

Female Reproductive System of Megathripine  
Species, *Bactridothrips brevitubus*  
(Thysanoptera : Insecta)\*

by  
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**INTRODUCTION**

It seems that the most species of the subfamily Idolothripinae (=Megathripinae) and certain species of the subfamily Phlaeothripinae have both forms of reproduction, oviparity and ovoviviparity (BAGNALL, 1921 ; JOHN, 1923 ; HOOD, 1934, 1936, 1938, 1939 ; HATHAWAY, 1938 ; BOURNIER, 1957, 1966 ; VISWANATHAN and ANANTHAKRISHNAN, 1973 ; HAGA, 1974).

In the largest thrips of Japan main land, *Bactridothrips spp.*, it can be observed that one female oviposits just fertilised eggs, and sometimes retains them in her lateral oviducts until just before hatching. BOURNIER (1957) studied the European large thrips, *Caudothrips buffai*, and concludes that the ovoviviparity of the species is only the retention of developing eggs in oviducts. He (1962, 1966) also detailed certain parts of the female internal reproductive system of the species, but the relations of the structure to the mechanism of the egg retention or to the switching the two ways are still not cleared.

On the other hand, it is well known that the Thysanoptera has an anomalous type of metamorphosis in which two larval stages are followed by three pupal stages before the adult is finally reached (HAGA, 1974, etc.). In spite of the great general interest of these peculiar life-cycle, the anatomical and histological knowledge of the adult reproductive system and its postembryonic development is rather insufficient (JORDAN, 1888 ; UZEL, 1895 ; BUFFA, 1898, 1907 ; MÜLLER, 1928 ; SHARGA, 1933 ; MELIS, 1935 ; PESSON, 1951 ; DAVIES, 1966 ; HEMING, 1970 ; HAGA, 1974).

The present work, however, deals with gross anatomy and histology of the female reproductive system of the species, but does not deal with the relation of the ovoviviparity to the structure.

**MATERIALS AND METHODS**

*Bactridothrips brevitubus* TAKAHASHI, common within the warm-temperate zone of Japan, is used for either to dissect anatomically or to prepare histological sections.

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\* Contributions from the Sugadaira Biological Laboratory of Tokyo Kyoiku University, No. 32

The insects are reared in the laboratory throughout their life. Some other allied species of the genus *Bactridothrips* are compared with *brevitubus*.\*

The insects are anaesthetised or killed by ethylalcohol, and dissected in RINGER's solution under binocular stereo microscope. Some organs and tissues are mounted in water soluble mountant after dying by Phenol Thionine or Borax Carmin.

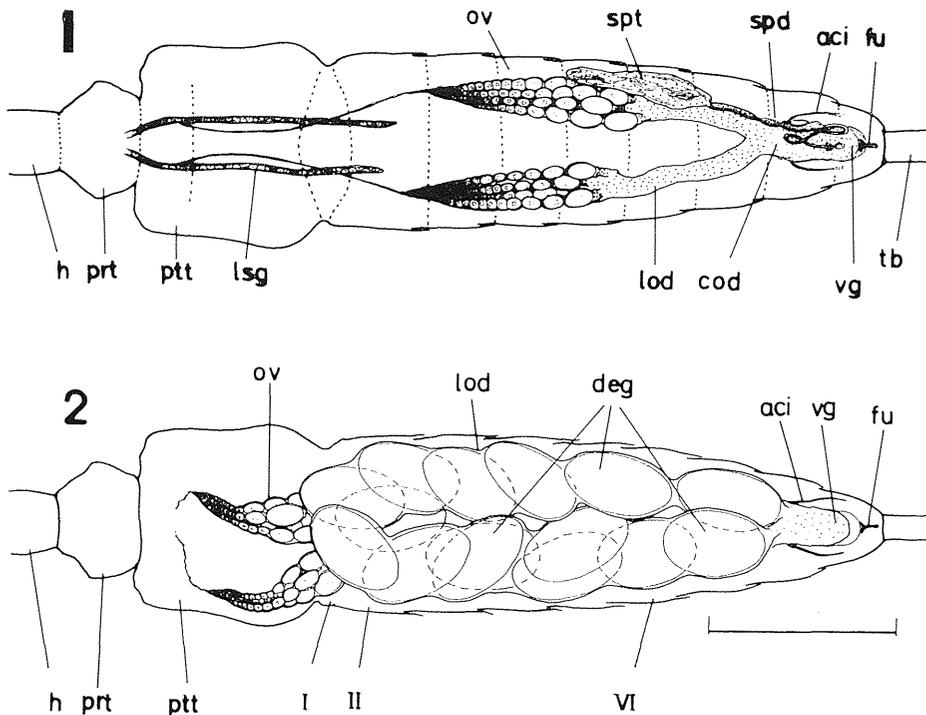
Stored specimens in 60% ethanol which were killed by A. G. A. fixative for taxonomic study are also used to observe sclerotised parts by dissection.

