Studies on the Genitalia of some Aquatic and Semi-Aquatic Heteroptera

By

R. KUMAR

(Department of Zoology, Birla College, Pilani, Rajasthan, India)

Introduction and Acknowledgements

Genitalia of aquatic Heteroptera have attracted the attention of many workers and there are several valuable works concerning them. Particular mention may be made here of the studies of Pruthi (1925), Larsen (1938), Truxal (1952) and Scudder (1959). But a need for further study of these organs becomes apparent due to their taxonomic value. Present paper deals with the study of genitalia in twelve families of aquatic and semi-aquatic Heteroptera and their bearing on the classification. The study reveals many interesting facts hitherto unknown.

The author wishes to express his gratitude to Dr. M. C. Parsons (Canada) for kindly donating many of the otherwise unavailable specimens used in the present study. Grateful thanks are also due to Mr. R. J. Izzard of British Museum (Natural History) London for identifying some of the specimens used in the present work. Dr. A. K. Datta has given many helpful suggestions in these investigations for which the author feels indebted.

Systematic Consideration of the Genitalia of the Families of Aquatic and Semi-Aquatic Heteroptera

SALDOIDEA

Saldidae

Ovipositor (Figs. 1, 2, 3)

Salda sp. probably dixoni

First valvifers cone shaped and make contact by their pointed ends with the basivalvulae of first valvulae; first valvula is an elongated curved plate which bears distally strong teeth on the upper surface, the inner surface of first valvula bears a elongated sclerite (basivalvula), pointed outer and of which makes contact with the first valvifer as mentioned above; first valvula bears an arcuate ramus which curves over the first valvifer to make contact by a sclerite (n) with the anterior extension of the ninth paratergite; second

valvulae fused through a membrane along their entire length excepting the truncate free distal ends; second valvifers divided into two parts, dorsal and ventral plates, the former being slightly curved and uniformly broad, it receives mesially a tergal apodeme from ninth paratergite, second valvifers make contact with the second valvulae by an arcuate ramus, the latter sliding into the concavity of the inner ramus of first valvula.

Snodgrass (1933) in his description of the ovipositor of Saldidae in *Pentacora lingata* states "First valvula connected externally with the lower angle of the first valvifer". However, this is not the case in *Salda dixoni* where a definite sclerite the basivalvula can be readily made out. As a matter of fact the diagram (Fig. 26 c, p. 81) of Snodgrass (1933) also indicates the presence of a sclerite but he seems to have overlooked it. Ekblom (1926) and Scudder (1959) do not mention such basivalvula, apparently having overlooked them.

Scudder (1959) mentions that each of the first valvula is partially split longitudinally but his figure (Fig. 44, p. 439) does not indicate so, the line in the first valvifer that he shows as a matter of fact delimits the basivalvula from first valvula. The connecting sclerite (n) as noticed above has been thought by Snodgrass (1933) to be a portion of first valvula as it is continous ventrally with the latter "by a fold of connecting membrane". Such connecting fold was not observed in the present study. Present author thinks that it should be considered to be merely an expanded portion of the inner arcuate ramus as in Lygaeidae. Scudder (1959) makes no mention of this sclerite. Scudder (1959) did not distinguish the second valvifers into dorsal and ventral parts but his figures 54 and 56 (p. 439) clearly show them. In Fig. 54 he has shown only ventral plate and in Fig. 56 only dorsal plate. In *Pentacora,* according to Snodgrass (1933) the styloids arise from the distal ends of the second lobes but in *Salda* they are seen to have only membranous connections with the distal ends of the ventral lobes of the second valvifers.

External male genitalia (Fig. 4)

Phallotheca cylindrical; eight pairs of conjunctival processes present; vesica thrown into two coils, ejaculatory reservoir absent; parameres extremely long in comparison to phallus.

Spermatheca

There is a ovoid bulb which continues posteriorly into a extremely long duct, proximal pump flange present.

Mesovelidae

Ovipositor (Figs. 5, 6)

Mesovelia sp.

Eighth paratergite and first valvifer fused; first valvulae elongate, sclerotized and bear teeth like serrations distally on the upper margin; inner ramus of first valvula highly sclerotized and arch like; second valvifers elongate and uniformly broad; second valvulae membranous, fused together weakly; tergal apodeme present.

Scudder (1959) states that each of the first valvula in Mesoveliidae is partially split longitudinally but present author did not note such condition.

External male genitalia (*Fig. 7*)

Phallotheca sclerotized; ductus seminis forms several coils in the proximal region of phallotheca, two pairs of sclerotizations appear to be present in the proximal region of endosoma.

Remarks on Saldoidea

Mesoveliidae and Saldidae have been variously treated by different authors. Scudder (1959) has given an account of such attempts. This author suggests the inclusion of Mesoveliidae and Saldidae along with Leptopodidae in group Saldoidea on the basis of ovipositor. Scudder (1959) has summarized the characters of Saldoidea as follows:

> "The large nonoplacs, the fusion of Paratergites VIII and first gonocoxae and the partially divided and often serrate nature of first gonapophysis appear to be distinguishing characters of Saldoidea".

But large styloids (=gonoplacs) are found in Reduviidae and many other Cimicomorphan families, similar statement holds good for the fusion of eighth paratergites and first valvifers. So far as the partially divided nature of the first valvulae is concerned, it has already been pointed out in Saldidae that it is an imperfect observation, for, Scudder (1959) did not realise the presence of a basivalvula on first valvula of Saldidae and in the present work neither the presence of basivalvula nor a partial division of first valvula in Mesoveliidae was observed. Serrations on the first valvula as found is Mesoveliidae are present in Miridae, Nabidae and Tingidae as well. As far as the ovipositor is concerned, Mesoveliidae show good many resemblances to Cimicoid families rather than the families of Saldoidea altough there is a remarkable superficial resemblance between the ovipositor of Saldidae and Mesoveliidae. Moreover, there is no trace of conjunctiva in Mesoveliidae while conjunctiva is present in Saldidae. When external male genitalia are alone considered it would appear as pointed out by Pruthi (1925) that there is similarity between Mesoveliidae, Gerridae and Veliidae. Therefore, the inclusion of Mesoveliidae at least in Saldoidea on the basis of external genitalia would not appear to be justified.

