

A NEW SPECIES OF *CAPEDULIA* (ACARI: TENUTPALPIDAE)  
FROM A MARINE HABITAT IN ISRAEL

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ABSTRACT

*Capedulia maritima* n. sp. is described from roots of *Limonium meyeri* (Boiss.) O. Ktze. (Plumbaginaceae) growing on the coast of Israel. The plants were occasionally covered by sea water.

The monotypic genus *Capedulia* was proposed by Meyer (1979) to accommodate *Capedulia calendulae* Meyer, collected from a wild herbaceous plant, *Osteospermum calendulaceum*, in an arid region of the Eastern Cape, South Africa. A second species belonging to this genus was obtained from the roots of *Limonium meyeri* growing on the coastal plain of Israel. The plants were occasionally covered by sea water; the only two known species of *Capedulia* thus inhabit completely different habitats.

*Capedulia* Meyer

*Capedulia* Meyer, 1979: 109.

The genus is characterized by having one pair of dorsosublateral hysterosomal setae, a one-segmented palpus, the true claws and empodia padlike, the former bearing one long outer and 2 short inner tenent hairs.

*Capedulia maritima* n. sp. (Figs. 1-4)

FEMALE. Dimensions of holotype (measurements following in parentheses are variations in the paratypes): length of body (incl. rostrum) 319  $\mu$ m (353-359); length (excl. rostrum) 261  $\mu$ m (287-319); width 164  $\mu$ m (189-192); length of leg I 98  $\mu$ m (101-107); leg II 91  $\mu$ m (88); leg III 91  $\mu$ m; leg IV 87  $\mu$ m (85).

Dorsum (Fig. 1). Integument coarsely striate, striae medially transverse, laterally longitudinal, without any reticulations; most striae appear lobed. All dorsal setae finely serrate. First and second propodosomal setae subequal in length and longer than the