Histological samples are made by the paraffin section method in usual manner. The specimen are fixed by warm alcoholic BOUIN's fixative, cut in 7-10  $\mu\text{m}$  thickness, and stained with DELAELD's haematoxylin and eosin.

All drawings are made with ABBE's camera lucida.

### OBSERVATIONS

The female reproductive system of *Bactridothrips brevitubus* consists of two ovaries, two lateral oviducts, common oviduct, vagina, spermatheca, spermathecal duct, and genitalia. There are, however, neither accessory gland nor uterus, which are often



Figs. 1-2. Female reproductive system of *B. brevitubus*. — 1. Dorsal aspect of the system in oviparous female. — 2. Showing ovary position and developing embryos in lateral oviducts in ovoviviparous female. Scale: 1 mm.

\* The species profiles are shown in the advanced paper (HAGA, 1974).

described in other groups of the order Thysanoptera. This pattern is similar to that of *Caudothrips buffai* described by BOURNIER (1962).

**Ovary** The ovaries lie ventrolateral to the hind gut and lateral to the midgut in the abdominal segment II-V (Fig. 1). Each ovary consists of four panoistic ovarioles. within each ovariole there are 10-14 egg chambers, or ovarian follicles (Fig. 3). In general, insect ovarioles can be subdivided into five regions as indicated by MAHOWALD (1972). But, in Region II, above-mentioned four ovarioles are fused forming one coalescent germarium (Fig. 3). The germarium is tapered to the apex, and its epithelium smoothly elongates and forms a terminal filament, or Region I. In Region III, developing square shaped oocytes are oriented in a linear fashion, and surrounded by the thin rudimental follicular epithelium which has a few nuclei per oocyte. In Region IV follicular epithelium develops around the oocytes of which shapes become longer than wide and rounded off. The oocytes fully develop in Region V with well developed

