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THE TERMINAL ABDOMINAL SEGMENTS OF
FEMALE TIPULIDÆ.

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(PLATES X AND XI.)

In a paper not yet published * the writer has described and figured the terminal parts of the male abdomen for a large number of Tipulid species. The present paper is complementary to this one for the same species have been used in studying the female abdomen. The specimens were identified by Mr. R. W. Doane and belong to the zoölogical department of the Washington Agricultural College.

Tipula angustipennis Loew. (Pl. X, Figs. 2, 5, 7, 8, 9 and 10.)

This species will be described first as an example of the entire family.

The abdomen (Fig. 10) is long and slender, slightly swollen at the fourth and fifth segments. Posteriorly it terminates in a slender tapering point when the apical parts are appressed. There are ten abdominal segments. The first seven have the ordinary cylindrical shape. The eighth, ninth and tenth are the ones that present the genital modifications.

The eighth tergum (Figs. 5, 7, 9 and 10, *VIII t*) is only about a third of the length of the seventh tergum. It is otherwise unmodified. The eighth sternum (*VIII s*) on the other hand, is greatly elongate, reaching far beyond its tergum. It is strongly convex ventrally and projects posteriorly beneath the ninth and tenth segments. On the posterior half it presents a long median triangular membra-

* The Hypopygium of the Tipulidæ (MS.), Proc. Davenport Acad. Sci.

nous area. Two long, slender, blade-like processes (Figs. 5, 7, 9 and 10, *a*) arise from its posterior end and project backwards. They are almost as long as the sternum itself and are set on edge side by side. The space between the dorsal surface of the eighth sternum and the ventral surfaces of the ninth and tenth segments is the genital chamber. Arising from the floor of this chamber, *i. e.*, from the dorsal surface of the projecting part of the eighth sternum, is a small darkly chitinized plate (Fig. 8) ending posteriorly in two free diverging prongs. This plate may be the fused and rudimentary anterior gonapophyses.

The ninth segment (Figs. 5, 7, 9 and 10, IX) is very small. Its tergum consists of a narrow transverse band of chitin back of the eighth tergum. The ventral part of the ninth segment is entirely hidden above the eighth sternum. It is membranous and is continuous with the membranous ventral surface of the tenth segment. The two together form the roof of the genital chamber. In this membrane are two chitinous rods that arise close to the lower ends of the ninth tergum (Fig. 2) and converge posteriorly where they unite in a chitinous plate ending in two free prongs on the under side of the tenth segment. The two free processes are apparently the rudimentary second gonapophyses. The plate and converging arms may be regarded as the ninth sternum.

The tenth segment (Figs. 5, 7, 9 and 10, X) is relatively large. Its dorsum is convex and presents a number of transverse wrinkle-like grooves. Its basal part is widest, the median part somewhat contracted, and the terminal part is slightly expanded again into a triangular suranal plate. The membranous ventral part is slightly concave. It terminates in two rounded podical plates. On each side a long, rigid, tapering, chitinous cercus (Figs. 5, 7, 9 and 10, *cer.*) arises between the suranal and podical plates.

Tipula bella Loew. (Pl. X, Fig. 6.)

Externally this species scarcely differs from *T. angustipennis*. The lower ends of the ninth tergum are wider (Fig. 6, IX *t.*). The ninth sternum consists of two triangular plates, each with a long tapering angle projecting posteriorly and inwardly (Fig. 6, gon. 2). The first gonapophyses are slenderer than in the last species, and the podical plates are shorter.

Tipula retusa Doane. (Pl. X, Fig. 3.)

This species differs from *T. angustipennis* chiefly in the shape of the cerci (*cer.*). Instead of being long and tapering they are shorter and expanded terminally where they bear four small points. At the base of each is a sharp point on the tenth tergum. The appendages (*a*) of the eighth sternum are slightly curved upward. The ninth sternum is a slender V-shaped bar with the apex drawn out posteriorly into a sharp point. The first gonapophyses are represented by two small triangular plates on the floor of the genital chamber with a slender rod between them. Neither the plates nor the rod project from the chamber wall.

Tipula uncinata Doane. (Pl. X, Fig. 4.)

Externally the abdomen of this species is almost identically the same as that of *T. bella*. The ninth sternum is considerably different, however, as is shown in Fig. 4. It consists of two lateral, curved bars with a slender, tapering plate between their tips.

Tipula acuta Doane. (Pl. XI, Fig. 13.)

Externally very similar to *T. angustipennis*, differing only in the slightly longer tenth segment and shorter cerci. The ninth sternum (Fig. 13) is a very slender V-shaped rod with the apex drawn out posteriorly into a long parallel-sided point. On the floor of the genital chamber is imbedded a small chitinous rod.

Tipula carinata Doane. (Pl. XI, Fig. 11.)