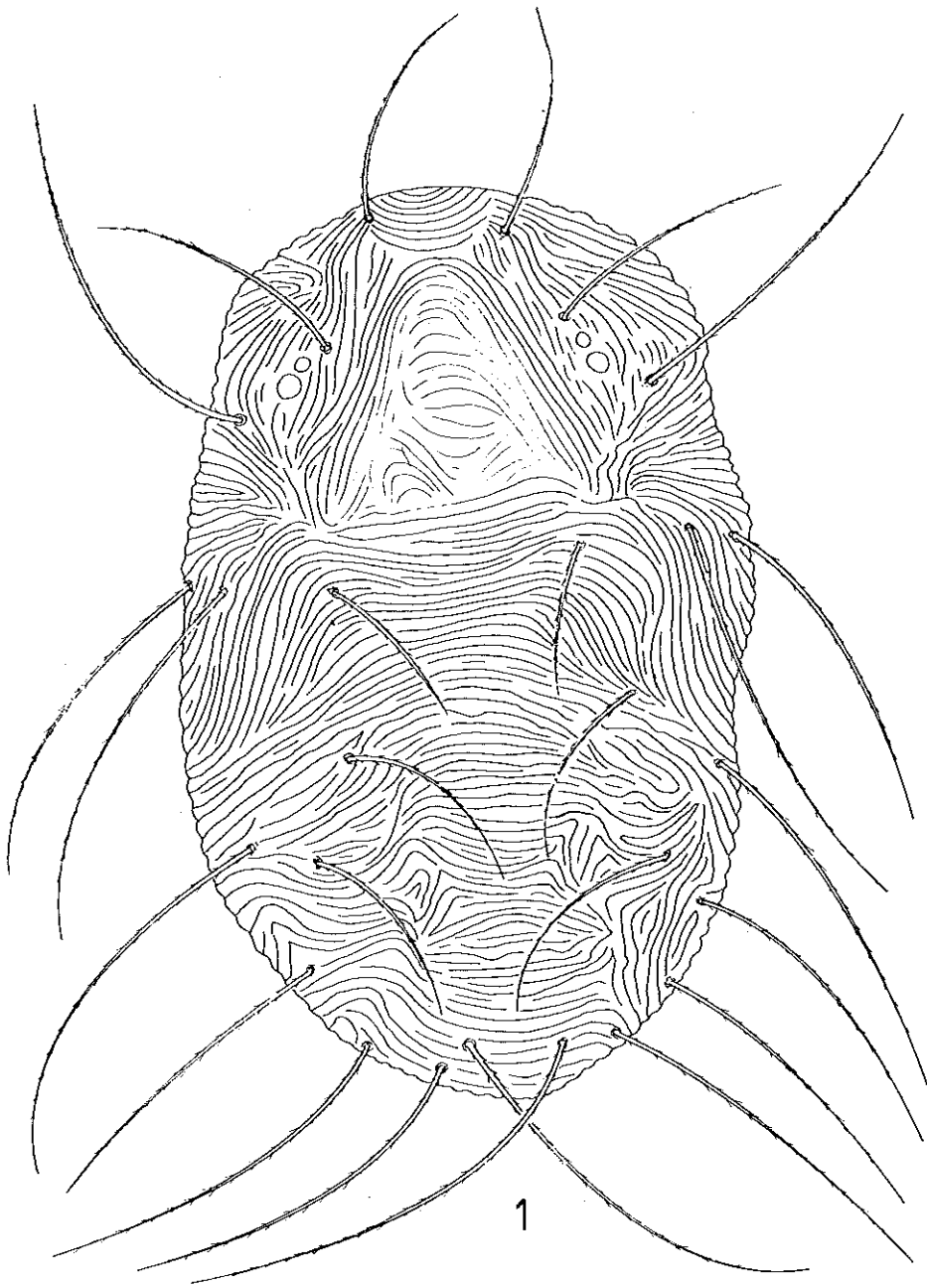
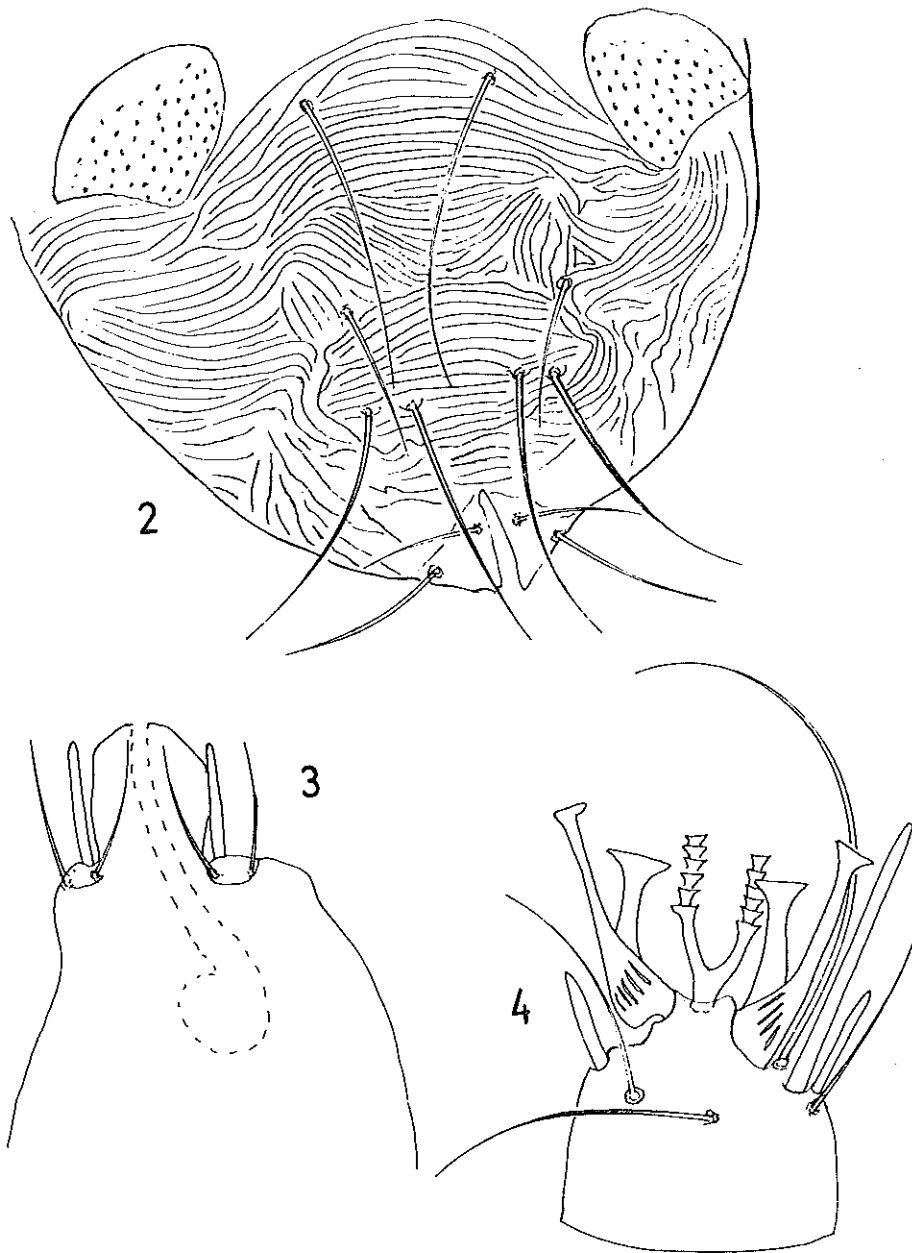


