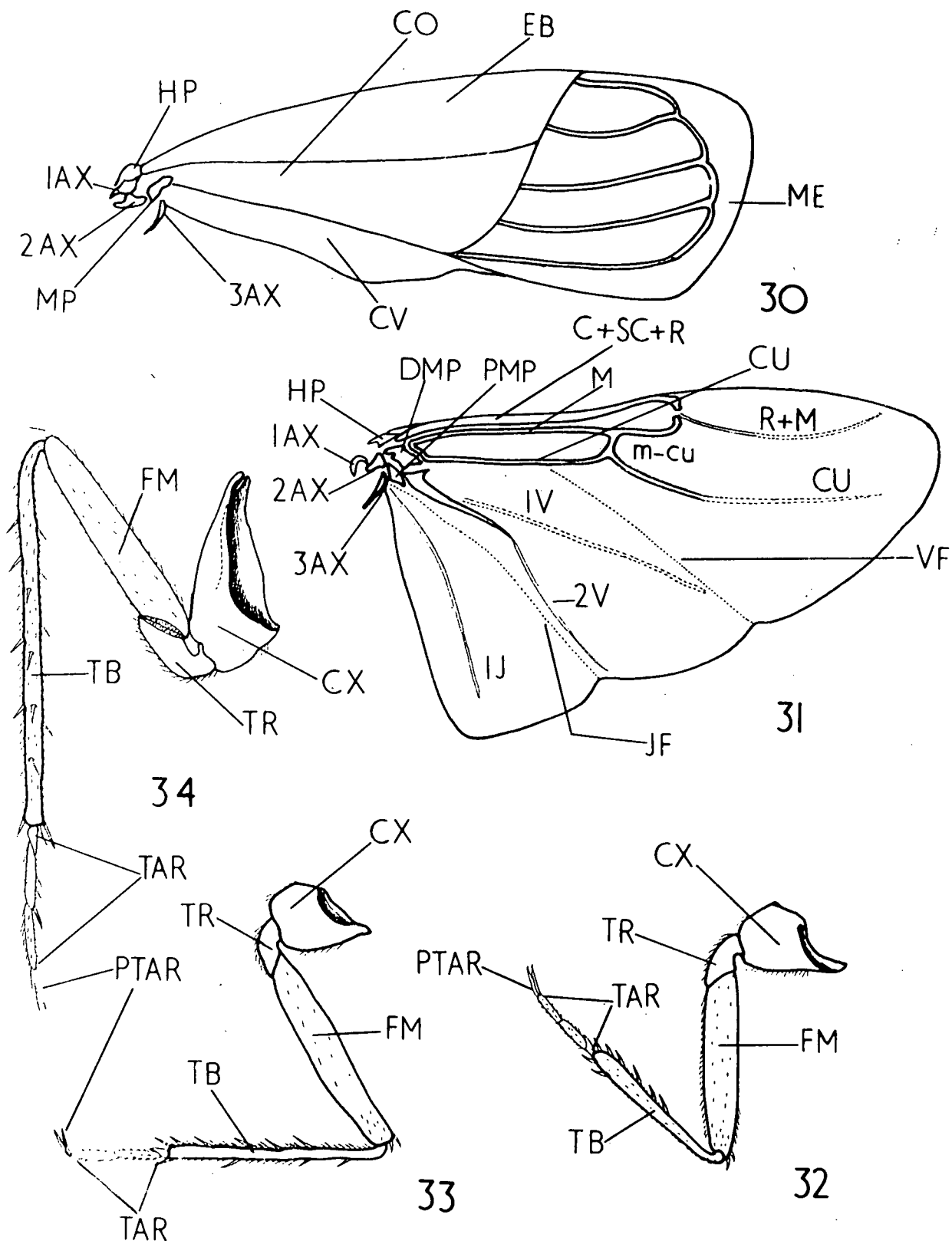
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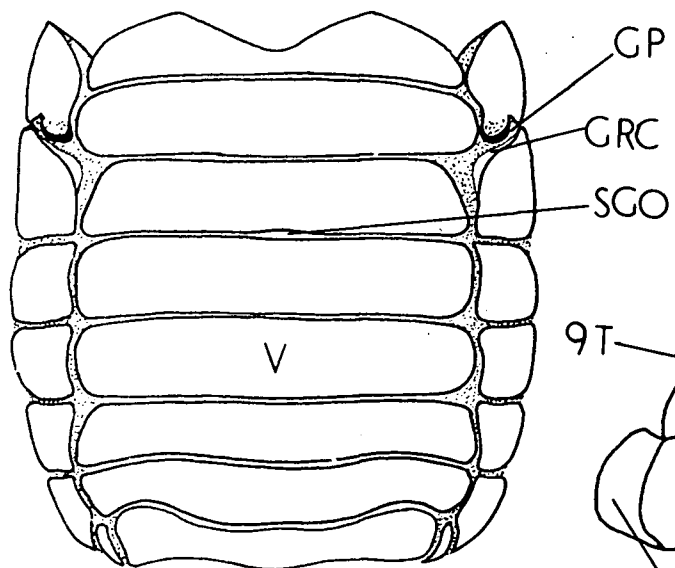


