OBSERVATIONS ON THE EXTERNAL MORPHOLOGY OF LIBURNIA FURCIFERA (HORVATH) (HOMOPTERA, FULGOROIDEA, ARAEOPIDÆ)

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I. INTRODUCTION

ARAEOPIDS (Delphacidæ) are an interesting group of Fulgoroidæ characterised by the presence of well-developed mobile spurs at the apex of their hind tibiae. They bear a superficial resemblance to Jassids in general form, habits and habitat, but the former can be easily distinguished by the presence of tibial armature. There has been little study on the Araeopidæ in India. In regard to this group Lefroy (1909) had affirmed that no family would so well repay study from every point of view. Despite this statement there has not been much addition to our knowledge of this family, particularly on morphology, except for the cataloguing of a few of its forms by Distant.
(1916) and Muir (1921, 1922). The present paper deals with the external morphology of *Liburnia furcifera*. According to Muir (1919), *Megamelus (Liburnia) furcifera* (Horvath) is identical with *Sogata pallescens* Distant, and *Sogata distincta* Distant, which have been recorded as pests of the paddy crop in various parts of India, such as Bihar, Bengal, Central Provinces, and Mysore, as well as in Ceylon and Malaya outside India. In 1915, a serious and widespread infestation in the Central Provinces was investigated by the Central Agricultural Research Institute, Pusa. The species in question, thus, appears to be of much economic importance. It was first described by Horvath (1899), and recorded for the first time from India by Distant (1906).

II. MATERIAL AND METHOD

The insects were procured from electric domes, where they were found attracted to light. They were also caught by sweeping grasses near marshy places. They were preserved in a solution made up of formalin, acetic acid and alcohol. Head, wings and legs were separately mounted in balsam. The male genitalia were severed from specimens and put in cold concentrated potassium hydroxide solution for about five minutes at room temperature. They were then transferred to glacial acetic acid and kept for about five minutes. The material was then dissected out under stereoscopic binocular microscope according to the method described by Giffard (1920, after which it was dehydrated in carbol-xylol mixture and mounted in balsam.

III. GENERAL DESCRIPTION

In *Liburnia furcifera* both the sexes are macropterous. The females are slightly bigger than the males and measure 4 mm., while the males measure only 3 mm. (both the measurements include the tegmen). They are almost ochraceous in colour on the dorsal surface except on the pronotum. There is a creamy white longitudinal area included in the lateral carinae of pronotum, with the remaining part black. The tegmina are subhyaline, tinted with brownish ochraceous, which assumes a little darker tint apically and also just beneath the fused first and second anal veins. On the ventral side, the male is dark brown in colour while the female is ochraceous, thus showing that in *Liburnia furcifera* sexual dimorphism is noticeable.

IV. HEAD AND THORACIC REGION

The head (Fig. 1) is opisthognathous and the mouth parts do not warrant any attention as they are the typical Hemipterous type, i.e., a piercing and sucking type. The carination of the head and thoracic regions are of some importance in classification, as the earlier workers on Homoptera
have invariably made use of them in distinguishing the species. At the same time this has given rise to many complications as 'there is considerable variation in this character' (Muir, 1915).

The clypeus, which is situated ventrally, is a small triangular sclerite that is distinctly tricarinate. Anterior to it is located the frons, which is five carinate. The outermost carinae terminate at the region of the antennal sclerites, while the remaining three continue anteriorly up to the vertex. Of the five carinae of frons, the middle one is the stoutest and there is a gradation in thickness from the middle towards either side. The vertex is longer than broad with the apex slightly narrower than the base. The middle carina of vertex bifurcates into two at its base, a distinguishing feature of the genus Liburnia. Immediately posterior to the bifurcation there are two small carinae bounding a small area which appears as a depression in that region. Posteriorly, the vertex is characterised by the presence of two

**Fig. 1.** (A) Dorsal view of head, pronotum and mesonotum. (B) Ventral view of head ce, compound eye; cl, clypeus; fl, flagellum; fr, frons; lo, lateral ocellus; mt, mesonotum; pe, pedicel; pt, pronotum; sc, scape; vx, vertex.
pentagonal areas, separated by a faint medio-longitudinal carina. These two areas are slightly depressed. The two lateral carinae of the vertex become apposed to the upper edge of the compound eyes and disappear posteriorly in the area of the pronotum. The pronotum is tricarinate and the lateral carinae gradually fade before reaching the posterior edge of pronotum. The middle one, even though it narrows down posteriorly, is quite pronounced in its thickness and is continued into the median carina of the mesonotum. Anteriorly two pit-like depressions are observable, one on either side of the median carina. On the mesonotum there are three carinae, of which the middle one is quite prominent and reaches the posterior margin, while the lateral ones are faint and fade off before reaching the posterior edge.

V. ANTENNÆ

The antennæ (Fig. 1, B) arise from the antennal sockets and extend well beyond the clypeus. The scape is almost equal to the pedicel, which bears a number of tubercles around it. The terminal division, namely, the flagellum, is bristle-like and tapers to a point distally. It is more than one and a half times the length of the scape and pedicel put together. One of the characteristic features of the antennæ of the genus *Liburnia* is that the scape and the pedicel are of equal length.