Fig. 1. *Capedula maritima* n. sp. Female. Dorsal view.



Figs. 2-4 *Capedulia maritima* n. sp. Female. 2. Genito-anal region. 3. Gnathosoma. 4. Tarsus I.

distances separating their bases. Third pair of propodosomal setae longer, overreaching bases of anterior propodosomal setae. Hysterosoma with 10 pairs of setae: 3 pairs of dorsocentrals, 1 pair of dorsosublaterals, 5 pairs of dorsolaterals and a pair of humerals. All dorsocentrals more or less shorter than distances separating them. Dorsolaterals and dorsosublaterals about 50% longer than dorsocentrals. Propodosoma with 2 pairs of eyes, diameter of the corneae of the anterior pair about half that of the posterior pair.

Venter. All coxae punctate. Podosoma mostly with transverse, lobed striations, except for longitudinal, lobed striae between coxae I and coxal fields III-IV. Two pairs of medioventral setae located between coxae III and IV, respectively, their length less than distance to base of other pair. Genital plate with transverse striae and 2 pairs of setae, subequal to medioventral ones. Pregenital setae about half as long as genital setae. Two pairs of anal setae flank anal aperture, those of the posterior pair slightly longer than the anterior ones and subequal in length to the pregenital setae (Fig. 2).

Gnathosoma. Rostrum reaches mid-tibia I. Palpus 1-segmented, with 2 setae and a solenidion which equals them in length (Fig. 3).

Legs. Distribution of setae as follows: coxae 3-1-1-1; trochanters 1-1-0-0; femora 3-3-2-2; genua 1-1-0-0; tibiae 4-4-3-3; tarsi 5(+1)-4(+1)-3-3. Claws padlike, each with 2 inner, shorter tenent hairs and one longer, outer tenent hair, the bases of all hairs made up of 5-6 strands. Empodia padlike, each bearing 2 rows of 6 tenent hairs (Fig. 4).

Males and immature stages not seen.

MATERIAL EXAMINED. Holotype ♀, Israel, Dor (coastal plain), roots of *Limonium meyeri* (Boiss.) O. Ktze. (Plumbaginaceae), 11. VIII. 1966, U. Gerson (in the collection of the Department of Entomology, Faculty of Agriculture, Rehovot, Israel (No. 1773)). Paratypes, 3 ♀♀, same data as holotype, to be placed in the collections of the Plant Protection Research Institute, Pretoria, South Africa, the British Museum (Natural History), London, and the U.S. National Museum, Washington, D.C.

REMARKS. *Capedulia maritima* n. sp. differs from *C. calendulae* in that the dorsal body setae are much longer, the palpal solenidion is also relatively longer, and in having fewer setae on the leg podomers.

#### REFERENCE

- Meyer, M. K. P. Smith. 1979. The Tenuipalpidae (Acari) of Africa with keys to the world fauna. *Entomology Memoir Department of Agricultural Technical Services, Republic of South Africa*, Memoir No. 50.

