

DISAPPEARANCE OF THE MEDIAN DORSAL BRIDGE OF IXTH ABDOMINAL TERGUM IN FEMALE HYMENOPTERA

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ABSTRACT

The median dorsal bridge of the IX abdominal tergum, which plays an important role in the working mechanism of female genitalia is quite prominent in all the symphytan families (Xyelidae, Pamphiliidae, Tenthredinidae, Diprionidae, Cimbicidae, Aigidae, Cephidae, Xiphydriidae and Siricidae). However, in Ichneu-monoidea and Chalcidoidea, representing Hymenoptera-Parasitica, this bridge is comparatively reduced in its breadth. In the lower families of Aculeata (Chrysidiidae, Scoliidae and Sphecidae), it is further reduced into a structure which is no more than a sclerotic transverse line, the rest of it having become membranous. In Eumenidae and Pompilidae the sclerotic bridge is totally wanting, and is being represented by membrane alone. Thus at this stage the IX tergum consists of two lateral halves but with their mesal ends still lying close to each other. Further modification in this condition occurs in Vespidae, Formicidae, Mutillidae and Xylocopidae where the mesal ends of the lateral halves of the IX tergum are far removed. In this condition, the entire IX dorsum is represented by membrane only. These modifications, when arranged, bring to light series of evolutionary changes which are helpful in establishing the phylogenetic relationships among the various families of this insect order.

INTRODUCTION

The following is one of the links consisting of an extensive work tracing the evolutionary trends within the entire range of the order Hymenoptera. This particular work deals with the trans-mutations in the median dorsal bridge dorsally forming the median portion of the IX abdominal segment in the female. These changes are progressive and consistent and could be arranged into a serial pattern for establishing the phylogenetic relationship among the various families of this insect order. Such comprehensive studies designed to bring to light the series of evolutionary modifications affecting the median dorsal bridge, have not yet been undertaken.

However, numerous fragmentary works are available in the morphological litera-

ture concerning the IX tergum which has always been explored on an individual basis but not as a step in the long series of transformations. In addition, one finds ample mention in the literature of its ontology. Some of the important references include: Snodgrass (1925, 1933, 1935), Alam (1953), Arora (1953, 1956), Rivard (1955), Tait (1962), Wong (1963), Dhillon (1966, 1971), Hermann & Blum (1966, 1967, 1968), Hermann (1968a, 1968b, 1969a, 1969b), Hunt and Hermann (1970), Smith (1970), Copland and King (1970, 1971, 1972, 1972a, 1972b), Iuga (1972, 1973), Copland (1976), Matsuda (1976) and Michener (1944). The above works, though, hardly discuss the modifications pertaining to this dorsal sclerotized band or bridge occurring among the species related proximally or distally, with which the present studies are directly concerned, and which are based on the observations made on the various members belonging to 22 different families of this insect order.

MATERIAL AND METHODS

Most of the specimens of Apocrita were collected from the Punjab and the Himachal Pradesh during the months of September and October, 1975 and preserved in 80% alcohol. Symphyta, with the exception of Megalodontidae and Orussidae, were supplied by the Biosystematic Research Institute, Canada, and the Zoological Survey of India. As the specimens provided by them were dry, they were softened by immersion in 2% KOH for about six days. Figures were drawn using a stereo-microscope fitted with an ocular micrometer.