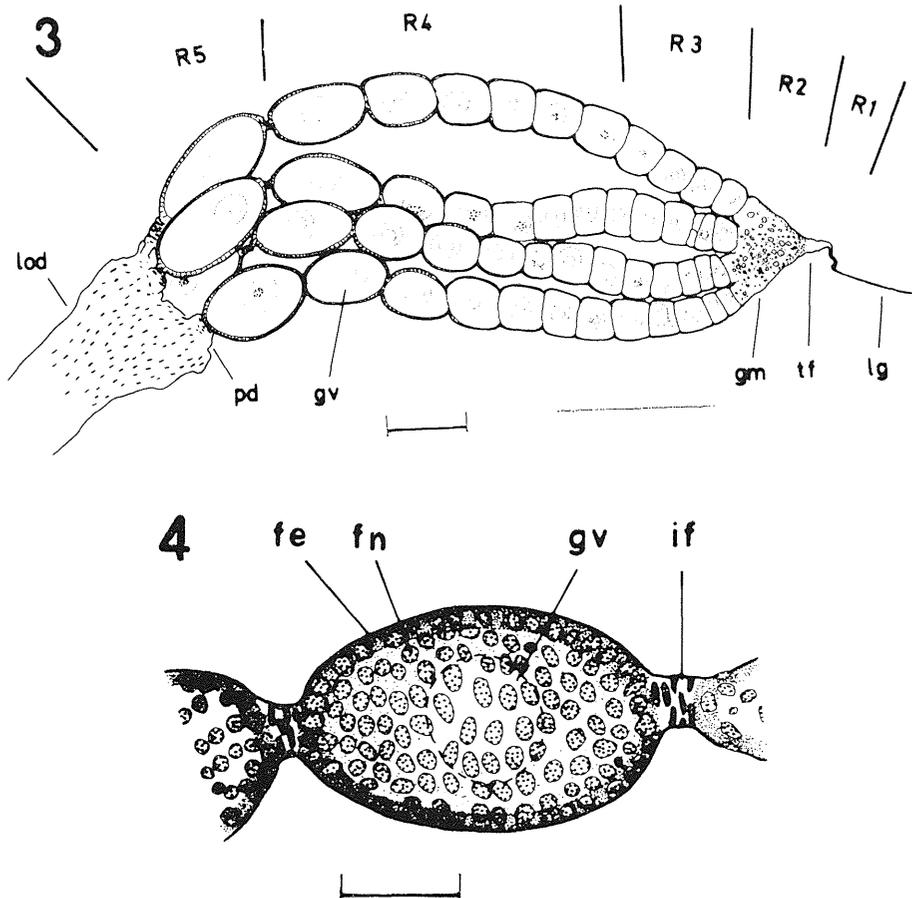


Fig. 3. Ovary of *B. brevitubus*, subdivided into five regions (R1-R5). Scale: 100  $\mu\text{m}$ .

Fig. 4. Ovarian follicles of *B. brevitubus*. Scale: 50  $\mu\text{m}$ .

follicular epithelium.

Interfollicle tissues (Fig. 4) are largely present between each two oocytes of Region V having several nuclei.

The ovary is subsequently succeeded to the lateral oviduct by the short pedicels (Fig. 3). The long, elastic ligament of the ovary is connected with the middle inner wall of the long salivary gland, nearly under the intermediate line between meso- and metanota (Fig. 1). In the ovipositing female the ovary situates in the abdominal segments II-V, but it is drawn up largely in the metathorax and abdominal segments I and II when the ovoviviparous female has many developing embryos in its lateral oviducts (Fig. 2).

**Oviducts and Vagina** The lateral oviducts are paired, long, elastic tubular ducts which connect anteriorly to the each four ovarioles and join posteriorly to a short common oviduct,

Their walls are thin, transparent, and multinucleate. In the young adult the lateral oviducts measure about 600  $\mu\text{m}$  long, 80  $\mu\text{m}$  wide. However, they are very expanded either width or length in the ovoviviparous females (Fig. 2), and there are occasionally more than twenty ova in the paired oviducts. They occupy, in this case, the greater part of the abdomen (HAGA, 1974).

These long lateral oviducts are characteristic contrasting with short ones of Phlaeothripine species, *Haplothrips distinguendus* and *Liothrips oleae* (SHARGA, 1933; MELIS, 1935).

The common oviduct is a short tube situated between the lateral oviduct junction and the vagina. It can often contain two or more eggs side by side in the ovoviviparous females.

The posterior chamber of the common oviduct is a vagina or genital chamber. It is supported by a pair of aciculae, operculum and fustis. The aciculae are a pair of slender endocuticle connected with the inside of the ninth sternite by a tendinous fibre, and their anterior end is a small plate adhering to the vaginal wall. There are numerous short rows of microtrichial patterns as same as illustrated by BOURNIER (1962) in *Caudothrips buffai* on the vaginal wall.

**Spermatheca** The spermatheca is a white elongate sac situated in mostly right dorsal side of the abdominal segments V-VI (Fig. 1). It is difficult to recognise its position in the virgin females because it is small and hyaline, but after copulation it appears conspicuously.