**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, Argidae, Cephidae, Xiphydriidae and Siricidae). However, in Ichneumonoidea and Chalcidoidea, representing Hymenoptera-Parasitica, this bridge is comparatively reduced in its breadth. In the lower families of Aculeata (Chrysididae, 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 hymenopterans. 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

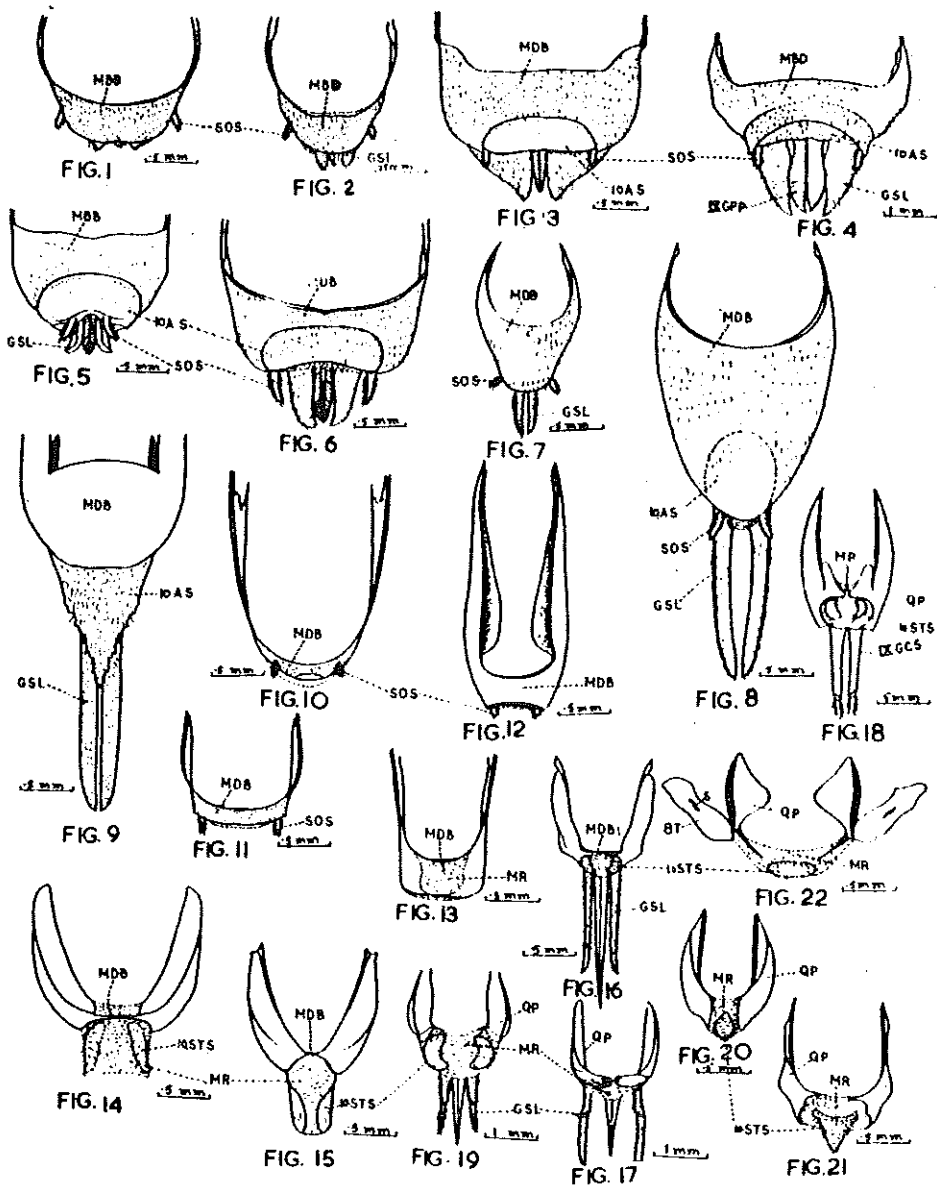
The IXth tergum plays an important role in the working mechanism of female genitalia by affecting particularly the activity of the VIII gonocoxite and VIII gonapophysis. In all the symphytans and also in the members of Hymenoptera-Parasitica, the IX tergum is easily divisible into three distinct parts, 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 terna 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 stabillis* (Walker); 11 - *Netelia kashmirensis* Cameron; 12 - *Trachysphyrus* sp.; 13 - *Chrysis indogotea* Duf. et Pesr.; 14 - *Scolia quadripustulata* F.; 15 - *Stizus vespiformis* F.; 16 - *Scelephron intrudens* Smith; 17 - *Calicurgus* sp.; 18 - *Eumenes dimidiatopennis* Sauss; 19 - *Vespa orientalis* L.; 20 - *Mutilla* sp.; 21 - *Sima rufonigra* Jerdon; 22 - *Xylocopa lemuisca* 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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## REFERENCES