OBSERVATIONS AND DISCUSSION

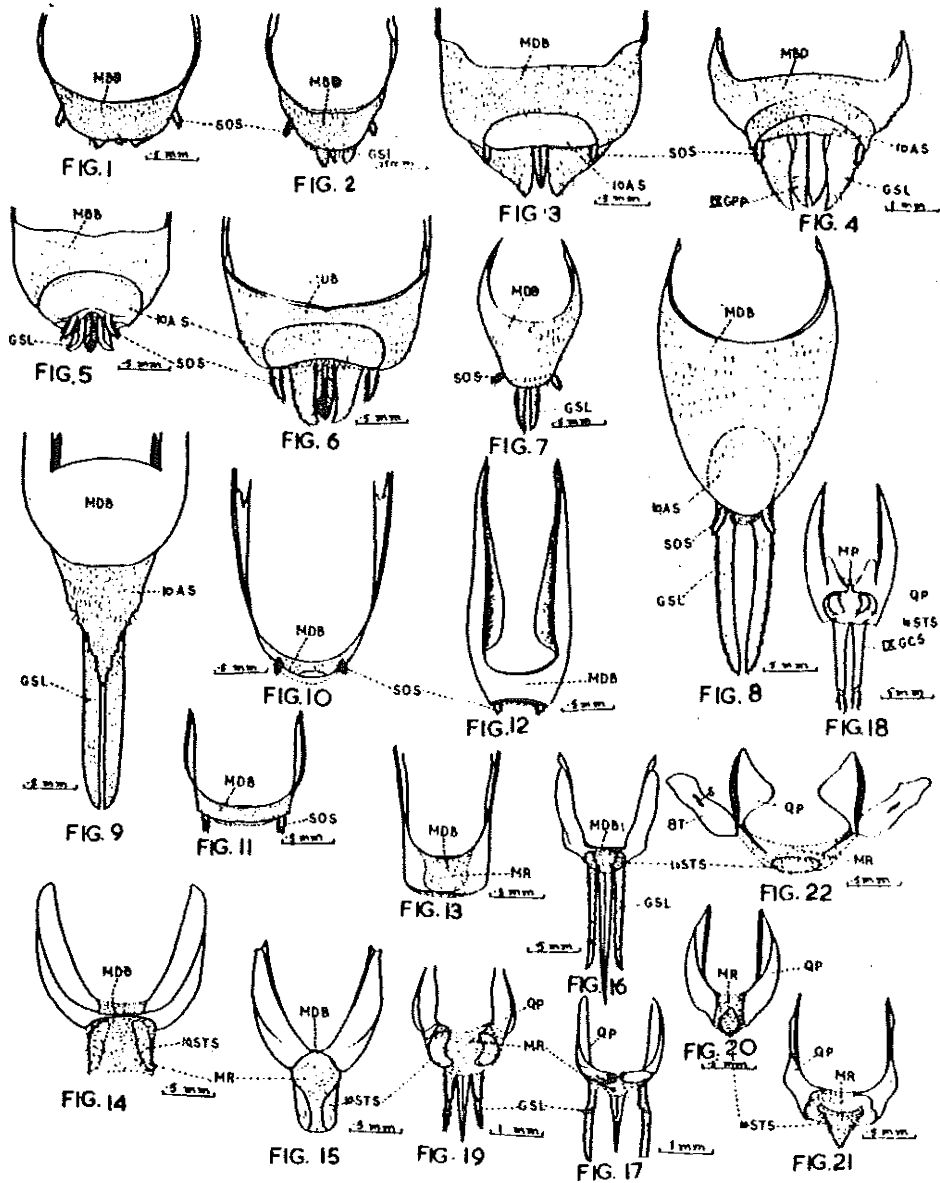
The IXth tergum plays an important role in the working mechanism of female genitalia by affecting particularly the activity of the VIII gonocoxite and VIII gonapophysis. In all the symphytans and also in the members of Hymenoptera-Parasitica, the IX tergum is easily divisible into three distinct parts, out of which two are lateral plates (quadrate plates) which are mesally interconnected through a distinct bridge, the median dorsal bridge. The latter is well developed in symphytans but is somewhat reduced in Hymenoptera-Parasitica. It keeps the IXth tergum in properly secured state and does not allow the latter to sag during the activity of VIII gonocoxites which are pushed back and forth through their retractors at the time of oviposition (Smith, 1970). On the other hand, in almost all the aculeatans, with the exception of chrysidids, the median dorsal bridge connecting the two lateral halves of the IXth tergum is either inconspicuous or completely absent. As a consequence the lateral halves of the IXth tergum assume a tilted position in order to impart motion to the VIII gonocoxites and VIII gonapophyses. This observation is further substantiated by Snodgrass (1933) and Smith (1970). The comparative study of various hymenopteran types reveals that this reduction in the stature of the median dorsal bridge is not abrupt. It has been a gradual change culminating in its total loss in the higher apocritans which entirely altered the way of functioning of the VIII gonocoxite and VIII gonapophysis. In almost all the symphytans, starting from pamphiliids up to the siricids, the median

dorsal bridge is conspicuously represented but according to Smith (1970), the process of reduction in the breadth of the median dorsal bridge starts from the Argidae or Xyelidae. In Hymenoptera-Parasitica this bridge is narrower and in some aculeate families like Chrysididae, Scoliidae and Sphecidae it is further narrowed to a linear joint. In rest of the aculeatans this bridge has lost its identity and only its remnants are present. Thus, these serialized changes in the stature of the median dorsal bridge are an indication of an evolutionary trend within the entire range of the order Hymenoptera which is as follows:

