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THE FURCULA IN THE COLLEMBOLA.

BY J. E. GUTHRIE.

The Collembola or "Spring-tails" comprise a very interesting order of wingless insects, usually associated with the order Thysanura, and frequently placed in that order.

These little insects are common under bark and stones and among loose debris, wherever they can find dark, moist hiding places. As they range from less than 1 to only about 4 millimeters in length, and are usually very agile, we seldom notice them when collecting unless we are looking especially for them.

In Iowa, the Collembola have been but little studied as yet. I have taken at Ames about 18 species representing 12 genera. The order, and, in fact, many of its species is of world-wide distribution.

The wingless condition of the Collembola is usually regarded as primitive, and thus these insects acquire an interest as throwing light, possibly, upon conditions which obtained among ancestral insects.

Imagine a wingless ancestor which had already become a hexapod, that is, had the three pairs of thoracic legs developed for ambulatory purposes as is the usual condition in the group today. Picture to yourself the segments of the abdomen of this insect as each possessing a pair of jointed, leg-like appendages, such as we may still find in more or less modified form in many aquatic larvae and in the adults of some of the species of Thysanura proper.

From such a primitive stock let us suppose the Collembola to have branched off.

The abdomen of the Collembola possesses six somites and it is upon the third and fourth of these that the appendages were found useful and were retained. The pair which remained upon the fourth somite has been specialized into a very efficient organ for leaping, variously known as the "furcula," "saltatory appendage," "spring," "spring-gabel," and "tail." The appendages upon the third somite have become an organ known as the "tenaculum" or "catch," accessory to the furcula.

This specialization of organs for springing is analogous to the super-development of legs for leaping in the fleas, flea beetles, crickets, etc.; only that in the Collembola organs having no other use are specially set apart for the purpose.

The furcula seems to be a pair of three-jointed appendages which have their basal segments joined together, side by side, to produce one median basal piece. This first segment which is usually more or less flattened and often shows characters indicating its double origin is called the manubrium. Figs. 1 and 2. From the distal end of the manubrium proceed two parallel or divergent pieces called the dentes, and each of these bears at its distal end a short segment called the mucrones or mucro. The mucrones usually bear one or more teeth of various forms and in various positions.

The history of the development of the furcula seems to have followed a law which might be stated thus: "A pair of similar organs which habitually work together and only in the same direction, tend to become united, beginning at their bases." Doubtless the development of the normal labium in the class Insecta from a second pair of maxillæ to a united organ will fall under this law.

In many of the Collembolans the furcula is apparently an appendage of the fifth somite, and has been so regarded by Sir John Lubbock and several other writers upon Collembola. It was held that in the Family Entomobryidæ, the appendages of the fifth somite were represented, and

that therefore the furcula in that family was not really homologous with that of the Poduridæ which bear the organ upon the fourth somite. I can not agree to this view. The furcula seems to me to belong to the fourth somite, and to be merely shunted backward in some cases to a position beneath the following segment. Its muscle attachments, I think, indicate its true position. In several genera of the Entomobryidæ the fourth somite has a tergum considerably longer and larger than that of any other somite of the body. Perhaps this great development is for muscle attachment as it is among these that the furcula reaches its maximum development.

The furcula is provided with flexor and extensor muscles, the latter being the stronger. As the furcula is usually carried with its ends pointing forward, these strong muscles are normally tense and ready always for a spring. To counteract this tension and to hold the furcula in position, the "catch" or "tenaculum" on the third somite is provided with two short, roughened blades which pass down between the bases of the dentes, close to the manubrium and then close up under them, turning outward to either side, thus holding the furcula up close to the body. The short leverage obtained by these blades enables their muscles to balance the more powerful furcula extensors. Fig. 6 and 7. The whole device is a simple one, yet so effective that in Achorntes boletivorus, a species common on decaying mushrooms, I have seen leaps of about fifty times the animal's own length; and this species has by no means a well developed furcula when compared with many other Collembolans.

It is interesting before going farther to compare with the Collembolan furcula, the condition and use of some of the abdominal appendages found in another form. One of the most active of Thysanura is the Machilis, a genus which I think has not yet been recorded from our State but which I have taken several times along the Mississippi river bluffs in Minnesota and Wisconsin. This insect has a 10-segmented abdomen, and eight of these somites beginning with the second, bear each a pair of small,

jointed appendages. The largest pair is the pair borne by the eighth somite and I think that these are usually carried directed downward like the furcula. This Machilis not only runs swiftly but leaps with great agility by means of this pair of appendages, possibly aided to some extent by the others.

The Collembolan furcula varies considerably throughout the different genera, and the shape of its terminal segments, the mucrones, afford excellent specific characters in many genera. See figs. 3, 4, and 5.