GERROIDEA

Veliidae

Ovipositor

Rhagovelia oriander (*Figs. 8 A and B*)

First valvifer and eighth paratergite fused together; first valvula short, broad and hairy, inner ramus of first valvula highly sclerotized, anterior extension of ninth paratergite long, sclerotized and broader at the base, second valvifer elongated, in intimate contact with the anterior extension of ninth paratergite and is invariably lost with the latter during separation of first and second valvulae; second valvulae bear thick hairy projection distally, ramus of second valvula present.

External male genitalia

Rhagovelia oriander (*Fig. 9*)

Basal plates fused together through a partially sclerotized membrane, a pair of small sclerotized bag like hairy structures attached to the distal ends of basal plates present, unfortunately, satisfactory mounts of phallothecal region could not be obtained, but two pairs of sclerotized processes can be seen protruding through the distal region.

Gerridae

Ovipositor

Limnogonus nitidia Mayr (*Figs. 10, 11*)

First valvifer and eighth paratergite fused together, densely hairy; first valvula elongated sabre shaped and bears spine like projections; second valvula elongated, lacinate and covered with feathery projections (cf Scudder, 1959) the ramus of second valvula has become intimate with the inner ramus of first valvula and during separation of the parts of ovipositor, it is carried along with inner ramus of first valvula; second valvifers and styloids absent, a pair of elongated sclerotizations present on the vaginal wall. In *Gerris remigis* (Fig. 12) the ovipositor is similar but first valvulae are much longer and highly sclerotized at places and second valvulae bear more hair.

External male genitalia

Gerris remigis (*Fig. 13*)

Basal plates as in *Rhagovelia,* phallotheca oval, sclerotized and bears two pair of sclerotized patches, one pair proximally and other pair distally; vesica elongated, narrow and sclerotized; endosoma projects out of phallotheca in the form of a flat sclerotized process.

Limnogonus nitidia Mayr (*Fig. 14*)

Basal plates fused dorsally and joined through a membranous region, two pairs of dark heavily sclerotized processes present in endosoma, latter not differentiated into conjunctiva and vesica, a pair of hood like structures in contact with basal plates present as in Veliidae.

Spermatheca (*Fig. 15*)

L. nitidia Mayr

It is similar as described in Gerridae by Pendergrast (1957). There is a fecundation canal, a basal bulb and numerous coils of the apical tube.

Hydrometridae

Ovipositor

Hydrometra lineata Esch (*Figs. 16, 17*)

First valvifers completely fused with eighth paratergite, the distinction between the two is apparent in view of a suture; first valvula broader at the base but tapering at the apex (not triangular, cf. Scudder, 1959), membranous,

slightly hairy, rami of first valvula lacking; second valvifer broad, hairy, sclerotized and narrows into a slender arm anteriorly; second valvulae subtriangular, membranous and bear a sclerotized ramus, a sclerotized rod like structure attached to the distal ends of second valvifers probably represents the remanants of Styloids.

External male genitalia

Hydrometra sp (*Fig. 18*)

Basal plates arch like and fused with each other through a membrane, phallotheca broader at the distal ends; three pairs of distinct sclerotizations present in endosoma, vesica not distinct; parameres applied to the distal ends of the basal plates; a pair of hood like structures attached to basal plates also present.

Spermatheca (*Fig. 19*)

H. lineata Esch

The spermatheca is similar as described by Pendergrast (1957) in Hydrometridae, there is a fecundation canal.

Remarks on Gerroidea

While considering the classification of Gerroidea Pendergrast (1957) showed it to contain Gerridae, Veliidae, Hydrometridae, Mesoveliidae and Hebridae while Scudder (1959) removed Mesoveliidae from it. Present study supports Scudder (1959) and an additional differentiating character may be added to this group viz. the presence of hood shaped structures attached to basal plates. These structures are absent in Mesoveliidae but present in Gerridae, Veliidae and Hydrometridae. Hebridae could not be studied but a subsequent examination may reveal the presence of above mentioned structures in them as well.

NEPOIDEA

Nepidae

Laccotrephes robustus (*Figs. 20, 21*)

First valvifers densely hairy and have a characteristic shape, outer margin of the valvifer produced into a long spodeme; second valvulae triangular and hairy, inner ramus present, outer ramus absent; anterior extension of ninth paratergite slender, broader at the base (cf. Scudder, 1959); second valvulae hairy, broader proximally, narrowing distally and fused for a greater part of their length, thin slender ramus present; second valvifers slender and curved; styloids oval and densely hairy.

Ovipositor in *L. maculatus* Fabr is on the same lines as in *L. robustus* but second valvulae are much less broad and bear teeth like serrations at their distal ends. Styloids are longer and slender.

Ranatra elongata (*Fig. 22*)

First valvifers hairy, broad in the middle and greatly narrowing anteriorly; first valvulae slender, slightly sclerotized and hairy; second valvifers very

small and triangular; second valvulae very long, longer than the first, highly sclerotized and hairy; styloids absent.

Larsén (1938) though mentions about second valvifers but he gives no description regarding them. His figure of the Ovipositor seems to suggest that he has regarded certain sclerotizations present in the anal tube as the second valvifers.

Male genitalia

Laccotrephes maculatus Fabr (*Figs. 23, 24*)

Basal plates long, curved and fused posteriorly, the points of attachment of basal plates continue into a pair of downwardly directed struts which continue for some distance and are adpressed to the vesica; a second pair of long sclerotized struts traverse through both anterior and posterior regions of phallotheca; attachment of basal plates to the phallotheca is marked by a grooved and deeply sclerotized region (Fig. 24); vesica extremely long and narrow, proximal region of phallotheca membranous (termed diverticulum by Pruthi, 1925), distal region sclerotized and tough; parameres hooked in the distal region.

Larsén (1938) describes the presence of "Fuhrungsstuck" in the vesica of Nepidae, such differentiation was not observed in the present work. As a matter of fact the struts press against vesica in such a way that it appears that proximal region of vesica is more differentiated in comparison to the rest.