In the symphytans such as in *Acantholyda maculiventris* (Norton) (Fig. 1) (Pamphiliidae), *Xyela bakeri* Konow (Fig. 2) (Xyelidae), *Arge clavicornis* (F.) (Fig. 3) (Argidae), *Cimbex americana americana* Leach (Fig. 4) (Cimbicidae), *Pristiphora cincta* Newman (Fig. 6) (Tenthredinidae), *Neodiprion abietis* (Harris) (Fig. 5) (Diprionidae), *Cephus (Cephus) cinctus* Norton (Fig. 7) (Cephididae), *Xiphydria mellipes* Harris (Fig. 8) (Xiphydriidae) and *Sirex cyaneus* F. (Fig. 9) (Siricidae), the median dorsal bridge is quite prominent. In these, it is visible externally even when the insect is resting or laying eggs, with the exception of *Cephus*, *Xiphydria* and *Sirex* sp. where it is partially withdrawn under the VIIIth tergum. This condition puts these three symphytans in close approximation to the Hymenoptera-Parasitica where the IXth tergum is visible only partially. Closely following the fate of IXth tergum, is the Xth tergum which is represented in all the symphytans. In *Arge*, *Cimbex*, *Neodiprion*, *Pristiphora* and *Sirex* it remains exposed while in *Acantholyda*, *Xyela*, *Cephus* and *Xiphydria*, it is concealed underneath the IXth tergum, and its presence can be made out only through the presence of two peg like hairy structures, the socii which arise from it posterolaterally and project beyond the posterior boundary of the IXth tergum. Similar observations pertaining to IXth and Xth terga have also been made on some other symphytans such as *Pamphilius luteicornis* (Norton) and *Cephalcia provancheri* (Huard) (Pamphiliidae), *Pachyprotasis versicolor* Cameron, *Pachyprotasis brunetti* Rohw. and *Tomostethus (Eutomostethus) assomensis* Rohw. (Tenthredinidae) and *Zarae inflata* Norton (Cimbicidae). These studies are further substantiated by the works of Snodgrass (1933, 1935), Reeks (1937), Ross (1937, 1948), Arora (1953, 1956), Rivard (1955), Tait (1962), Wong (1963), Dhillon (1966, 1971) and Smith (1970), on the various symphytans.

Further modification in this regard is revealed by the representatives of Hymenoptera-Parasitica. In *Netelia kashmirensis* Cameron (Fig. 11) and *Trachysphyrus* sp. (Fig. 12) (Ichneumonidae), the median dorsal bridge is quite narrow as compared to those occurring in the symphytans. Moreover, the entire IXth tergum consisting of the lateral plates and the reduced median dorsal bridge, is completely telescoped underneath the VIIIth tergum. In this case, the Xth tergum is almost membranous and it is completely concealed under the IXth tergum. These observations are further substantiated by the works of Snodgrass (1933), Alam (1953), Imms (1963), Delong and Borror (1970), Smith (1970) and Jonathan and Gupta (1973). However, Snodgrass as cited by Alam (1953), has not shown the bridge in *Atanycolus rugosiventris* (Braconidae).

In the members of super family Chalcidoidea conditions pertaining to the median dorsal bridge are not uniform. In some cases, the bridge is conspicuous and can be partially seen from the outside. However, in *Sycoscapter stabilis* (Walker) (Fig. 10) (Torymidae), it is much reduced and only its posterior margin is visible from the out-