The cells composing of the wall of this organ contain a number of large nuclei with granular substances. So far as known in the suborder Tubulifera including *Bactridothrips spp.* any accessory glands are present in the female reproductive system, so that the glandulous structure of the spermatheca may be unique to activate and to give nutrition for spermatozoa.

There are densely bundled fibrous spermatozoan tail, convoluted or elongated. After copulation the length of the organ is about 70  $\mu\text{m}$ , and width is about 30  $\mu\text{m}$ .

**Spermathecal duct** *Bactridothrips spp.* or, presumably, most of Megathripine species

are characterised by having the long varied spermathecal duct (Fig. 5). This duct can be subdivided into five sections.

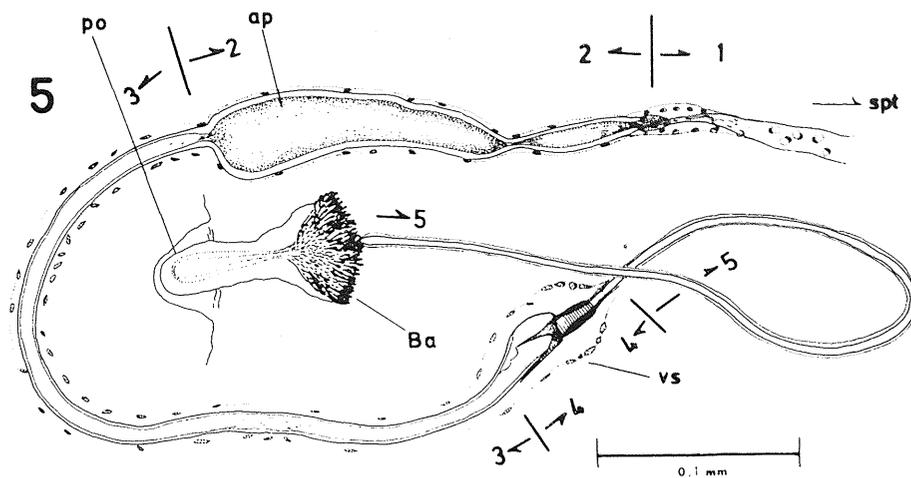


Fig. 5. Spermathecal duct of *B. brevitubus*, subdivided into five sections (1-5).

Scale: 100  $\mu$ m.

The first section of the duct is a membranous tube with the granular large nuclei same as those of the spermathecal wall. This section is so weak and fragile that it is easily broken in the course of dissection.

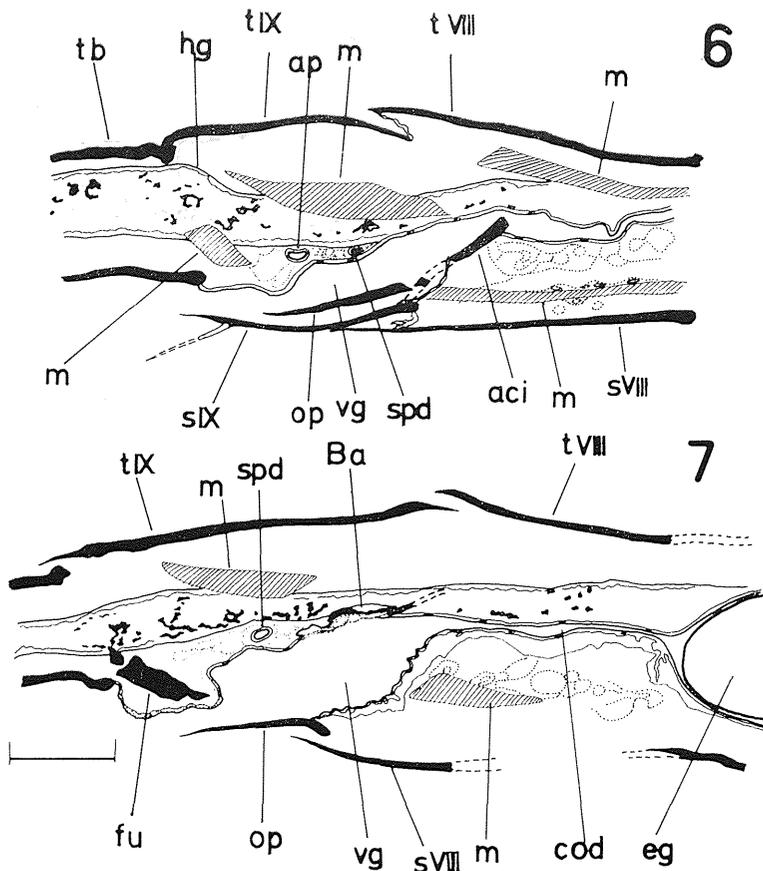
The second section is a elongate guitar-shaped ampoule with the hard wall. The anterior end of this part forms a bottleneck by the thickening of the wall. The ampoule has two chambers linked by a median constriction. There is no mechanical structure for contraction, and the function of the ampoule is still unknown.