Some curious and beautiful adaptations have taken place to suit different modes of life. For instance, in the more active species living a rather free, roving life as the Smino-thuridæ and many of the Ento-Mobryidæ, we find the organ usually long, slender and very supple, reaching forward in some cases almost to the head. Fig. 8.

In some of the heavy bodied species among the Poduridæ, the organ is short and stout and far stiffer in proportion to its length. Fig 9. These are species which usually inhabit places more or less enclosed as spaces under bark, in worm holes, etc., where there is less room to use a longer spring. In Xenylla the spring is weak and apparently not much used while in Friesia it has almost disappeared by atrophy, I suppose. Fig. 10.

Some Collembola grouped together in the Family Aphoruridæ are without the furcula entirely, but they are generally found in situations where the springing power could rarely be exercised. As the gradations of atrophy in different genera and species are so complete, I have little doubt that their habits are responsible for the loss of the organ from disuse. Thus I would hold that their springless condition must not be looked upon as primitive and I therefore regard them as regressive rather than as ancestral members of the group.

I might mention one or two of the most remarkably modified furculas. Some of our species of Sminthurus live on the surface of ponds and have a fan-like furcula. Fig. 11. The manubrium is short, broad and flattened and the dentes diverge widely. On the outer and inner sides of

the dentes are borne rows of long, strong hairs or bristles which present an almost solid surface to strike the water. The mucrones are of very unusual form, being flat and spoon-shaped and with their ends turned in toward each other. In another unrelated genus we find a modification for the same purpose which differs somewhat. Fig. 12.

In this species, Podura aquatica Limie, the manubrium is extremely short and each dentes has an outward direction from its base to near its middle where there is a bend that appears almost a joint. Beyond this bend, the dentes turn inward again. The mucrones are flattened somewhat as in the Sminthurus just mentioned.

PLATE II.

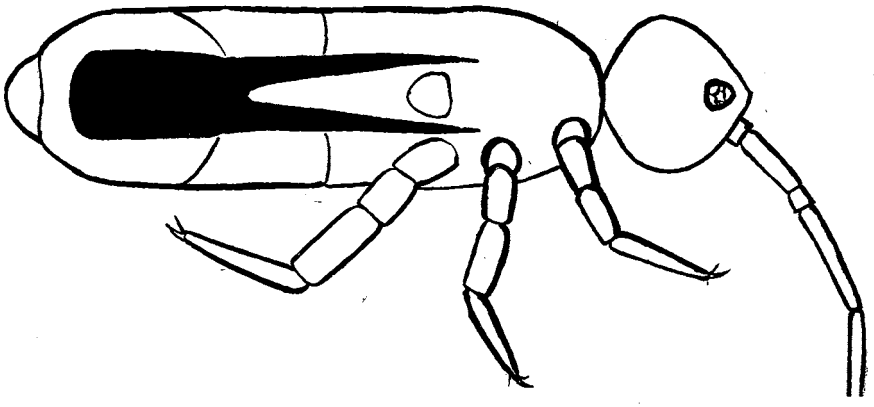


Fig. 1.

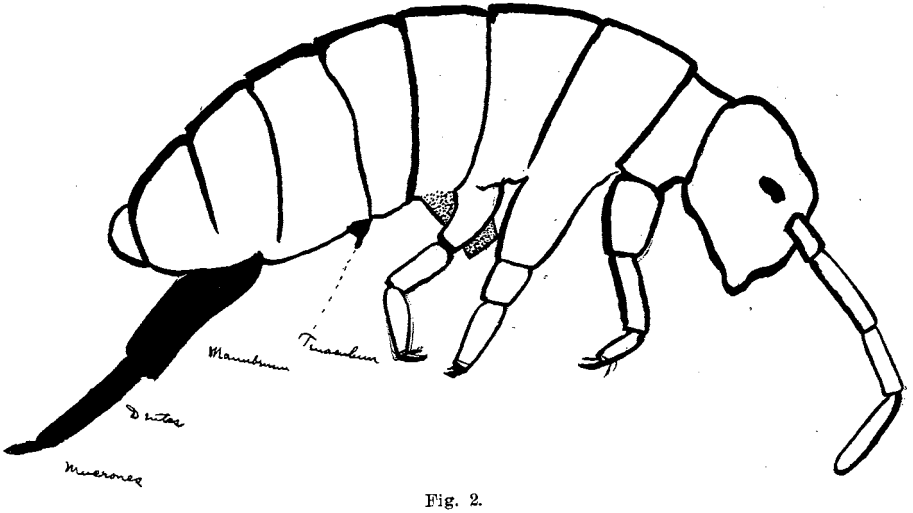


Fig. 2.

PLATE III.

