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TERGO-STERNAL MUSCLES IN THE THYSANOPTERA.

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In 1909, in describing *Urothrips paradoxus* as a new type of thysanopterous insect for which he erected the new family Urothripidae, Richard S. Bagnall stated that it possessed eleven pairs of stigmata—one on the mesothorax, one on the metathorax, and one on each of the first nine abdominal segments.¹ The insect belonged, however, to the suborder Tubulifera, which had always been considered specialized rather than primitive; and this startling disposition of the spiracles, somewhat suggesting that found in *Japyx* of the primitive order Thysanura, made it necessary to place the Tubulifera first in the thysanopterous series instead of last, and to derive the other suborder—the Terebrantia—from tubuliferous or proto-tubuliferous ancestors. The solution of the several phylogenetic problems entailed by this transposition seemed to be the erection of a third suborder, the Polystigmata. This name was later (Bagnall, '30) replaced by Pseudostigmata, which is hence an outright synonym of the former.

Four years after Bagnall's paper appeared, the late Dr. Philip Trybom described two new species of Urothripidae from Natal and at the same time had before him for study additional specimens of Bagnall's *Urothrips paradoxus*. He says of the seven supernumerary "stigmata," ". . . it seems to me very doubtful

¹ In making this count, Mr. Bagnall overlooked two pairs of true stigmata—those found on the first and eighth abdominal segments in all Thysanoptera. Had he seen these, his total would have been thirteen pairs, and segments one and eight of the abdomen would have had two pairs each.

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that these structures are really stigmata. I have been unable to recognize in these structures any pustules (Jordan) and, if I do not err, they are not situated in the surface of the integument. They are to be seen at least as well on the ventral surface of the body as on the dorsal." (Translation from Trybom, '12, p. 35.)

What these structures really are has never been answered. To the taxonomist they are still organs of unknown function. Dr. C. B. Williams, now entomologist of the Rothamsted Experimental Station, at the time of his visits to America in 1915 and 1919 was much interested in determining their nature; and a hasty survey of the Thysanoptera made at the time by him and Hood showed their presence in all species examined, and that they were not, by any means, structures peculiar to the urothripids.²

The authors of this paper began in the fall of 1930 a study of the anatomy and histology of *Hoplothrips major* Hood, partly for the purpose of determining the nature of the organs in question and partly for answers to certain other questions. The abundance in which *H. major* occurs in the vicinity of Rochester, its availability in all stages every day of the year, and its large size, were the factors which determined its selection. *Trichothrips angusticeps* Hood and *Megalothrips spinosus* Hood were also dissected, simply because their abundance brought them to hand in getting new supplies of *H. major*.

After a number of gross dissections had been made, material was killed and fixed in a variety of the standard solutions, and then washed, dehydrated, cleared in xylol, imbedded in paraffin, sectioned, stained, and mounted. Bouin's solution seemed to be more satisfactory for killing and fixing than any other; and in staining, the highly satisfactory results obtained in this work with Delafield's hæmatoxylin were hardly surpassed by the numerous special and more difficult stains which were also employed. Living specimens were perforated before being placed in the killing solution. Little difficulty was experienced in sectioning when the paraffin blocks were oriented so that the microtome knife passed through the softer and less brittle ventral surface first. The harder integument of the notum, however, was frequently broken by the knife. This difficulty could no doubt have been lessened

² If I remember correctly, either Williams or myself suggested that these might be muscles. [J. D. H.]

to some degree by using teneral specimens whose integuments would still be soft.

It was noted at once that the paired abdominal structures in question were vertical or dorso-ventral muscles; and they were readily identified as the tergo-sternal muscles—found in most, if not all, insects. At their upper or dorsal ends they are attached to the notum or tergite and at their lower or ventral ends to the sternite of every abdominal segment from the first to the eighth or ninth. The attachment is just laterad of the outermost of the longitudinal tergal and longitudinal sternal muscles (see Plates I–III).

Jordan ('88), Uzel ('95), and Hinds ('02) make little or no mention of muscles, and apparently did not observe the tergo-sternals. Buffa ('98) calls them the "*costrittori dell' addome*," and on Plate VI, fig. 9, h, pictures those pertaining to the first two abdominal segments of *Heliothrips hæmorrhoidalis*. Priesner ('26) calls them the "*M. transversales abdominis*," but does not identify them with the structures observed by Bagnall.