The third section succeeds to the ampoule without a bottleneck structure. This part is a duct of uniform thickness, and surrounded by the multinuclear tissue which covers the ampoule and the following valvular structure. The wall of this part is made by the same thickness to the ampoule, but it is weaker than the fifth section duct.

The valvular structure (Figs. 9, 11) is situated between the third and the fifth sections, and connected these two long tubes. It has a swollen chamber surrounded with a thin, elastic membrane, two stout levers, and bulbous sacs. At the base of the lever the duct tube is heavily constricted,

The following duct is the fifth section. This part is very long, sometimes looped or curved in sigmoid shape, and ended on the dorsal wall of the vagina. This ending part is also characteristic, and recognised as a part of the genitalia. The duct of the fifth section has no tissue covering as regarded on the second to the fourth sections. The tube is made of hard sclerotised wall, and has fine transverse lines on the inside wall (Fig. 10).

**Genitalia** Under the definition of the term in wide sense including all of external and internal copulatory organs, the genitalia of this species group consist of the operculum,



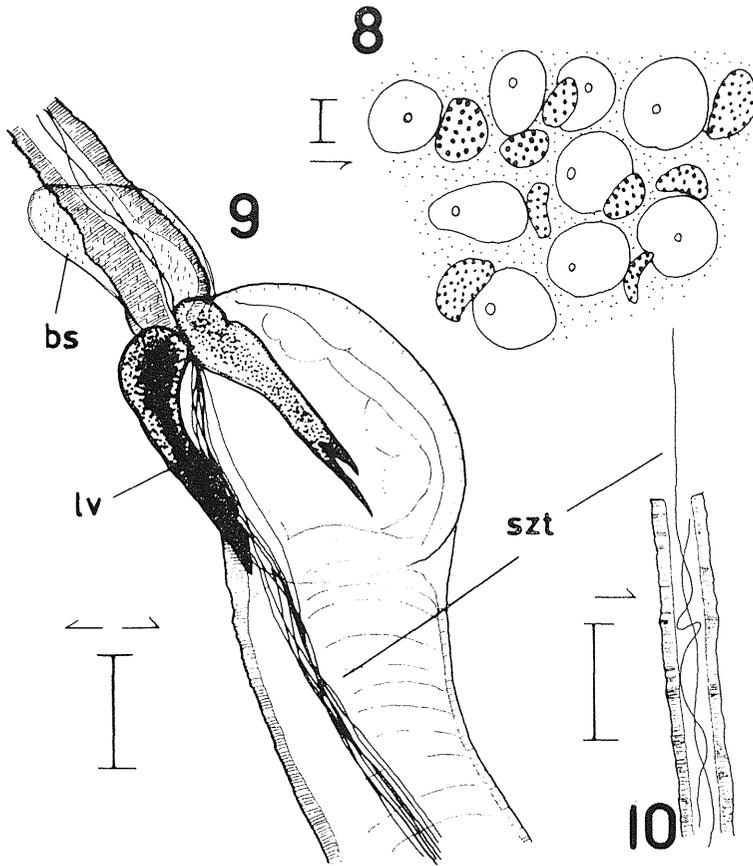
Figs. 6-7. Sagittal sections of genital region of *B. brevitubus*. — 6, Through right of midline. — 7. Through midline. Scale: 100  $\mu$ m.

fustis, aciculae, vagina, and Bournier apparatus.