Belostomatidae

Lethocercus sp (*Figs. 25, 26*)

First valvifers hairy in the posterior region and sclerotized on the outer side; first valvulae triangular, sclerotized and densely hairy, they bear small sclerites towards the anterior end, inner ramus of first valvula present; anterior extension of ninth paratergite slender proximally flattened distally; first valvulae fused anteriorly; second valvifers small slender and held together over the second valvulae as shown in the diagram (Fig. 26, normal position indicated by dotted lines); second valvulae triangular, highly sclerotized and fused anteriorly; styloids absent.

Scudder (1959) gives an incomplete description of the Ovipositor in *L. grandis*. He makes no mention of the second valvulae and valvifers, but at the same time he states the presence of styloids which he calls as stylus like structures. No styloids were found in the present study. Larsén (1938) also states the absence of styloids in the Ovipositor of Belostomatidae.

Sphaerodema rusticum Fabr (*Fig. 27*)

First valvifers and valvulae similar to *Lethocercus sp*; second valvifers do not appear to be present, second valvulae joined by a sclerite possessing three arms.

External male genitalia

Lethocercus sp (*Fig. 28*)

Basal plates U-shaped and held together at the two ends by a membranous bridge; basal plate struts traverse a greater part of the endosoma but not the entire length, endosoma stiff, organised into a definite shape and produced

into two small diverticulae curving inwardly at the tips; phallotheca produced into a highly sclerotized ventral diverticula; parameres curved at the tip.

Sphaerodema rusticum Fabr (*Fig. 29*)

Basal plates elongated, ring like, continued posteriorly into a long strut which runs through the middle of the phallotheca upto posterior end as in Reduviidae; phallotheca takes the form of two plates which enclose the endosoma; the latter being small, loose and carries one 'a' type endosomal sclerite; parameres hook like in the distal region.

Larsén (1938) erroneously states the presence of a ventral diverticula in *Sphaerodema rustica*. His figure 147 c, p. 239 indicates that he has mistaken the endosomal sclerite for the diverticula.

Remarks on Nepoidea

Considering the ovipositor only Scudder (1959) has supported Borner (1934) and Pendergrast (1957) in the inclusion of Nepidae and Belostomatidae in Nepoidea. The characters which Scudder (1959) used to support these conclusions are "the very long paratergites VIII forming a respiratory siphon and stylus like gonoplacs". But as has been said above, styloids are absent from the Ovipositor of Belostomatidae and from *Ranatra* amongst Nepidae. Therefore, his conclusions are not supported by the present author. Moreover, the aedeagi of Nepidae and Belostomatidae are very different. In Nepidae the aedeagus is highly specialized and very complex while in Belostomatidae the aedeagus has characteristics of its own which brings it very near the Reduviid aedeagus, in *Sphaerodema* even endosomal sclerites are present. The Ovipositor of Belostomatidae is on the same lines as in Reduviidae excepting that the styloids are absent. Particularly, there is striking similarity between the second valvifers and valvulae of Belostomatidae and Reduviidae. Similarities between the aedeagi of Belostomatidae and Reduviidae have already been pointed out. It seems that Reduviidae and Belostomatidae probably had a common origin.

The study of the Ovipositor of *Ranatra* and *Nepa* shows great differences in the structures of the two so much as to warrant their inclusion in separate families. But on the other hand there is great similarity in the male genitalia of the two.

From the foregoing discussion it seems that Belostomatidae should be removed from Nepoidea and the latter should contain only Nepidae and Ranatridae.

Naucoridae

Ovipositor

Pelocoris femoratus (*Figs. 30, 31*)

First valvifers large, triangular, strongly hairy posteriorly; first valvulae fused together into a characteristic hairy structure (Fig. 30); the anterior extension of the ninth paratergites of the two sides fused together; second valvifer and valvulae fused into a compact structure; styloids appear to be represented by a pair of hairy oval structures, closely applied to the anal tube.

Description of the ovipositor as given above differs from those of other Naucorids hitherto studied in the fusion of second valvifers and valvulae of both the sides.

Remarks on Naucoroidea

Scudder (1959) from a study of female terminalia concluded that only Naucoridae should be included in Naucoroidea along with Aphelocheridae. He stated that structure of styloids, VIII paratergites, reduced second valvifer, anterior extension of ninth paratergite characterize the super-family. But the female genitalia as described here in *Pelocoris* would appear to be unique in Heteroptera. There is a total fusion of second valvifers and valvulae with each other into a compact structure in addition to the fusion of first valvulae. In certain of these respects they show resemblances to highly specialized Pentatominae.

NOTONECTOIDEA

Notonectidae

Notonectinae

Ovipositor

Notonecta lunata (*Figs. 32, 33*)

First valvifers almost U-shaped, hairy and highly sclerotized; first valvulae also U-shaped, highly sclerotized and bear long thick hairs; second valvifers elongated, sub-triangular and slightly sclerotized; styloids very long, sclerotized and hairy; second valvulae fused at the bases, free at apices, the apices highly sclerotized and bear short thick hairs on the inner side.

Enithares indica Fabr. (*Figs. 34, 35*)

First valvifers quadrilateral shaped, sclerotized and hairy; first valvulae triangular highly sclerotized, hairy and bear many strong spines on the lower and delicate hairs on the upper side, inner ramus distinct, outer ramus lacking; extension of ninth paratergite rod like; second valvifers thin and curved; second valvulae narrow proximally, broad distally, the distal ends of the second valvulae fused and bear numerous black spines; styloids hairy and stylus like.

External male genitalia

Notonecta lunata (*Fig. 36*)

Basal plates completely fused into a ring like structure; phallotheca elongated, cylindrical and narrows distally; endosoma permanently exposed, covered with numerous tubercles throughout and has characteristic shape, a pair of curved thickened processes present on the sides of endosoma.

E. indica (*Fig. 37*)

Basal plates fused with each other ventrally; phallotheca narrow and annulated in proximal but wider in distal region; endosoma produced into two distinct processes, one of which is distinctly sclarotized and annulated and can be safely compared to the endosomal process of certain Reduviidae (personal observations); parameres hairy, with characteristic shape and are attached to the basal plates.