Eighth sternum rather large and swollen, making the end of the abdomen subterminally enlarged. Tenth segment shorter than in the other species described. Cerci long, blade-like, slightly constricted at the middle, tapering distally. Ninth sternum similar to that of *T. uncinata* but the median semi-chitinous point much larger.

Tipula sulphurea Doane.

Externally very similar to *T. angustipennis*, the principal difference being in the shorter eighth segment and in the wider ninth tergum. The eighth tergum is even a little shorter than the ninth. Tenth tergum lacks the transverse wrinkles. Ninth sternum a simple narrow U-shaped bar with the closed end posterior and produced into a short slender bar.

Tipula dorsolineata Doane.

Externally almost identical with *T. angustipennis*. The tenth tergum, however, has no transverse wrinkles, and the ninth sternum is

U-shaped with a Y-shaped bar between the arrow, having the forked part posterior.

These forms described are typical of the genus *Tipula*. The following species are all very similar to *T. angustipennis*: *T. bisetosa* Doane, *T. æqualis* Doane, *T. caloptera* Loew, *T. lamellata* Doane, *T. flavicollis* Fab., *T. tephrocephala* Loew, *T. cinerea* Coq., *T. trivitta* Doane, *T. fallax* Loew, *T. brevicollis*, *T. incisa* Doane, *T. impudica* Doane, *T. truncorum* Meig., *T. cognata* Doane, *T. spernax* O. S., *T. cuspidata*, *T. inermis* Doane.

Tipula bicornis. (Pl. X, Fig. 1, and Pl. XI, Fig. 16.)

This species and the next described depart from the general form for the genus more than do any others examined. In *T. bicornis* the eighth sternum is unusually large and prolonged posteriorly as far as the lips of the very short cerci. It bears at the end two very short, vertical, apical lobes (Fig. 1 a). The tenth segment is very short, the cerci (*cer.*) are small and spatulate. The ninth sternum consists of a bilobed plate having the form shown in Fig. 16.

Tipula streptocera Doane. (Pl. XI, Fig. 19.)

Of the same type as the last, but the ninth tergum is shorter and is deeply notched above on the posterior margin. Both eighth tergum and sternum large, apical appendages of the latter small. Ninth sternum (Fig. 19) consists of two leaf-shaped plates, each produced posteriorly and inward as a long stem-like process, the two stems fusing into a median point. Tenth segment consists of a narrow transverse band expanded triangularly on dorsum. Cerci are short, vertical, semicircular plates.

No other species in the collection were found of the *bicornis* and *streptocera* type. The males of these species present the same type of structure in the form of the hypopygium but they differ greatly in degree of development of certain parts. For example, in each a process projects backward from the "pleural" plates, but in *T. bicornis* they are short and inconspicuous, while in *T. streptocera* they form a pair of long rod-like arms projecting posteriorly and upward.

All the lower genera show the same plan of structure as does *Tipula*. Their species differ in various minor ways from the species of this genus, but there are no generic and super-generic variations in the female genitalia as there are in the male hypopygia.

Dicranomyia venusta Berg. (Pl. XI, Figs. 12 and 14.)

Very similar to *Tipula*. The eighth tergum is narrow above, widened on the sides (Fig. 14, VIII t). The eighth sternum is prolonged posteriorly beneath the ninth and tenth, and terminates in two blade-like appendages (a). The ninth tergum is a narrow band back of the eighth. The ninth sternum (Fig. 12) is a curved transverse bar of chitin bearing a median bar projecting caudally. This supports a free membranous flap on the dorsal wall of the genital chamber. The tenth segment is comparatively long and supports two curved, tapering cerci.

Dicranomyia longipennis Schum.

In this species the appendages of the eighth sternum are longer than in the last, and the ninth sternum is a simple transverse bar of chitin. Otherwise the two species are alike.

Symplecta punctipennis O. S. (Pl. XI, Fig. 15.)

Very similar to *Dicranomyia*, differing in the proportionally larger and strongly up-curved cerci of the tenth segment.

Limnophila sciophila O. S. (Pl. XI, Fig. 17.)

Very similar to *Dicranomyia* and *Symplecta*. The eighth sternum short but its appendages (a) large. Cerci long, slender and curved. Ninth sternum is a sinuous transverse bar of chitin bearing a median rod projecting posteriorly as in *Dicranomyia venusta* and supporting a long triangular membranous flap (Fig. 17, gon. 2).

Antocha opalizans O. S.

Does not differ from the last.

Dicranoptycha scabrina.

Tenth segment rather elongate and the cerci spatulate in form.

Erioptera caloptera Say and **E. septentrionis** O. S.

Differ in no way from the foregoing genera. The cerci are curved upward.

Epiphragma forcipennis Say (Pl. XI, Fig. 18) and **Trimicra anomala** O. S.