The operculum is a median ventral plate of the genital opening situated inside of two separated sternites of the abdominal segment IX (Fig. 14). The fustis is one of the prominent features to recognise female insect of the suborder Tubulifera. It is a rod-type endoskeleton situated in the abdominal segment IX near ventral base of the tube, or abdominal segment X. Some genital muscles arise from its dilated head which shapes are variable intraspecifically (Figs. 13, 14).

The vagina is supported indirectly by the fustis whereas directly by the pair of aciculae and the operculum.

The Bournier apparatus, the author uses this term tentatively, is situated on the upper wall of the vagina at the opening of the spermathecal duct, and consists of a flower-like patterned cuticle, a pouch, and tiny teeth (Figs. 5, 12, 13). These structures are possible to hold male genitalia when they are inserted. The flower-patterned median culicle has an anterior round part and a posterior stalk-like slender part, which the



Figs. 8-10. Details of spermathecal duct. — 8. Wall of section 1, showing granular nuclei.  
 — 9. Valvular structure, or section 4. — 10. Duct of section 5, showing spermatozoan tails within. Scales: 10  $\mu$ m.

patterns are specifically characterised. The small pouch is situated behind the median cuticle, covered by a very thin membrane. The row of tiny teeth is furnished under the stalk, and the apices of the teeth are slightly hooked.

### DISCUSSION

The number of ovarioles per ovary is constantly four without exception in the order Thysanoptera, while many other orders have specific variations of the number. But the ovary types are variable in this order, and they are related with taxonomic group shown as follows: -

1. Each ovariole is independent apically, and has a terminal filamement .....  
 .....Suborder Terebrantia  
 Family Aeolothripidae

Family Thripidae

- . Apices of ovarioles are not independent. At least two apices fused and have a common terminal filament..... Suborder Tubulifera

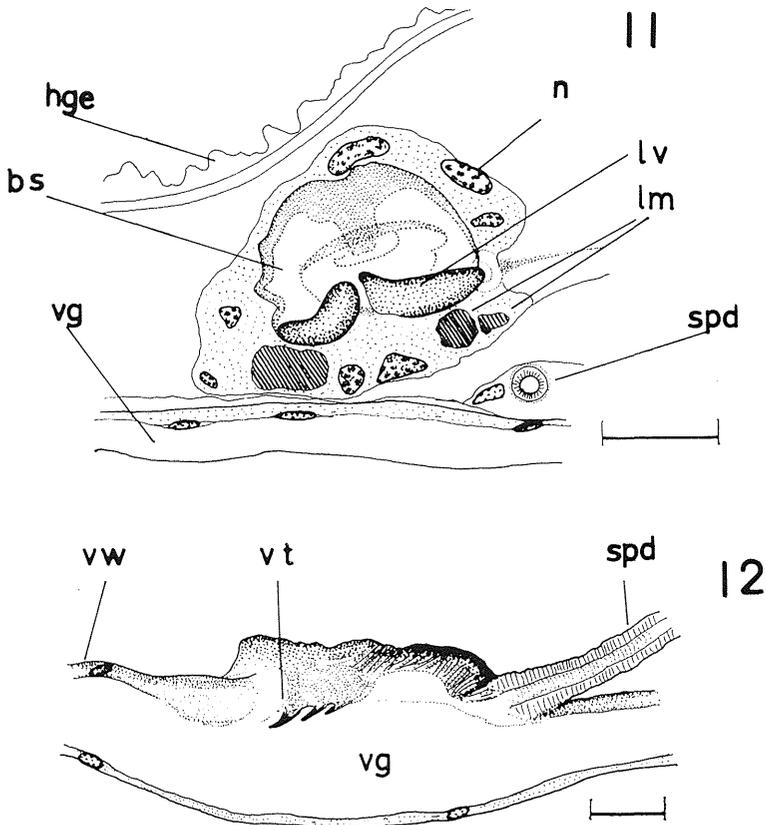
Family Phlaeothripidae...2.