Anisopinae

Ovipositor

Anisops sardea H. S (Figs. 38, 39)

First valvifers almost triangular, highly sclerotized on the sides but membranous towards the centre, densely hairy; first valvulae highly sclerotized, slightly curved towards the middle and bear two pairs of highly sclerotized and regularly arranged teeth like structures; first valvula joined to the first valvifer by a rod like structure which seems to be a downwardly directed apodeme of first valvifer; second valvifers sclerotized, pubescent, possess a characteristic shape and are fused anteriorly; second valvula small, slender and membranous; styloids stylus like and hairy.

External male genitalia

Anisops sardea H. S (Fig. 40)

Basal plates completely fused with each other; phallotheca narrow and membranous in anterior but sclerotized and very wide in the distal region, a pair of sclerotizations present in the basal region of phallotheca; endosoma highly developed and stiff, lateral sides of its tip highly sclerotized; parameres asymmetrical.

The penis valves mentioned by Truxal (1952) are in fact a pair of sclerotizations present in the phallothecal wall and to a cursory observer they would appear to pertain to basal plates. Pruthi (1925) also does not note such valves.

Remarks no Notonectidae

Scudder (1959) has divided family Notonectidae into Notonectinae and Anisopinae on the basis of female genitalia and present studies are in agreement with it. As a matter of fact the ovipositor in Notonectinae is hardly different from that of Coreidae. Particularly remarkable is the similarity in the first valvulae of the two. External male genitalia in Notonectinae are more specialized and sometimes possess endosomal processes.

Pleidae

Plea striola (Fig. 41)

Basal plates fused with each other into the shape of U, phallotheca narrow proximally, wider distally.

Corixidae

Agraptocorixa hyalinipennis (Figs. 42, 43)

First valvifers broad, hairy, produced anteriorly and held together by a strong anterior intervalviferal membrane; first valvulae club like and closely applied to the distal ends of first valvifers, they bear a small stylus like structure; anterior extension of ninth paratergite S-shaped; second valvifers membranous, broad posteriorly, narrow anteriorly, the latter bearing some short hairs; second valvulae membranous slender and hairy.

It will be noticed that there is a clear distinction between second valvulae and valvifers. Scudder (1959) states that the second valvifers are probably

fused to second valvulae. The intervening region between second valvifers and valvulae in *Agraptocorixa* is narrow and membranous so that the distinction between second valvula and valvifer is clear.

Hesperocorixa interrupta (*Figs. 44, 45*)

First valvifers and eighth paratergites fused into a broad membranous structure; first valvulae roughly triangular, highly sclerotized and bear a patch of small hairs distally in addition to a pair of small stylus like structures, rami absent; anterior extension of ninth paratergite highly sclerotized and of characteristic shape; second valvifers small, slightly sclerotized and fused with the second valvulae proximally; second valvulae longer than the second valvifer and bear hairs at the apices.

Scudder (1959) makes no mention of first valvifers in his description of the ovipositor of Corixidae, probably having overlooked them. It will be noticed that there is a distinction second valvulae and valvifers in this case as well.

External male genitalia

Agraptocorixa hyalinipennis (*Fig. 46*)

Basal plates fused with each other and produced into a pair of downwardly directed processes; phallotheca highly sclerotized, tube like and bent in the proximal region; ductus seminis has circulii and traverses a greater part of phallotheca, vesica long and thin; endosoma tube like and thin, parameres asymmetrical.

Pruthi (1925) distinguishes endosoma into conjunctiva and vesica, no doubt the central portion of endosoma stains more deeply in comparison to the outher hayline one but this cannot be a sufficient ground to distinguish between conjunctiva and vesica.

Hesperocorixa interrupta (*Fig. 47*)

External male genitalia same as in *Agraptocorixa* but ductus seminis does not form ring like coils; endosoma covered with many tubercles.

Spermatheca of A. hyalinipennis (*Fig. 48*)

There is a large bulb the apex of which is thrown into large number of coils. A proximal pump flange is present. Pendergrast (1957) did not note a pump flange in corixid spermatheca.

Remarks on Corixoidea

Scudder (1959) states that the female genitalia of Corixidae are so different as to warrant the inclusion of the latter in a separate series. He evidently means the fusion of second valvifers and valvulae. But it has already been pointed out that there does exist a distinction between second valvifers and valvulae. The fusion of first valvifers in Corixidae is worth noting. But it is a sign of specialization and should not be given undue importance. Because, in many families of Heteroptera there is fusion of first or second valvulae while in others second valvifers may be fused. External male genitalia of Corixidae are also highly specialized but specializations to the extreme occur in aedeagi of Nepidae as well. Corixidae are specialized no doubt but the specializations are not to an extent as to warrant their inclusion in a separate series.

Therefore, a family status for Corixidae within superfamily Corixoidea will seem to be quite satisfactory.

Galgulidae

Ovipositor

Gelastocoris oculatus (*Fig. 49*)

First valvifers probably fused to eighth paratergite; presence of first valvulae cannot be said with certainty in view of the few specimens studied, probably they have fused together, anterior extension of ninth paratergites of both sides fused together as in *Pelocoris femoratus* (Naucoridae, Nepidae, etc.); second valvifers very small, bean like; second valvulae completely fused excepting the tip region and highly sclerotized at the sides, ramus of second valvula small; styloids absent.

External male genitalia

Gelastocoris oculatus (*Fig. 50*)

Basal plates elongated and fused ventrally; phallotheca in the form of a tube of fair size, phallothecal mouth wide; endosoma not differentiated into conjunctiva and vesica.

Some phylogenetic considerations of aquatic Heteroptera

Present studies have not been much helpful in order to ascertain the phylogeny of aquatic Heteroptera although some interesting facts have been brought to light. It is interesting that there are remarkable similarities between the ovipositors of Coreidae and Notonectinae. It may be that the Notonectids were one of the first stocks of water bugs that might have diverged from the common terrestrial ancestor. China (1955) considers that nepid-belostomatid complex was the first to diverge from the ancestral line while Parsons (1959) has suggested that the Corixids might have diverged from the ancestral line along with nepid-belostomatid complex.

Study of external genitalia strongly suggests that Belostomatidae and Reduviidae probably had a common ancestor. There is very little difference in the external genitalia of the two.