VI. WINGS

Metcalf (1913) published an account of the wing venation of certain families of Fulgoroidea. A decade later, Muir (1923) observed that the vein associated with the claval suture was the second main branch of the cubitus and that the so-called ‘Y’ vein of Fulgoroidea was formed by the union of the first and second anal veins. He, however, regarded the costal vein as the humeral branch of the sub-costa, which is not borne out by observed facts. Fennah (1944) categorically rejected it on two grounds; firstly, “it is under the onus of demonstrating how the supposed humeral vein acquired in Fulgoroidea the same relationship to the humeral plate as the costal vein bears it in other orders of insects” and secondly it would necessitate the conclusion that the costal vein and in certain families, even the costal cell, have also been lost by specialisation. If this view is accepted the region in front of the marginal vein is the ‘costal cell’ and consequently the reduction or disappearance of it indicates an evolutionary trend. Thus Flatidæ and Ricaniidæ, where the ‘costal cell’ is present, are more primitive than Cixiidæ and Tettigometridæ, where it is absent. Muir (1923) himself disagreed with this conclusion since he has stated that the more primitive type of venation of Homoptera is found among the Cixiidæ.
All the specimens of *Liburnia furcifera*, we were able to procure, were macropterous with an almost hyaline tegmen. The wing venation is comparatively well developed. Unlike that of certain Fulgoroidea, such as the members of the families Flatidae and Ricaniidae etc., there is no pre-costal region. In the tegmen (Fig. 2) the costa is marginal and simple and is followed by a two branched sub-costa. The subcostal and costal veins form a common stalk basally. Radius is coalesced with sub-costa for nearly half of its length, and basally the first axillary is fused with the second one.

The radius is two-branched, representing the radial 1 and radial sector. Media is three-branched, namely, media 1, media 2 and media 3. According

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**Fig. 2.** (A) Venation of tegmen. (B) Venation of hind wing.

1 *IA*, II *A*, first and second anals; II *A1*, II *A2*, II *A3*, first, second and third branch of second anal; I *Ax* and II *Ax*, fused first and second axillaries; III *Ax*, third axillary; c, costa; cu 1, cu 2, first and second cubitus; *cula*, *Culb*, first and second branch of first cubitus; m, median plate; M, media, M1, M2, M3, first, second and third branch of media; R, radius; R1, radial one; Rs, radial sector; Sc, subcosta; Sc 1, Sc 2, first and second branch of subcosta; Sc + R, subcosta plus radius.
to Metcalf (1913) media 3 is formed by the union of media 3 + media 4 during the course of its development. The medial plate is intimately approximated with the base of the fused first and second axillaries. Cubitus is two-branched, namely, the cubitus 1 and cubitus 2. Further, cubitus 1 in its turn splits up into cula and culb. Basally the two cubital branches unite on a common elongated stalk. Posterior to cubitus 2 lies the first anal vein which independently springs from the basal sclerite. The second anal vein, which also springs independently from the base and runs parallel, joining the first anal a little posterior to its middle, and the union of the two anal veins gives rise to the characteristic ‘Y’ vein of the Fulgoroidea, which is distinctive of all Fulgoroidea, according to Imms (1957). The first anal represents the post-cubitus of Snodgrass (1935) as it has an independent origin and it does not fuse either with the base of the cubitus or with the third axillary. As the revised nomenclature of Snodgrass (1935) in respect of the cubito-anal region has not met with general acceptance, the present authors prefer to retain the old name, cubitus 2. A noteworthy feature of the tegmen is the presence of macrotrichiae all along the course of veins except on the cubitus 2.

The striking features in the hind wing are the enlarged anal region, the reduced number of veins in respect of subcosta and media, and the complete absence of macrotrichia on the veins. The costa is marginal and the subcosta is unbranched. Both the radius and media are united basally. The radius is unbranched. The media is also unbranched and considerably reduced. The cubital vein is divided into two branches as in tegmen, and the cubital 1 in its turn splits into Cu 1a and Cu 1b; the Cu 1a coalesces with the media for almost its entire length being separated only near the marginal region (Metcalf, 1913). In the hind wing the first anal is unbranched, while the second anal is three-branched covering the enlarged anal area.

VII. LEGS

The fore and middle legs are similar to other Fulgoroidea. The hind leg (Fig. 3) bears the spur or calcar on the tibia which is important, as it is on this character the family is distinguished from other members of the superfamily Fulgoroidea. The shape of the spur is also an important factor, as the division of the family into sub-families is based on it (Muir, 1915). Its significance in taxonomy was first pointed out by Kirkaldy (1907) and later by Crawford (1914). In Liburnia furceifera the spur is foliaceous with a large number of teeth on the hind margin (the number varying from 25–30). The calcar gives the appearance of a lanceolate stipule toothed
along one edge. The foliaceous nature of calcar is regarded as the most advanced type by Muir (1915).

