Journal of the Minnesota Academy of Science

Volume 29 | Number 1 Article 28

1961

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ZOOLOGY

CAMPANIFORM SENSILLA PATTERNS ON THE WINGS OF DROSOPHILA[1]

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Campaniform sensilla have been described from the wings, mouthparts, legs, and other parts of the insect body. These small sense organs were known under several terms until Berlese (1909) applied the term "campaniformi" because of their dome, or bell-shaped character. Numerous functions have been suggested for these organs which seem to be stress receptors of some sort. Very few attempts have been made to utilize these sensilla as taxonomic characters.

Eastham (1936) did attempt to construct a key based upon the numbers and distribution of gill sensilla for the separation of *Caenis* nymphs. His success was limited to breaking the genus into what he believed to be related sections. Vogel (1911), McIndoo (1917), Baus (1937), and Melin (1941) all believed the number and position of the wing campaniform sensilla indicate relationship within the Lepidoptera. Hamrum (1957) surveyed the wing sensilla patterns of 65 families within the Diptera, and found these patterns differed significantly among the family groups. Within the latter study, it was noted that the white eye mutant of *Drosophila melanogaster* displayed a wing sensilla pattern markedly different from the wild type of this species.

This study was undertaken to test the value of companiform sensilla patterns as a guide in recognizing *Drosophila* populations.

METHODS. One wing was broken from the thorax of each dried specimen by applying an insect pin to the extreme proximal region of the wing. The usual pre-mounting treatment consisted of boiling the wing in 95% alcohol for one minute to remove the air from the veins. The wing was then cleared in xylene, and placed in Piccolyte on a glass slide and covered with a cover slip. All veins were searched with a compound microscope using 430 magnifications, and if sensilla were found, their numbers and points of occurrence were recorded. The wing veins were designated under the Comstock-Needham system. The proximal portions of the subcosta (Sc) and radius (R) were divided into areas for descriptive purposes in order better to locate the sensilla groups occurring on these veins. These sensilla groups are shown in Figure 2.

[1] Supported by the Minnesota Dental Foundation, Inc.

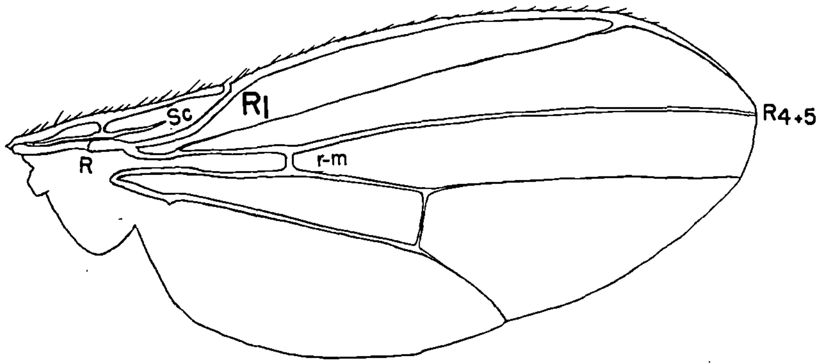

Figure 1. Wing of *Drosophila melanogaster* showing veins normally bearing campaniform sensilla.

All flies used in rearing experiments were reared on standard Drosophila media. Experimental crosses were made with single pairs selected from isolated pupae.

REARING EXPERIMENTS. This investigation started with a wing sensilla survey of several mutant strains of *Drosophila melanogaster.* These results are shown in Table 1. It was quickly evident that the sensilla counts on the bases of R and Sc could not be used. These areas are too often damaged when the wing is removed from the specimen. As Table 1 indicates, nearly all strains show approximately the same sensilla population as the wild type *D. melanogaster.* However, white eye (Turtox), curved wing, and bifid cut garnet all show more sensilla than normal on the first branch of the radius (R1). This deviation from the wild type is shown in Figure 2. Emphasis has been placed upon the R1 area for it normally bears 3 sensilla in all species examined. Another variable area, shown in Table 1, is the stem of the radius (R). Hamrum (1957) found that the size of the wing in *Sarcophaga* influences the sensilla population in this area.