According to China (1955) Galgulidae branched off at a very early stage from ancestral line. If that is so they must at least retain some primitive characters. But external genitalia do not seem to indicate so. The Ovipositor in Galgulidae is quite specialized, second valvulae are fused and second valvifers are extremely reduced. External male genitalia are also specialized.

Summary

Genitalia in twelve families of aquatic and semi-aquatic Heteroptera have been studied and their bearing on the classification is considered. It has been suggested that Mesoveliidae and Belostomatidae should be removed from Saldoidea and Nepoidea respectively and that Corixidae do not deserve to be placed in a separate series.

Ovipositors of Notonectinae and Belostomatidae show striking similarities to the Ovipositors of Coreidae and Reduviidae respectively. It has been shown that there does exist a distinction between second valvifers and valvulae in Corixidae and that they are not fused inseparably as is believed generally. Presence of a basivalvula on the first valvula of Saldidae has been described and the absence of styloids in Belostomatid Ovipositor has been supported. On the basis of external genitalia alone it has been suggested that Belostomatidae and Reduviidae probably had a common ancestor. It appears that notonectids were the first stock to diverge from the common ancestral line.

References

BORNER, C., 1934, Über system und stammesgeschichte der Schnabelkerfe. Ent. Bein., Berl.-Dahlem 1: 138—44.

CHINA, W. E., 1955, The evolution of waterbugs. Bull. Symposium on organic evolution. Nat. Inst. Sci. India, New Delhi 7: 91—103.

EKBLOM, T., 1926, Morphological and biological studies of the Swedish families of Heteroptera Part I. Zool. Bidr. Uppsala 10: 31—180.

LARSÉN, O., 1938, Untersuchungen über den Geschlechtsapparat der aquatilen Wanzen. Opusc. Ent. Suppl. 1: 1—388.

PARSONS, M. C., 1959, The midgut of aquatic Heteroptera. J. Morph., 104(3): 479—525.

PENDERGRAST, J. G., 1957, Studies on the reproductive organs of the Heteroptera with a consideration of their bearing on the classification. Trans. R. ent. Soc. Lond. 109: 1—63.

PRUTHI, H. S., 1925, The morphology of the male genitalia in Rhynchota. Trans. ent. Soc. Lond. 1925: 127—267.

SCUDDER, G. G. E., 1959, The female genitalia of the Heteroptera: morphology and bearing on classification. Trans. R. ent. Soc. Lond. 3: 405—467.

SNODGRASS, R. E., 1933, Morphology of the Insect abdomen. Part II. The genital ducts and the ovipositor. Smithson misc. Coll. 89(8): 1—148.

TRUXAL, F. S., 1952, The comparative morphology of the male genitalia of the Notonectidae (Hemiptera). Journ. Kans. Ent. Soc. 25: 30—38.

Key to the Lettering of Figures

Ovipositor

ANT.EXT	=Anterior extension of ninth paratergite.
BAS.VAV	=Basivalvula.
D.P	=Dorsal plate of second valvifer.
INT.VAV.ANT	=Anterior intervalvular membrane.
N	=A sclerite connecting anterior extension to first valvifer.
R_2	=Inner ramus of first valvula.
R_3	=Ramus of second valvula.
ST	=Styloids.
TG.AP	=Tergal apodeme.
V.P.	=Ventral plate of second valvifer.
1st VAL	=First valvula.
1st VF	=First valvifer.
2nd VAL	=Second valvula.
2nd VP	=Second valvifer.
VIII	=Eighth paratergite.
IX	=Ninth paratergite.

External male genitalia

B.P	=Basal plates.
CON.PR	=Conjunctival processes.
DU.SM	=Ductus seminis.
END	=Endosoma.
END.PR	=Endosomal processes.
PR	=Parameres.

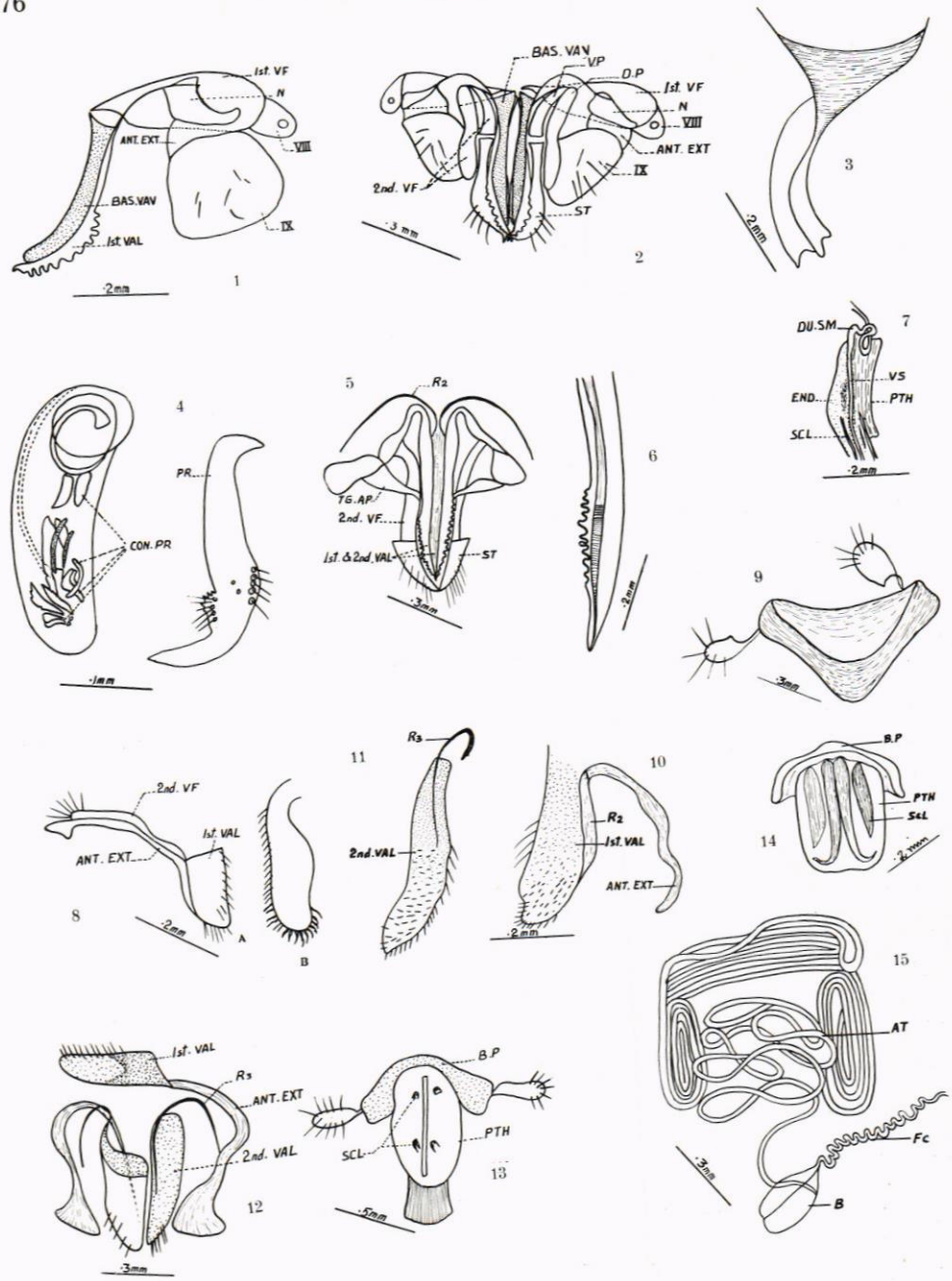
PTH =Phallotheca.
PTH.DIV =Phallothecal diverticula.
SCL =Sclerotizations.
ST =Strut.
VS =Vesica.
a ='a' type endosomal sclerite.