2. Each ovariole has a germarial region whether it fused or not..... Subfamily Phlaeothripinae

- . Apices of each four ovarioles coalesce completely, and form a common germarium... Subfamily Idolothripinae

(Families Merothripidae, Heterothripidae, Uzelothripidae, and subfamily Urothripinae are not yet studied.)

The postembryonic development of ovaries in these two suborders are studied by HEMING (1970). The ovary rudiment divides into four ovarioles in early pupal stage in both species, Terebrantian *Frankliniella fusca* and Phlaeothripine *Haplothrips vervasci*. It seems the above-mentioned variations of the ovary type are caused only by the rudiment division, complete or not. But there is a certain biological significance of the ovary type among the phylogenetic groups.



Figs. 11-12. *B. sp. II.* — 11. Cross section of the valvular structure through bases of two levers. — 12. Sagittal section of Bournier apparatus through middle. Scale : 10  $\mu$ m.

It also differs between two suborders where the ligament attached to. In the suborder Terebrantia ovarian ligaments are connected with distal portion of the short salivary glands in the suborder Tubulifera including only a family Phlaeothripidae. Presumably the fact observed in *Bactridothrips spp.* is a common manner in the subfamily Idolothripinae that the ligament is connected with the median portion of the long pair of salivary glands, not with the apex of it as observed in the subfamily Phlaeothripidae (SHARGA, 1933; MELIS, 1935).

It is thought that the ligament attaching position is gradually moved forwards on the long salivary gland in accordance with the evolution of the ovoviviparity.

On the spermathecal duct, the same structure to *Caudothrips buffai* described by BOURNIER (1962) is observed in *Bactridothrips spp.* The author accepts BOURNIER's assumption on the function of their structure as the pump system for sperm transfer, however, the knowledge on the musculature and fine structure of the duct and genitalia is so insufficient that BOURNIER's questions are still remained.

The structure of the duct end on the vaginal dorsal wall of *Bactridothrips spp.* is distinct from that of *Caudothrips buffai*. It seems that this corpus has functions not only as a funnel to accept sperm-bundles to the spermatheca, or an outlet of spermatozoa from the spermatheca but also to guide the apex of male genitalia to the funnel and to hold it in precise position for the delivery of the sperm-bundles. The structure of this

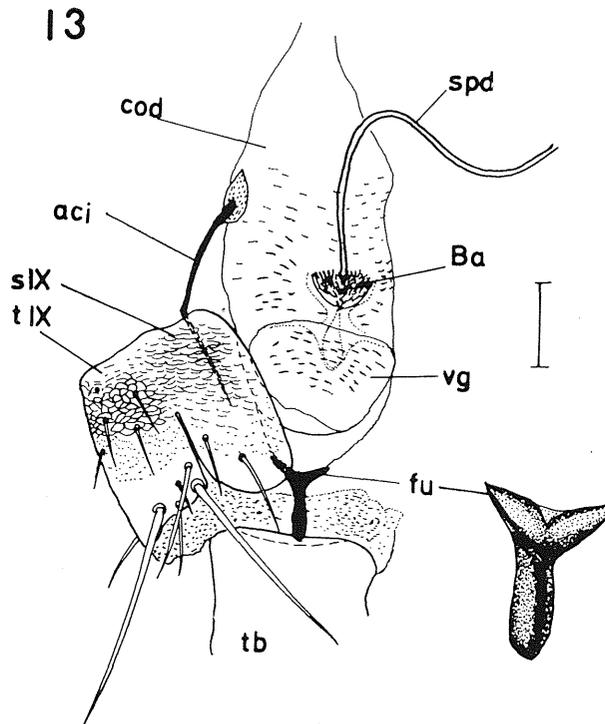


Fig. 13. Ventral aspect of genital region of *B. brevitubus*. Scale: 200  $\mu\text{m}$ .