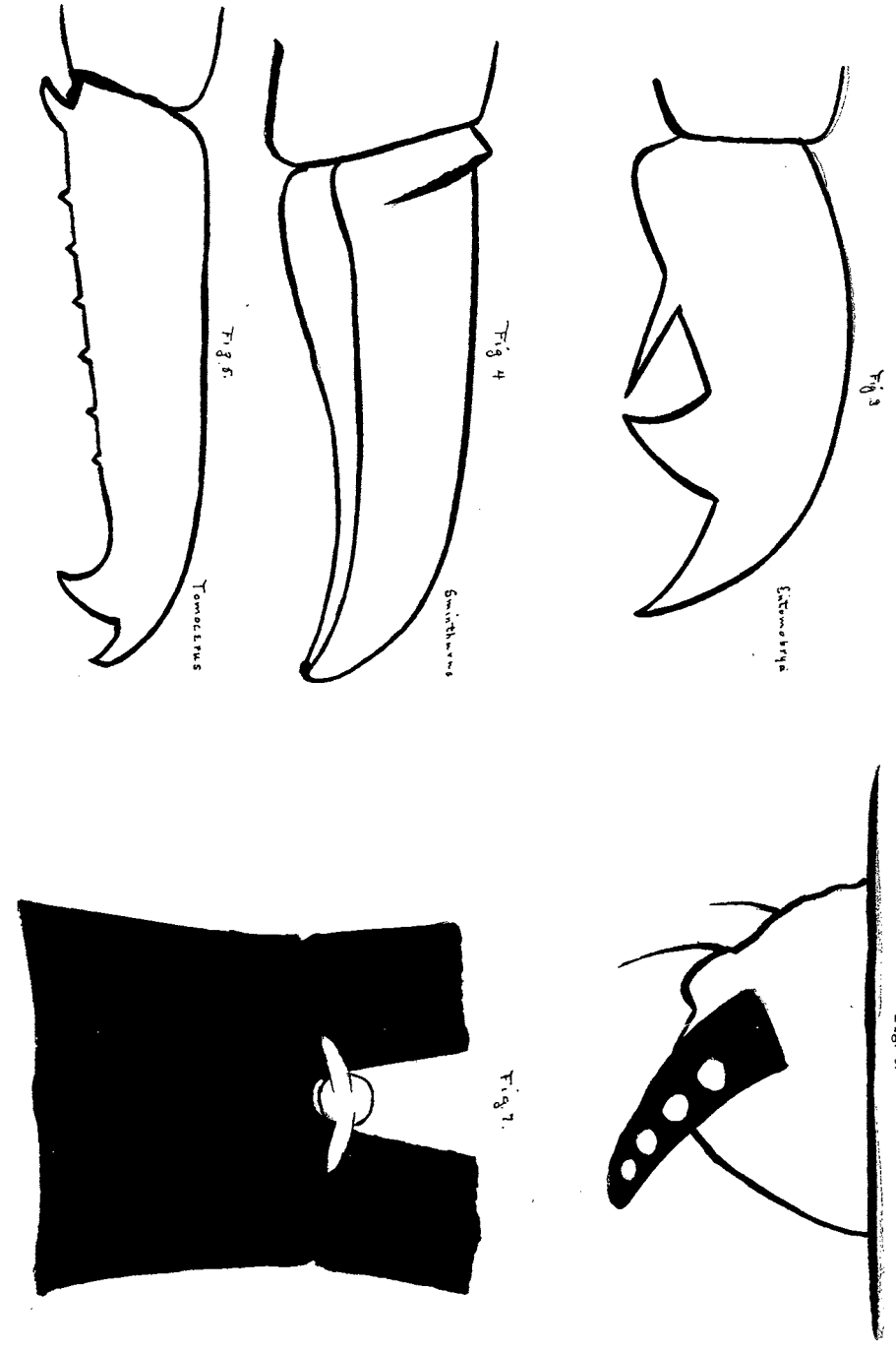
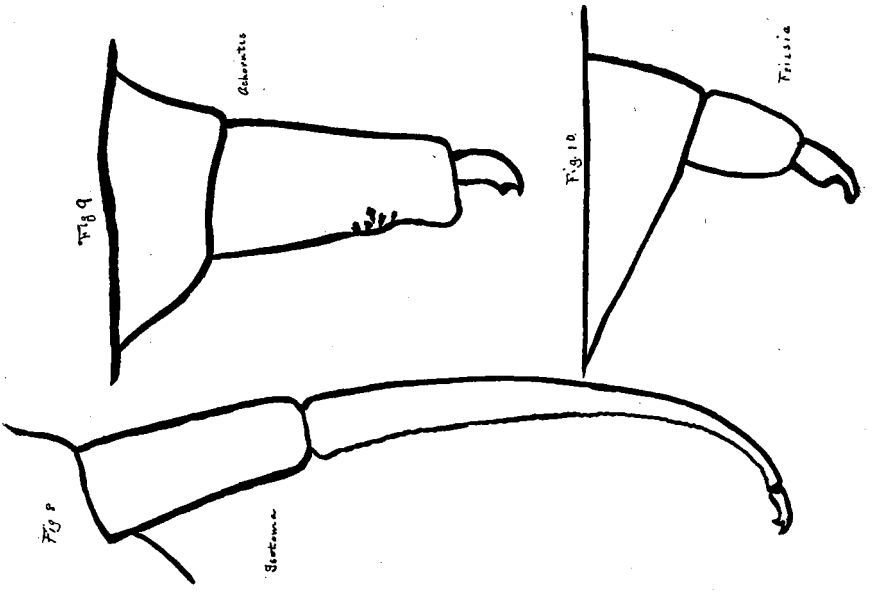