Spermatheca

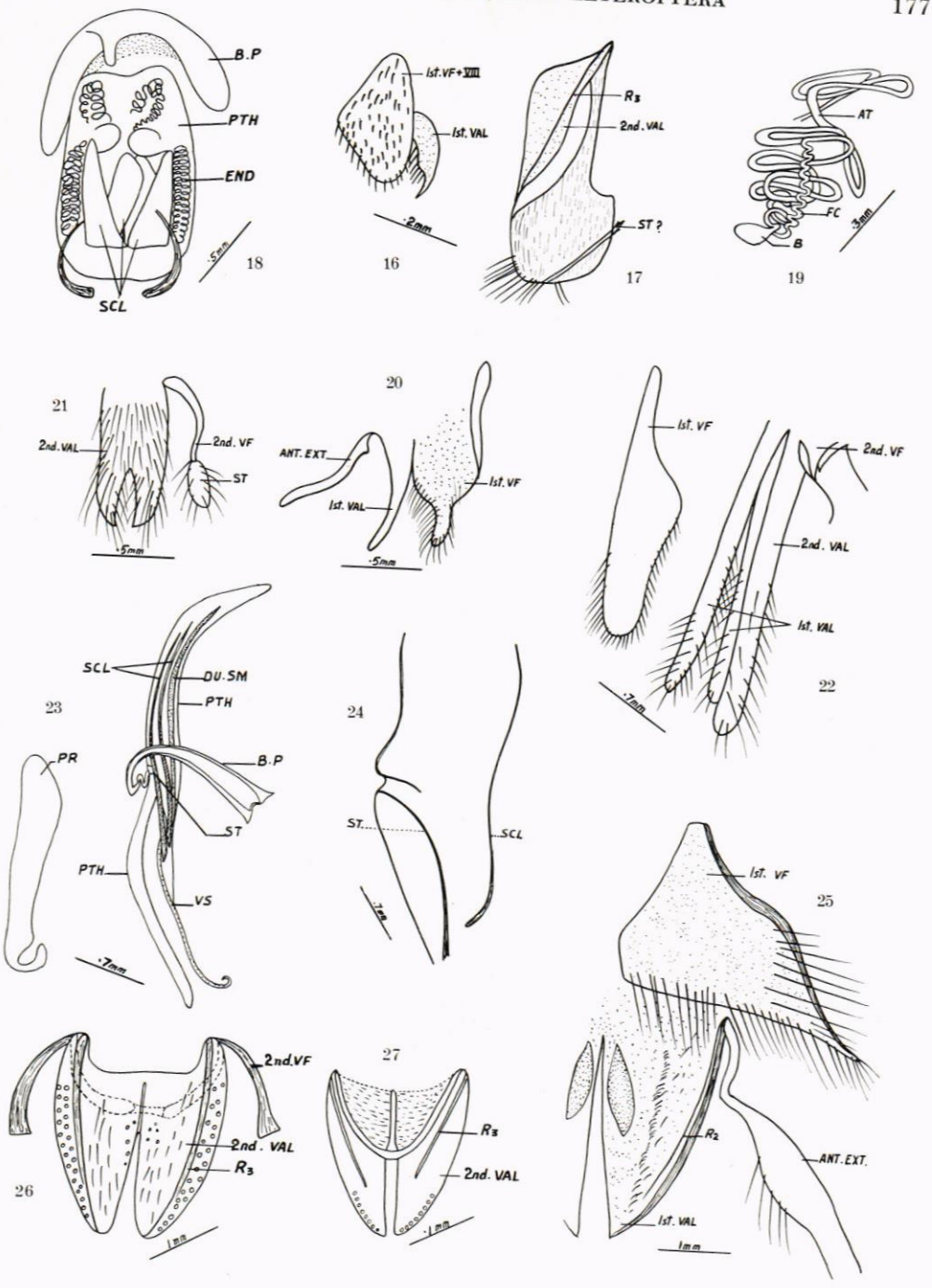
AT =Apical tube.
B =Bulb of spermatheca.
FC =Fecundation canal.
PF =Proximal pump flange.