- Alam, S.M. 1953. The skeleto-muscular mechanism of *Stecnohracon deesae* Cam. (Braconidae, Hymenoptera) – an ectoparasite of sugarcane and juar borers of India. Part II. Abdomen and Internal anatomy. *Aligarh Muslim University Publication (Zoological Series) on Indian Insect type*, 3: 75 pp.
- Arora, G.L. 1953. The external morphology of *Diprion pini* L. (Symphyta, Hymenoptera). *Research Bulletin of the East Punjab University Hoshiarpur, Zoology*, 25: 1-21.
- Arora, G.L. 1956. The relationship of the Symphyta to other orders of insects on the basis of adult external morphology. *Research Bulletin of the East Punjab University, Hoshiarpur Zoology*, 90: 95-119.
- Copland, M.J.W. 1976. Female reproductive system of the Aphelinidae (Hymenoptera: Chalcidoidea). *International Journal of Insect Morphology and Embryology*, 5 (3): 151-166.
- Copland, M.J.W. and King, P.E. 1971. The structure and possible function of the reproductive system in some Eulophidae and Tetracampidae. *Entomologist (London)*, 104: 4-28.
- Copland, M.J.W. and King, P.E. 1972. The structure of the female reproductive system in the Eurytomidae (Chalcidoidea, Hymenoptera). *Journal of Zoology, Proceedings of Zoological Society, London*, 166: 185-212.
- Copland, M.J.W. and King, P.E. 1972a. The structure of the female reproductive system in the Torymidae (Hymenoptera: Chalcidoidea). *Transactions of the Royal Entomological Society, London*, 124: 191-212.
- Copland, M.J.W. and King, P.E. 1972b. The structure of the female reproductive system in the Pteromalidae (Chalcidoidea, Hymenoptera). *Entomologist (London)*, 105: 77-96.
- Copland, M.J.W. and King, P.E. 1973. The structure of the female reproductive system in Torymidae (Hymenoptera: Chalcidoidea). *Transactions of the Royal Entomological Society, London*, 124 (2): 191-212.
- Delong, D.M. and Borror, D.J. 1970. An introduction to the study of Insects, 3rd edition. Holt, Rinehart and Winston, Inc.
- Dhillon, S.S. 1966. The morphology and biology of *Athalia proxima* Klug. (Tenthredinidae, Hymenoptera). *Aligarh Muslim University Publication (Zoological Series) on Indian Insect type*, 7: 165 pp.
- Dhillon, S.S. 1971. Morphological homologies of the external genitalia in the mustard sawfly. *Athalia proxima* Klug (Hymenoptera: Tenthredinidae). *Bulletin of Entomology, Entomological Society of India*, 12 (2): 100-108.
- Duncan, C.D. 1939. A contribution to the biology of North American vespine Wasps. *Stanford University Publication of Biological Sciences*, 8 (1): 272 pp.
- Hermann, H.R. Jr., 1968a. The hymenopterous poison apparatus. IV. *Dasymutilla occidentalis* (Hymenoptera: Mutillidae). *Journal of Georgia Entomological Society*, 3: 1-10.
- Hermann, H.R. Jr., 1968b. The hymenopterous poison apparatus. V. *Aneuretus simoni*. *Annals of Entomological Society of America*, 61: 1315-17.
- Hermann, H.R. Jr., 1969a. The hymenopterous poison apparatus VIII *Leptogenys elongata* (Hymenoptera: Formicidae). *Journal of Kansas Entomological Society*, 42: 239-243.
- Hermann, H.R. Jr., 1969b. The hymenopterous poison apparatus. Evolutionary trends in three closely related subfamilies of ants. (Hymenoptera: Formicidae). *Journal of Georgia Entomological Society*, 4: 123-141.
- Hermann, H.R. Jr. and Blum, M.S. 1966. The morphology and histology of the hymenopterous