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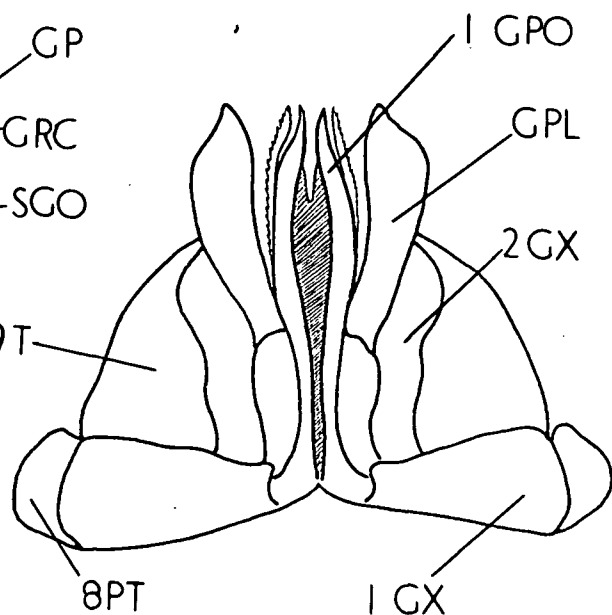




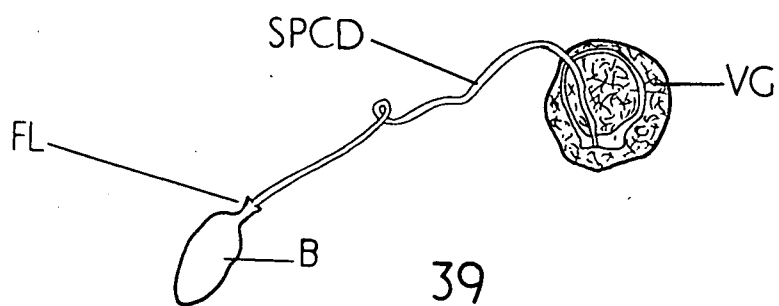




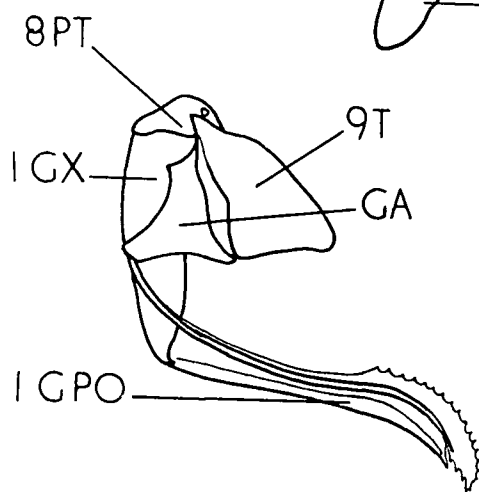
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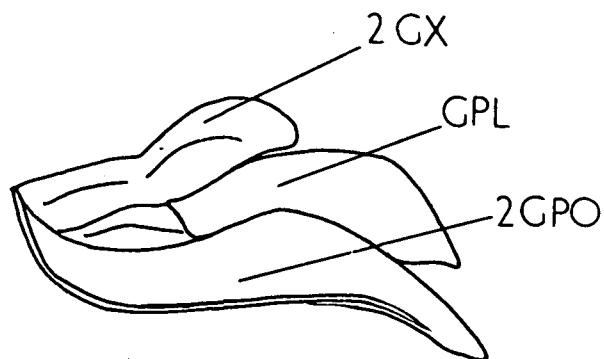
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