Explanation of figures

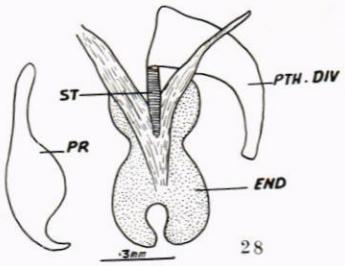
Figs. (1)—(4). *Salda sp.* probably *dixoni* (Saldidae): (1) First valvula and associated parts; (2) Ovipositor spread out (Dorsal view); (3) Second valvulae showing the intervalvular membrane; (4) Aedeagus and paramere, basal plates not shown.
Figs. (5)—(7). *Mesovelia sp.* (Mesoveliidae): (5) Dorsal view of ovipositor, first valvifers not shown; (6) First valvula, only a portion shown; (7) Aedeagus, basal plates not shown.
Figs. (8)—(9). *Rhagovelia oriander* (Veliidae): (8) A. First valvula and second valvifer. B. Part of second valvula; (9) Basal plates.
Figs. (10)—(11). *Limnogonus nitidia* Mayr (Gerridae): (10) First valvula and associated parts; (11) Second valvula.
Figs. (12)—13). *Gerris remigis* (Gerridae): (12) Ovipositor spread out (Dorsal view); (13) Aedeagus.
Figs. (14)—(15). *L. nitidia* Mayr (Gerridae): (14) Aedeagus; (15) Spermatheca.
Figs. (16)—(19). *Hydrometra lineata* Esch (Hydrometridae): (16) First valvifer and valvula; (17) Second valvula and associated parts; (18) Aedeagus; (19) Spermatheca.
Figs. (20)—(21). *Laccotrephes robustus* (Nepidae): (20) First valvifers and associated parts; (21) Second valvifers and associated parts.
Fig. (22). Components of the Ovipositor of *Ranatra linearis* Fabr (Nepidae).
Figs. (23)—(24). *L. maculatus* Fabr (Nepidae): (23) Aedeagus (Lateral view) and paramere; (24) One of the struts and sclerotizations present in the aedeagus.
Figs. (25)—(26). *Lethocercus sp.* (Belostomatidae): (25) First valvifers and associated parts; (26) Second valvifers and associated parts.
Fig. (27). Second valvifers and associated parts of *Sphaerodema rusticum* Fabr (Belostomatidae).
Fig. (28). *Lethocercus sp.* (Belostomatidae): Aedeagus, Basal plates removed.
Fig. (29). *S. rusticum* Fabr (Belostomatidae), Aedeagus, basal plates and struts shown in lateral view.
Figs. (30)—(31). *Pelocoris femoratus* (Naucoridae): (30) First valvulae and the anterior extensions of ninth paratergites; (31) Second valvifers and associated parts.
Figs. (32)—(33). *Notonecta lunata* (Notonectinae): (32) First valvifer and valvula; (33) Second valvifers and associated parts, styloids on the right side not shown.
Figs. (34)—(35). *Enithares indica* (Notonectinae): (34) First valvifer and associated parts; (35) Second valvifer and associated parts (second valvula on the left side not shown).
Fig. (36). Aedeagus of *Notonecta lunata.*
Fig. (37). Aedeagus of *E. indica* (Notonectinae).
Figs. (38)—(40). *Anisops sardea* H.S (Anisopinae): (38) First valvula and associated parts; (39) Second valvula and associated parts; (40) Aedeagus.
Fig. (41). Aedeagus of *Plea striola* (Pleidae).
Figs. (42)—(43). *Agraptocorixa hyalinipennis* (Corixidae): (42) First valvifers and valvulae; (43) Second valvifer and valvula.
Figs. (44)—(45). *Hesperocorixa interrupta* (Corixidae): (44) First valvifers and valvulae; (45) Second valvifer and valvula.
Fig. (46). Aedeagus and parameres of *A. hyalinipennis* (Corixidae).
Fig. (47). Aedeagus of *H. interrupta* (Corixidae).
Fig. (48). Spermatheca of *A. hyalinipennis* (Corixidae).
Figs. (49)—(50). *Gelastocoris oculatus* (Galgulidae): (49) Second valvifers and valvulae; (50) Aedeagus.


1st. VF
N
ANT. EXT
VIII
BAS. VAV
1st. VAL
IX
·2mm
1
BAS. VAV
VP
D.P
1st. VF
N
VIII
ANT. EXT
IX
2nd. VF
ST
·3 mm
2
3
·2mm
4
PR
CON. PR
·1mm
5
R2
TG. AP
2nd. VF
1st. & 2nd. VAL
ST
·3mm
6
·2mm
7
DU. SM
VS
END
PTH
SCL
·2mm
9
·3mm
2nd. VF
ANT. EXT
1st. VAL
·2mm
8
A
B
11
R3
2nd. VAL
10
R2
1st. VAL
ANT. EXT
·2mm
B.P
PTH
SCL
·2mm
14
15
AT
Fc
B
·3mm
1st. VAL
R3
ANT. EXT
2nd. VAL
12
·3mm
B.P
SCL
PTH
13
·5mm

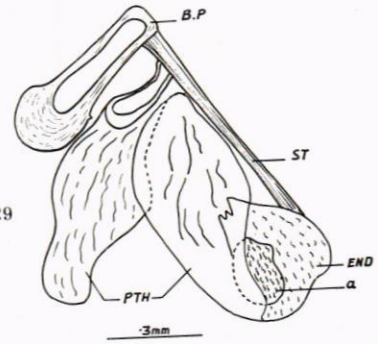
Figs. 1—15.


B.P
PTH
END
SCL
·5mm
18
1st.VF+VIII
1st.VAL
·2mm
16
R3
2nd.VAL
ST?
17
AT
FC
B
·3mm
19
21
2nd.VAL
2nd.VF
ST
·5mm
20
ANT.EXT
1st.VAL
1st.VF
·5mm
1st.VF
2nd.VF
2nd.VAL
1st.VAL
·7mm
22
SCL
DU.SM
PTH
23
PR
B.P
ST
PTH
VS
·7mm
24
ST
SCL
1mm
1st.VF
25
R2
ANT.EXT.
1st.VAL
1mm
2nd.VF
2nd.VAL
R3
26
1mm
27
R3
2nd.VAL
1mm

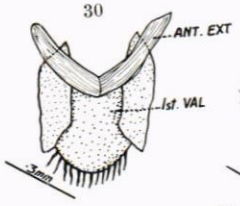
Figs. 16—27.