part is complicate and has a specific distinction. The author uses the new term for the above-mentioned part "*Bournier apparatus*" which is useful to classify species taxonomically. However, in the total mount specimens, it is difficult to observe this structure

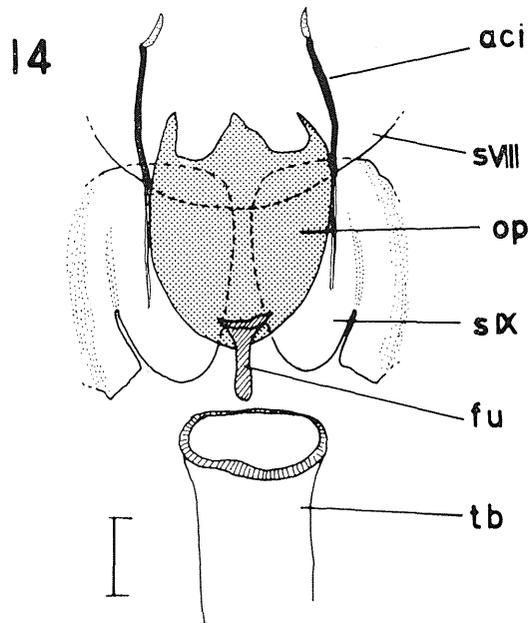


Fig. 14. Cuticles of genital region (dorsal view). Scale: 200  $\mu$ m.

in even well decoloured specimens.

Taxonomic utility is also recognised in the shape of the operculum. HEMING (1970) called this part "ovipositor", but it seem that the part is used to support the male genitalia at copulation. The operculum is a heart-shaped plate hinged to the eighth abdominal sternite of which posterior margin develops in a thin expansion forming the genital opening with membranous sternites of the segment IX. To observe the operculum, it is necessary to disconnect it from the body.

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#### SUMMARY

The female reproductive system of *Bactridothrips brevitubus* is described anatomically. The basic structures are as same as those of *Caudothrips buffai* described by BOURNIER (1962).

Each ovary has one coalescent germarium, panoistic four ovarioles and a terminal filament, and is connected to the median portion of long paired salivary glands by a long, elastic ligament. A pair of lateral oviducts are fully expanded containing many eggs in ovoviviparous females. Spermatheca has a glandular epithelium. Spermathecal duct is subdivided into five sections, containing ampoule and a valvular structure known as "pompe spermatique".

Bournier apparatus, newly termed, is present on dorsal wall of vagina, consisting median cuticle, stalk, pouch, and teeth. It has functions to hold the male genitalia, and accept sperm-bundles and as an outlet of the spermathecal duct.

Bournier apparatus and operculum are both have taxonomic utility to classify species.

#### ABBREVIATIONS

aci	aciculae	m	muscle
ap	ampoule	n	nucleus
Ba	Bournier apparatus	op	operculum
cod	common oviduct	ov	ovary
deg	developing egg	pd	pedicel
eg	egg	po	pouch
fe	follicular epithelium	prt	prothorax
fn	follicular nucleus	ptt	pterothorax
fu	fustis	s	sternite
gm	germarium	spd	spermathecal duct
gv	germinal vesicle	spt	spermatheca
h	head	szt	spermatozoan tail
hg	hind gut	t	tergite
hge	hind gut epithelium	tf	terminal filament
if	interfollicle tissue	vg	vagina
lg	ligament	vs	valvular structure
lm	lever muscle	vt	vaginal tooth
lod	lateral oviduct	vw	vaginal wall
lsg	long pair of salivary glands		
lv	lever		

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