Fig. 3. Hind leg.

*sp*, spur; *tb*, tibia.

VIII. GENITALIA

The taxonomy of Aræopids is complicated and there is as yet no complete key for the separation of all the known genera. Most of the taxonomists such as Kirkaldy (1907), Muir (1915), Giffard (1921) and Metcalf (1943), have stressed the importance of the male genitalia for an accurate system of classification of the family. Unfortunately few have studied in detail the male genitalia of the Indian forms, except Muir (1921, 1922). Distant (1906, 1916) a pioneer worker in this field did not extend his studies to the genitalia.

In the present description of the male genitalia, the terminology of Giffard (1921) and Hassan (1948) has been employed. The ninth segment in *Liburnia furcifera*, as in all Aræopids, is modified into a more or less chitinous ring, the pygofer (Fig. 4), in which no clear trace of tergum, sternum or pleurite is noticeable. The pygofer is rather elongated and is easily distinguishable from the other abdominal segments by its large size. It is dark brown, almost black, in colour. The opening of pygofer is longer than broad. Its posterior edge is more or less deeply emarginated, being
termed as the anal emargination. Out of this there projects a small tube-like structure, the anal segment of Giffard (1921), the result of the fusion of the tenth and eleventh abdominal segments. A more or less chitinous wall—the diaphragm—divides the pygofer into an inner and an outer chamber.

\[ \text{FIG. 4. (A) Pygofer. (B) Aedeagus with the basal plates. (C) Single genital style.} \]

ad, armature of diaphragm; ap, anal process; apr, aedeagus periandrum; as, anal style; bb, basal plate bridge; bp, basal plate prolongation; ca, connection to tenth abdominal segment; cp, connection to genital styles; go, gonopore; gs, genital style; ig, inner margin of genital style; og, outer margin of genital style; py, pygofer; wg, wing; Xab, tenth abdominal segment; XIab, eleventh abdominal segment.

The dorsal margin of the diaphragm is 'V'-shaped, through which the anal segment passes out. In the middle of the diaphragm there is a highly chitinised region, the armature (ad). On either side of the ventral margin of
the pygofer project a pair of plate-like sclerites, known as the genital styles (gs). Their basal parts are hidden inside the pygofer. The genital styles are of a peculiar scapula-like shape being somewhat rounded at the base, rather abruptly bulged in the middle—the bulge being prominent on the inner side—and ending distally in a bifid head (Fig. 4c). The styles are provided with minute hairs distally. The aedeagus arises from behind the diaphragm, and when at rest its apex projects above the middle of the dorsal margin of the diaphragm just above the armature. It consists of an ejaculatory duct surrounded by a sheath and passes right through a long chitinous tube, the aedeagus periandrum (apr). The aedeagus is spindle-shaped and opens terminally at the gonopore (go). On the lateral margins of the periandrum there are two rows of spines, one of which extends to the terminal portion, while the other stops rather short of it. The aedeagus is supported at the proximal end by chitinous plates, the basal plates of Pruthi (1925). The basal plates have a chitinous bridge called the basal plate bridge (bb) bearing a sclerotic ring, the wing of the basal plate bridge (wg). The basal plate is connected with the genital styles by a sclerite, termed the basal plate prolongation (bp), which is bifurcated distally—an arrangement which enables the insect to move the genital styles along with the aedeagus.

The tenth and eleventh abdominal segments are, as already mentioned, fused to form a single structure. The anal segment of Giffard (1921) consists of the tenth abdominal segment with its appendages as two divergingly curved processes called the anal processes (as), and the anal segment proper—the eleventh abdominal segment—with its posterior conical projection, the anal style (as). The anal style is wrinkled and beset with hairs.

IX. Summary

The present paper gives an account of the external morphology of *Liburnia furcifera* (Horvath):—

(1) The clypeus is tricarinate and the frons five-carinate. The middle carina of vertex bifurcates at its basal region and there are two pentagonal areas towards the posterior side.

(2) The antennae extend well beyond the clypeus with the scape equal to the pedicel.

(3) In the tegmen, the costa is marginal and the subcosta is two-branched. The radius is two-branched and coalesces with the subcosta for about half of its length. Media is three-branched, cubitus and the anals are two-branched, and the two anals fuse to form the ‘Y’ vein. In the hind wing, the costa as well as the subcosta are unbranched. The radius coalesces
with the subcosta for most part of its length, and passes on unbranched. The cubitus as well as the anal veins are two-branched and the second anal in its turn is three-branched.

(4) In the case of the legs, the hind tibia carries a spur, which is foliaceous with 25–30 teeth.

(5) The male genitalia have been studied. The opening of pygofer is longer than broad, and there is a well-developed armature on the diaphragm. The genital styles are simple. The aedeagus is spindle-shaped with two rows of spines on the periandrum. The tenth abdominal segment bears a pair of anal processes and the eleventh one an anal style.

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XI. REFERENCES


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* Not consulted in original.