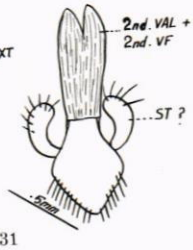
28



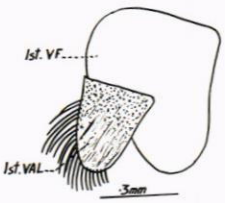
29



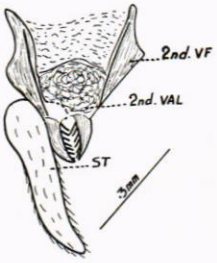
30



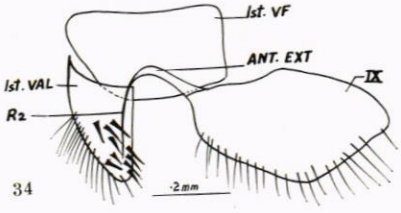
31



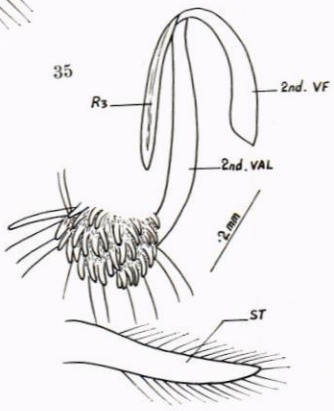
32



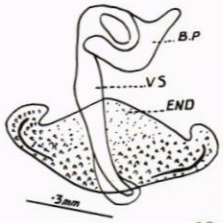
33



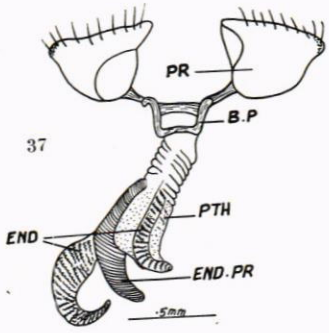
34



35

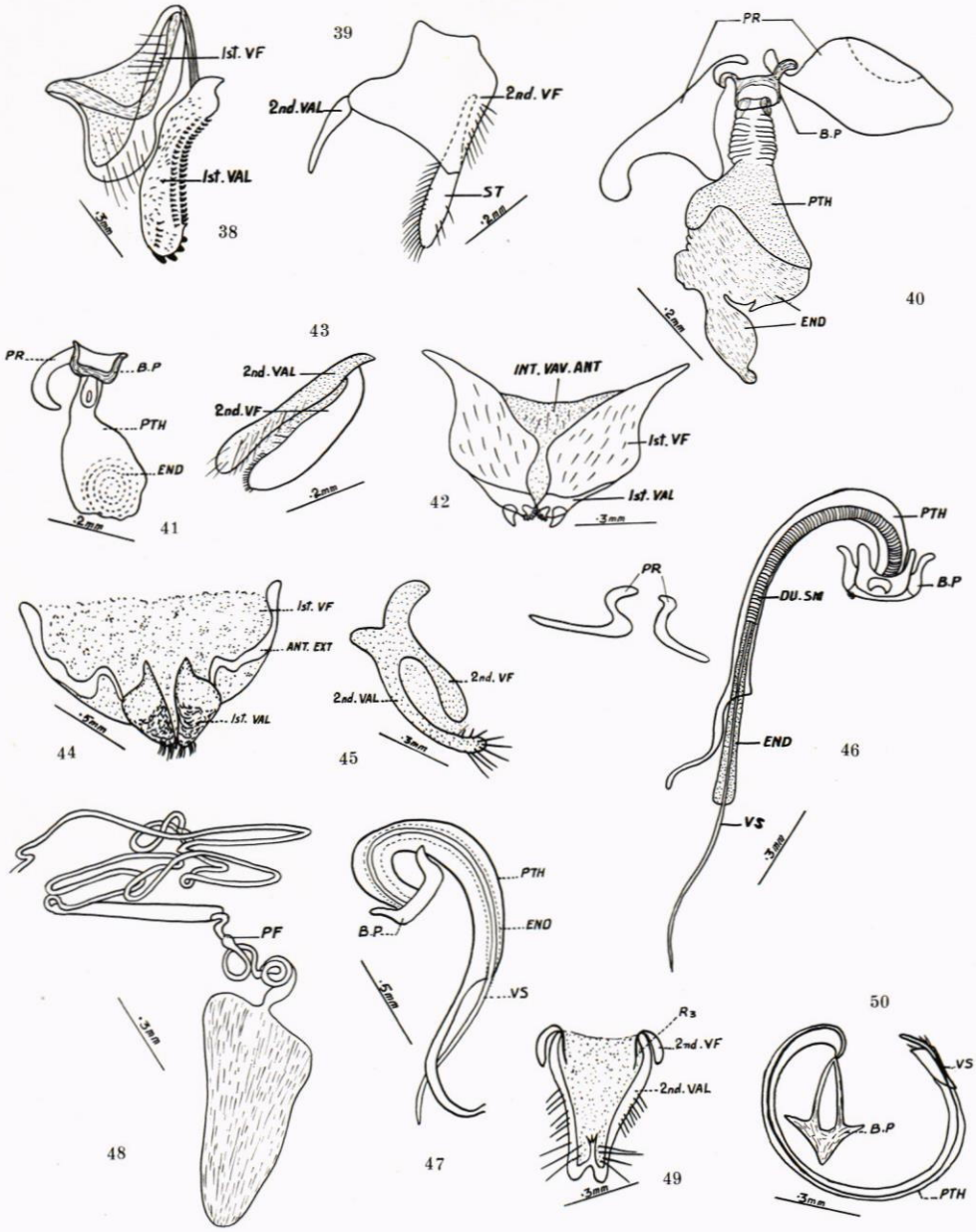


36



37

Figs. 28—37.


1st. VF
1st. VAL
.5mm
38
39
2nd. VF
2nd. VAL
ST
.2mm
PR
B.P
PTH
END
.2mm
40
43
PR
B.P
PTH
END
.2mm
41
2nd. VAL
2nd. VF
.2mm
INT. VAV. ANT
1st. VF
1st. VAL
.3mm
42
1st. VF
ANT. EXT
1st. VAL
.5mm
44
2nd. VF
2nd. VAL
.3mm
45
PR
PTH
B.P
DU. SM
END
VS
.3mm
46
PF
.3mm
48
PTH
B.P.
END
VS
.5mm
47
R3
2nd. VF
2nd. VAL
.3mm
49
50
VS
B.P
PTH
.3mm

Figs. 38—50.