PLATE IV.



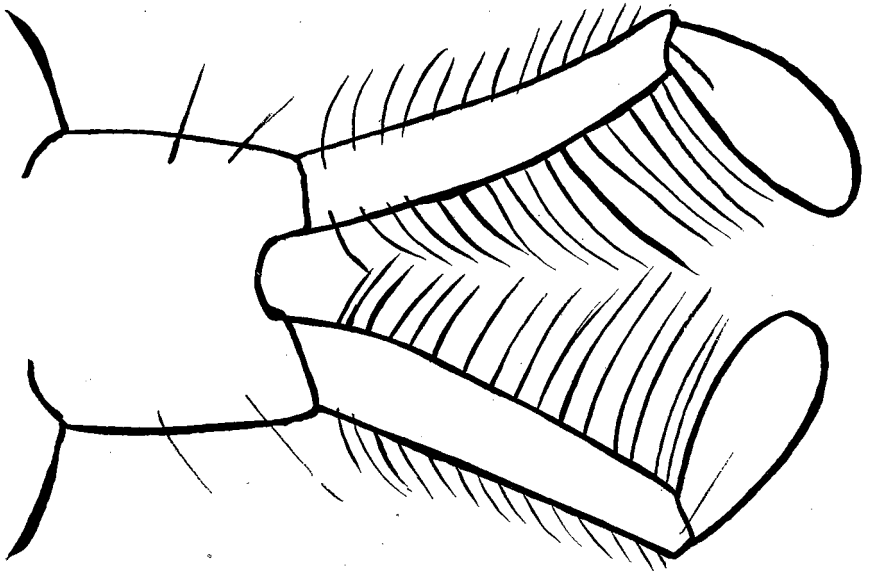


Fig. 11,

PLATE V.

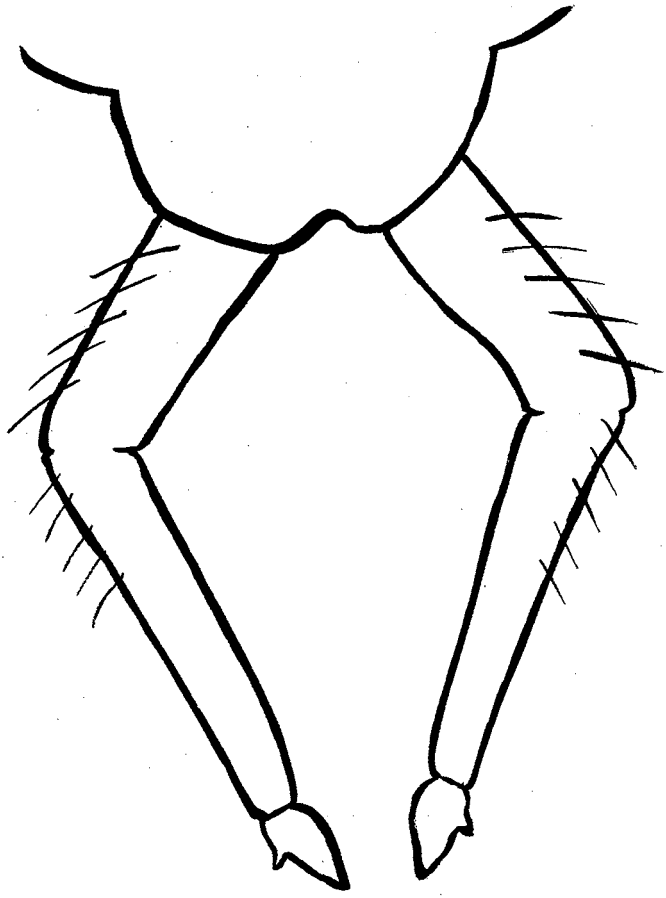


Fig. 12.