Figs. 1-22. Hymenoptera species, dorsal view of 9th and 10th terga of: 1 - *Acantholyda maculiventris* (Norton); 2 - *Xyela bakeri* Konow; 3 - *Arge clavicornis* (F.); 4 - *Cimbex americana americana* Leach; 5 - *Neodiprion abietis* (Harris); 6 - *Pristiphora cincta* Newman; 7 - *Cephus (Cephus) cinctus* Norton; 8 - *Xiphydria mellipes* Harris; 9 - *Sirex cyaneus* (F.); 10 - *Sycoscapter stabilis* (Walker); 11 - *Netelia kashmirensis* Cameron; 12 - *Trachysphyrus* sp.; 13 - *Chrysis indogotea* Duf. et Pestr.; 14 - *Scolia quadripustulata* F.; 15 - *Stizus vespiformis* F.; 16 - *Scelephron intrudens* Smith; 17 - *Calicurgus* sp.; 18 - *Eumenes dimidiatipennis* Sauss; 19 - *Vespa orientalis* L.; 20 - *Mutilla* sp.; 21 - *Sima rufonigra* Jerdon; 22 - *Xylocopa lemuscapa* Westwood. ABBREVIATIONS: 10AS - 10th abdominal segment; GSL - Gonostylus; IX GPP - 9th Gonapophysis; MR - Membrane; QP - Quadrate plates; S - Spiracles; SOS - Socii; 10 STS - 10th abdominal tergal sclerite; 8 T - 8th tergum.

side. Similarly, varying conditions have also been shown in the representatives of the various families of the super family Chalcidoidea by Copland and King (1971, 1972, 1972a, 1972b, 1973) and Copland (1976). Smith (1970) has also reported a reduced median dorsal bridge of the IXth tergum in Hymenoptera-Parasitica in general.

Concerning the members of the families Chrysididae, Scoliidae and Sphecidae of Hymenoptera-Aculeata the median dorsal bridge is further reduced into a linear connection. In *Chrysis indogotea* Dug. et Pesr. (Fig. 13) (Chrysididae), *Scolia quadripustulata* F. (Fig. 14) (Scoliidae) and *Scelephron intrudens* Smith (Fig. 16) and *Stizus vespiformis* F. (Fig. 15) (Sphecidae) the median dorsal bridge is only a thread like structure which joins the two lateral halves of the IXth tergum. The Xth tergum in the latter three insects is also reduced to two semi-sclerotized bean shaped hairy sclerites. Similarly, a reduced median dorsal bridge has been noted in *Scolia fulvifrons* Sauss and *Ellis* sp. (Scoliidae).

Further modification of the median dorsal bridge is manifested in *Eumenes dimidiatopennis* Sauss. (Fig. 18) (Eumenidae) and *Calicurgus* sp. (Fig. 17) (Pompiliidae). In these cases the bridge is absent and in its place has appeared a small membranous area which obstructs the sclerotic continuity of the two lateral halves of the IXth tergum. This discontinuation of the IXth tergum facilitates the independent movements of its lateral halves. The two mesal ends of the lateral halves lie in proximity to each other, thus further substantiating the view that in their immediate predecessors, the median dorsal bridge possessed its sclerotic identity. This hypothesis has already been confirmed through observations made on the representatives of the family Scoliidae and Sphecidae.

In the representatives of other families of apocritans such as in *Vespa orientalis* L. (Fig. 19) (Vespidae), *Xylocopa lemuisca* Westwood (Fig. 22) (Apoidea-Xylocopidae), *Mutilla* sp. (Fig. 20) (Mutillidae) and *Sima rufonigra* Jerdon (Fig. 21) (Formicidae) the median dorsal bridge is absent and only its remnants are traceable. The latter are in the form of pointed spine like structures projecting mesally from the two lateral halves of the IXth tergum which are separated from each other through a wide stretch of membrane. In *Vespa*, remnants of the Xth abdominal tergum (Fig. 19) are in the form of two bean-shaped semi-sclerotized hairy sclerites, whereas, in *Xylocopa* it is represented by an elliptical semi-sclerotized single structure lying in the centre of the membranous area slightly posterior to the disappeared median dorsal bridge of the IXth segment. In *Sima* and *Mutilla* it is represented by a single triangular and rectangular structures (Fig. 20 and 22), respectively, lying in the same position as that of *Xylocopa*. Similar observations pertaining to the fate of IXth abdominal tergum have also been made by Snodgrass (1925), Duncan (1939), Michener (1944), Hermann and Blum (1966, 1967, 1968), Hermann (1968a, 1968b, 1969a, 1969b), Pruthi (1969), Hunt and Hermann (1970), Smith (1970) and Iuga (1972, 1973).

This trend which covers the entire range of the order Hymenoptera if analysed minutely and critically, particularly in apocritans along with some other morphological features, it can be of great help in establishing the phylogenetic relationships among the various families.

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