TABLE 1. Number of campaniform sensilla on the wing veins of mutant strains of *Drosophila melanogaster.* Sc (subcosta), Sc-h (subcosta and humerus), R (radius).

strain	Sc	Sc-h	R	R1	R4+5
wild type (Turtox)	5	1	10-12	3	4
wild type	5	2	10-12	3	4
white eye (Turtox)	5-6	1-4	12-14	4-9	4-5
white eye (Calif.)	5	2-3	12-13	3	4
ebony body	5	1-2	10-12	3	4
II ple	5-6	1	10-12	3	3-4
curved wing	5	1-2	11-14	3-6	3-4
r9/yf	5	1-2	9-12	3	3-5
bifid	5	2	7-12	3-7	4
scute	5	1-2	8-11	3	4
shifted 2	5	1-2	7-9	3	3
net vein	5	1-2	11-13	3	4
plexus	5	1-2	12-14	3	4

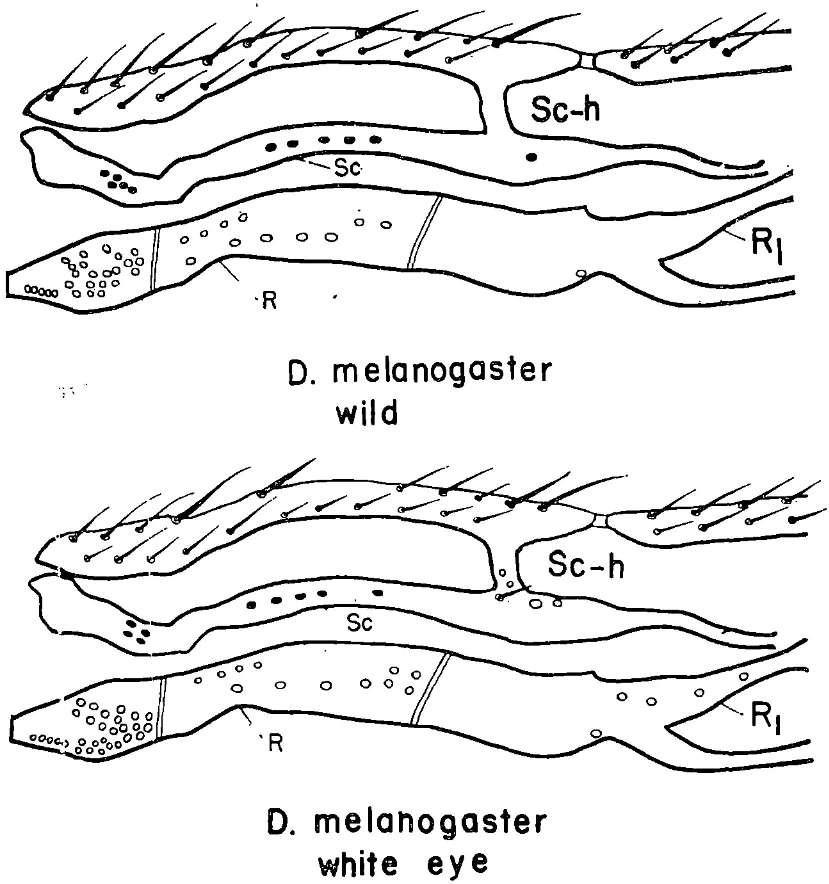

Figure 2. Base of wing showing greatest campaniform sensilla concentration. This figure illustrates the basic differences in sensilla distribution between wild and white eye strains of *D. melanogaster.*

The larger winged species had the greatest number of sensilla. This observation seems to be also true for *Drosophila.*

Crosses were made using a white eye (Turtox) or curved wing parent with wild or ebony eyes. The progeny showed some variation in R1 sensilla from the wild type. Whenever a curved wing fly was mated with a white eye fly, nearly all F1 individuals examined had more R1 sensilla than either parent. In the F2 and F3 individuals, the R1 sensilla pattern varies from fewer sensilla than either parent to more sensilla than both parents. Another change in sensilla distribution was noted in these F2 and F3 hybrids. Five or six sensilla were frequently observed along the course of R4+5. Hamrum (1957) found that 4 R4+5 sensilla is virtually constant for the Drosophilidae and related families. The white eye X curved wing matings seem to indicate that a significant wing sensilla change may occur in a very few generations. These experiments further suggest that deviations in sensilla pattern may indicate a reproductively isolated population.

