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Observations on Antennal Morphology in Diptera, with Particular Reference to the Articular Surfaces between Segments 2 and 3 in the Cyclorrhapha

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ABSTRACT. The main features of antennal segments 2 and 3 seen in the higher Diptera are described, including many that are not or inadequately covered in available publications. The following terms are introduced or clarified: for segment 2 or the pedicel—annular ridge, caestus, chin, collar, conus, distal articular surface, encircling furrow, foramen of articulation, foraminal cusp, foraminal ring, pedicellar button, pedicellar cup, rim; for segment 3 or the postpedicel—basal foramen, basal hollow, basal stem, postpedicellar pouch, sacculus, scabrous tongue, sub-basal caecum; for the stylus or arista—stylar goblet. Particular attention is given to the occurrence and position of the pedicellar button. The button is the cuticular component of a chordotonal organ, which perhaps has the role of a baroreceptor. It is present in the majority of families of Diptera, and possibly was present in the ancestral dipteran. Some generalizations about antennal structure are made, and a diagram showing the main trends in antennal evolution in the Eremoneura is provided. The general form of the antenna shows a transition from approximate radial symmetry (e.g., in *Empis*, *Microphor*, and *Opetia*) through to superficial bilateral symmetry (in many taxa of Eumuscomorpha), though there is usually much asymmetry in detail. More detailed descriptions and illustrations are given for selected taxa of Cyclorrhapha. The phenomenon of an additional concealed segment-like structure between segments 2 and 3, found among the Chloropidae, Pyrgotidae, etc., and formed from the basally flexible conus, is described. Some antennal features of the Calyptratae suggest a relationship to the Tephritoidea. Critical comments are made with regard to the recently published phylogenetic association of the Ironomyiidae with the Phoridae and the Pallopteridae with the Neurochaetidae. In discussing relationships of some taxa, a few non-antennal features, some needing further study, are mentioned, e.g., variation in separation of abdominal tergites 1 and 2 in the Opetiidae and other lower cyclorrhaphous families; the presence of supplementary claw-like terminal tarsal processes in the Lonchopteridae; the apparent restriction of the presence of barbed macrotrichia to the Phoridae, among lower cyclorrhaphans; variation in structure of the prelabrum in the Pyrgotidae; the microstructure of the facial cuticle in the Syringogastridae as compared with that of other families; the calyptrate-like development of the squama in some tephritoid taxa; variation in the subscutellum in the Conopidae; a feature of the larval posterior spiracles diagnostic for Coelopidae.

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Introduction

From morphological studies relating to my taxonomic research on cyclorrhaphous Diptera, it has become apparent that much of the structural diversity in the antenna of these insects remains unrecorded, and that established terminology does not adequately cover this diversity. Difficulties in observation have occurred because some structures are concealed until careful separation of certain segments is carried out, and in the past access to electron microscopy was more limited.

It is probable that much of the diversity now described has phylogenetic significance, but I do not here propose alterations to current classification. Antennal characters will need to be further checked for consistency and correlated with other data, if such changes are to be made, as I find much evidence of homoplasy. However, the broader trends in at least some aspects of antennal morphology in the higher Diptera seem to follow the course outlined (and simplified) in Fig. 23.

In order to present my more significant findings within a reasonable time, I have limited the range of taxa for detailed study to those of more immediate interest and availability, and some other significant groups have been omitted or given slight attention. Therefore, there remains a large field for investigation by other students, e.g., in the Muscoidea or Calyptratae. Theodor (1967) has described the extraordinary antennal features of the Nycteribiidae. I have omitted my observations on the superfamily Nerioidea and the families Somatiidae and Heteromyzidae s.l. (including Heleomyzidae, Rhinotoridae, Sphaeroceridae, Trixoscelididae, etc.), as these show such diversity as to require separate studies.

Morphological study for this paper has been performed using a stereo light microscope (SLM), a compound light microscope (CLM), and a scanning electron microscope (SEM).

Collections mentioned in the text are: Australian Museum, Sydney (AM); Natural History Museum, London (BMNH); Zoological Museum, Copenhagen (ZMUC).