Tergo-sternal muscles in insects are expiratory in function, serving to draw the tergum and sternum together, thus compressing the tracheæ and forcing the deviated air out through the spiracles. They are illustrated and described in most text-books of entomology, including those of Imms ('24) and Folsom ('22).

Representatives of all the superfamilies of Thysanoptera and of nearly every one of the so-called families have been examined in balsam mounts, and the tergo-sternal muscles invariably found in more than five hundred species.

The erection of the Suborder Polystigmata (Bagnall, '12), later replaced by Pseudostigmata (Bagnall, '30), for a certain few species of thrips in which these muscles are perhaps a bit more conspicuous than usual, cannot be justified on the strength of this character alone. The validity of the Polystigmata must be determined on the other differences shown. The subject was discussed by Hood ('30), and it was pointed out at the time that the only important difference between the Polystigmata and the Tubulifera is the distance between the coxæ of the hind pair, this distance being greater than that separating each of the others—certainly a character of less than subordinal value.

Since the publication of that paper, it has been possible to examine the maxillary palpi of *Amphibolothrips*. They are two-segmented, as in all other Tubulifera examined. *Urothrips*,

Bradythrips, *Trachythrips*, *Stephanothrips*, and *Amphibolothrips*—all of the known urothripid genera, save *Bebelothrips* only which we do not know—have, then, *two*-segmented maxillary palpi, not one-segmented as frequently stated by Bagnall.

Accordingly, we place the Suborders Polystigmata and Pseudostigmata as synonyms of the Suborder Tubulifera. The synonymy is as follows:

Suborder *Tubulifera* Haliday.

1836. *Tubulifera* Haliday, Ent. Mag., 3: 441.
 1912. *Polystigmata* Bagnall, Ann. & Mag. Nat. Hist., Ser. 8, 10: 220.
 1930. *Pseudostigmata* Bagnall, Ann. & Mag. Nat. Hist., Ser. 10, 5: 572.

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EXPLANATION OF PLATE I.

Hoplothrips major Hood, adult female, horizontal section of abdomen in segments 3 and 4. Photomicrograph of section 25-A6-1 (4 μ), killed and fixed in Bouin's Solution (3-3-1/2 hrs.), stained with Delafield's hæmatoxylin; $\times 115$.

Æ.....Ænocytes.

Nu.....Nucleus of ænocyte cell.

Tr.....Trachea.

I.M.....Intersegmental membrane (conjunctiva).

T.-S.....Tergo-sternal muscle.

F.B.....Fat body.

P.C.....Primary cuticula ("epidermis," auct.).

S.C.....Secondary cuticula.

Ep.....Epidermis ("hypodermis," auct.).

EXPLANATION OF PLATE II.

Hoplothrips major Hood, adult female, sagittal section of abdomen in segments 4 and 3. Photomicrograph of section 23-d-1 (4 μ), killed and fixed in Picro-sulphuric Acid, stained with Delafield's hæmatoxylin; $\times 115$.

F.B.....Fat body.

Æ.....Ænocytes.

Nu.....Nucleus of ænocyte.

- T.-S.....Tergo-sternal muscles.
Tr.....Trachea.
Ep.....Epidermis ("hypodermis," auct.).
S.C.....Secondary cuticula.
P.C.....Primary cuticula ("epidermis," auct.).

EXPLANATION OF PLATE III.

Hoplothrips major Hood, adult female, transverse section through abdomen. Photomicrograph of section 25-A10-2 (4 μ), killed and fixed in Bouin's Solution (3-3-1/2 hrs.), stained with Ehrlich's "Triacid" Mixture; $\times 115$.

- Pi.....Pigment (crystals) in fat body.
L.T.....Longitudinal tergal muscles.
F.B.....Fat body.
Nu.....Nuclei in cells of fat body.
Tr.....Tracheæ.
T.-S.....Tergo-sternal muscles.
Hæ.....Hæmocœle.
F.E.....Follicular epithelium of ovariole.
Oö.....Oöcyte.
L.S.....Longitudinal sternal muscles.



Hood, J. Douglas and Hook, Sabra J. 1932. "Tergo-sternal muscles in the Thysanoptera." *Bulletin of the Brooklyn Entomological Society* 27, 1-6.

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