In both of these forms the cerci are rather large and strongly bent upward.

Amalopsis constans Doane and **A. inconstans** O. S.

Very similar to *Epiphragma* and *Trimicra*.

Ptychoptera lenis O. S. (Pl. XI, Fig. 20.)

Considerably different from any others examined. The abdomen is club-shaped, enlarging posteriorly to the seventh segment. The eighth, ninth and tenth terga are consolidated and covered by the posterior margin of the seventh. The eighth sternum is short and thick and its appendages (*a*) are rudimentary. The cerci (*cer*), on the other hand, are extremely large plates widest near the middle, tapering to a point distally.

Ctenophora bimaculata, C. flaviolata, C. angustipennis.

Parts all of ordinary form. In *C. atrata* the tip of the abdomen and the cerci are greatly prolonged and tapering.

Pachyrrhina, spp.

Eight species were examined and none were found to depart from the ordinary type.

This study of the female abdomen shows that there is but one type of structure throughout the entire family, and that the generic and specific modifications of this type are but slight. The contrast between the males and the females in this respect is very striking. The modifications of the female parts are insignificant when compared with the enormous variety of hypopygial structure in the males. It is utterly impossible to point out any correlation between the variations of the corresponding parts in the two sexes. There consequently arises the interesting problem of explaining the modifications of the male genital parts by some other theory than that of adaptation to the female organs.

EXPLANATION OF THE PLATES.

a, appendages of eighth sternum; *cer*, cercus; *gon. 2*, second gonapophyses; *VIII t*, eighth tergum; *VIII s*, eighth sternum; *IX, X*, ninth and tenth terga.

PLATE X.

- FIG. 1. *Tipula bicornis*, lateral view of end of abdomen.
FIG. 2. *Tipula angustipennis*, second gonapophyses (*gon. 2*) and lower ends of ninth tergum (*IX t*).
FIG. 3. *Tipula retusa*, lateral view of end of abdomen.
FIG. 4. *Tipula uncinata*, ninth sternum.
FIG. 5. *Tipula angustipennis*, lateral view of end of abdomen.
FIG. 6. *Tipula bella*, ninth sternum and lower ends of tergum.
FIG. 7. *Tipula angustipennis*, ventral view of end of abdomen.
FIG. 8. *Tipula angustipennis*, fused first gonapophyses.
FIG. 9. *Tipula angustipennis*, dorsal view of end of abdomen.
FIG. 10. *Tipula angustipennis*, lateral view of entire abdomen.

PLATE XI.

- FIG. 11. *Tipula carinata*, lateral view of end of abdomen.
 FIG. 12. *Dicranomyia venusta*, ninth sternum and appendage.
 FIG. 13. *Tipula acuta*, ninth sternum.
 FIG. 14. *Dicranomyia venusta*, lateral view of end of abdomen.
 FIG. 15. *Symplecta punctipennis*, lateral view of end of abdomen.
 FIG. 16. *Tipula bicornis*, ninth sternum.
 FIG. 17. *Limnophila sciophila*, lateral view of end of abdomen.
 FIG. 18. *Epiphragma forcipennis*, lateral view of end of abdomen.
 FIG. 19. *Tipula streptocera*, ninth sternum.
 FIG. 20. *Ptychoptera lenis*, lateral view of end of abdomen.

NOTES ON THE INTERNAL ANATOMY OF PERANABRUS SCABRICOLLIS (THOM.).

BY ROBERT E. SNODGRASS.

(PLATES XII AND XIII.)

Peranabrus scabricollis (Thom.) is a large, thick-bodied, short-legged locustid inhabiting the central part of the State of Washington. The writer has already prepared an account of its interesting life-history to be published as a bulletin of the Washington Experiment Station under the name of the "Coulee Cricket."

The Alimentary Canal (Fig. 13) has the ordinary *Anabrus* form. The crop is large, extending back to the posterior edge of the thorax. The ventriculus and small intestine form a complete dorsal loop. The numerous, thread-like Malpighian tubules are grouped in six bunches. The gastric cæca (*gas. c.*) are two wide pouches embracing the posterior end of the crop.

The Salivary Glands (Fig. 4) are composed of groups of racemose glands in the ventral part of the thorax. The scattered groups (*s. gls.*) on each side are connected by ducts which finally form one main tube (*s. d.*). Into this opens the duct from the large sac-like reservoir (*s. r.*) of the same side. The final right and left ducts then unite in a median duct that opens at the base of the hypopharynx.

The Respiratory System is highly developed and all of the main tracheæ are large. The dorsal longitudinal trunks (Fig. 12, *d. l. tr.*) lie just at the edges of the diaphragm. Each is connected with the spiracle trunks of same side by two transverse tubes (Fig. 12, *t. tr.*). The anterior one of each pair is larger than the other.



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