- poison apparatus. I. *Paraponera clavata* (Formicidae). *Annals of Entomological Society of America*, 60: 1282-91.
- Hermann, H.R. Jr. and Blum, M.S. 1967. The morphology and histology of hymenopterous poison apparatus. III. *Eciton hamatum* (Fabricius). *Annals of Entomological Society of America*, 60: 1282-91.
- Hermann, H.R. & Blum, M.S. 1968. The hymenopterous poison apparatus. IX. *Camponotus pennsylvanicus* (Hymenoptera: Formicidae). *Psyche*, 75: 216-17.
- Hunt, A.N. and Hermann, H.R. Jr. 1970. The hymenopterous poison apparatus. XI. *Polistes annularis* (Hymenoptera: Vespidae). *Journal of Georgia Entomological Society*, 5: 128-135.
- Imms, A.D. 1963. The General Book of Entomology. Asia Publishing House, New York, 886 pp.
- Iuga, V.G. 1972. A comparative study of abdominal tip of Scoliidæ, Sphecidae and Vespidae (Hym. Aculeata). *Travaux du Museum d'Histoire Naturelle "Grigor Antipa" Bucar*, 12: 273-306.
- Iuga, V.G. 1973. Comparative morphology of the abdominal apex in Apoidea (Hym.). *Travaux du Museum d'Histoire Naturelle "Grigor Antipa" Bucar*, 13: 203-226.
- Jonathan, J.K. and Gupta, V.K. 1973. Ichneumonologia orientalis. Oriental insects Monograph No. 3. The Association for the study of Oriental insects C/O Department of Zoology, University of Delhi.
- Matsuda, R. 1976. Morphology and Evolution of the Insect abdomen. Pergamon Press, Oxford, 534 pp.
- Michener, C.D. 1944. Comparative external morphology, phylogeny and a classification of the bees (Hymenoptera). *Bulletin of American Museum of Natural History*, 82: 157-326.
- Pruthi, H.S. 1969. Textbook of Agricultural Entomology. Indian Council of Agricultural Research, New Delhi.
- Reeks, W.A. 1937. The morphology of the adult of *Diprion polytomum* (Hartig). *Canadian Entomologist, Orillia*, 69: 257-264.
- Rivard, I. 1955. Contribution to the morphology of the pine web-spinning sawfly *Cephalcia marginata* Middlekauff (Hymenoptera: Pamphiliidae). *Illinois Biological Monograph*, 87: 382-99.
- Ross, H.H. 1937. A generic classification of the Nearctic sawflies (Hymenoptera: Symphyta). *Illinois Biological Monograph*, 15: 1-173.
- Ross, H.S. 1948. A Textbook of Entomology, 1st Edition, Toppan Co. Ltd., Tokyo.
- Smith, E.L. 1970. Evolutionary morphology of the external insect genitalia 2. Hymenoptera. *Annals of Entomological Society of America*, 63: 1-27.
- Snodgrass, R.E. 1925. Anatomy and Physiology of Honey-bee. McGraw Hill Book Co., New York.
- Snodgrass, R.E. 1933. Morphology of the insect abdomen II. The genital ducts and the Ovipositor. *Smithsonian Miscellaneous Collections*, 89 (8): 148 pp.
- Snodgrass, R.E. 1935. Principles of Insect Morphology. McGraw Hill Book Co. New York.
- Tait, N.N. 1962. The anatomy of the sawfly *Perga affinis affinis* Kirby (Hymenoptera: Symphyta). *Australian Journal of Zoology*, 10: 652-683.
- Wong, H.R. 1963. The External morphology of the adult and ultimate larval instar of the Larch sawfly, *Pristiphora erichsonii* (Htg.) (Hymenoptera: Tenthredinidae). *Canadian Entomologist, Orillia*, 95: 897-921.