A wing bristle abnormality was observed among some of the white eye X curved wing F2 and F3 individuals. These structures often appeared to be intermediate between a normal trichoid sensillum and a campaniform sensillum. In other instances they would appear as normal bristles in an area normally occupied by campaniform organs. Lees (1941) described such "intermediate" structures on the veins of the "hairy" wing mutant of *D. melanogaster*. Lees found the "hairy" wing to have almost twice the normal campaniform sensilla population. The presence of intermediate structures on this wing with profuse trichoid and campaniform sensilla prompted Lees to suggest that the trichoid and campaniform sensilla are homologous structures. The derivation of the various types of insect sensilla from a single basic type has been suggested. Snodgrass (1935) hinted that campaniform sensilla may have lost the bristles with the sockets alone remaining. Lees stated that the "hairy" gene is in control of extra bristle production on the wings and thorax of *Drosophila*. However, our white eye-curved wing hybrids are no more hairy on these parts than the wild type. At this time we are not prepared to explain the presence of these intermediate sensilla or the "out of place" sensilla which appeared in our experimental stock. These experiments, however, do seem to serve as support for Lees idea on homology of the campaniform organs.

SENSILLA PATTERNS OF DROSOPHILA SPECIES. The survey of *Drosophila melanogaster* wild type and mutants was made from commercial stocks. Therefore it was deemed wise to determine if the cultured wild type had the same wing sensilla pattern as natural breeding wild stock. Four populations of *D. melanogaster* were trapped at different points in southern Minnesota. One consistant variation between the wild and cultivated stocks appeared in the Sc-h region. The commercial stock (Turtox) has only a single sensillum in this region, whereas the wild trapped flies all have two sensilla.

Patterson and Stone (1952) have compiled a tremendous amount of information on evolution in *Drosophila*. Several species groups are treated in detail in this useful work. As is well known, many of the sibling species are very difficult to differentiate. Even chromosome configurations may not serve to separate some species. Two well known sibling species of the *obscura* group, *D. pseudoobscura* and *D. persimilis*, fit into this category. Several wings of both species were examined. The general sensilla distribution was found to be similar to the wild *D. melanogaster* except for an occasional extra sensillum on the R4 + 5 in some specimens of *D. pseudobscura*. Our material was taken from several localities in western U.S. which carries the implication that in some populations the R4 + 5 sensilla pattern may change. This is only a preliminary observation since rearing experiments involving these species will be continued. At present we cannot distinguish between all specimens of *D. pseudoobscura* and *D. persimilis* on the basis of wing sensilla patterns.

Six South American species belonging to the *mesophragmatica* group were also examined. Brncic et al (1957) studied this group and prepared a key to separate these species: *D. altiplanica, D. viracochi, D. gaucha, D. pavani, D. orkui,* and *D. mesophragmatica.* Dr. Brncic generously provided us with dried specimens of the *mesophragmatica* species. The wing sensilla pattern of this group is very similar to the North American species studied except for a short row of six sensilla on Sc. Six sensilla on the Sc were encountered only in some *D. melanogaster* mutants. This observation certainly does not do violence to the belief that the *mesophragmatica* group is composed of related species.

Although this study is somewhat fragmentary in its present scope, it seems to indicate that campaniform sensilla distribution may be a useful indicator for evaluating certain *Drosophila* populations. No claim is made that sensilla distribution alone indicates close or distant relationship; however, the inclusion of a new character can hardly handicap any phylogenetic study.

LITERATURE CITED

BAUS, A. 1937. Die Reduktion der Flügel and Flügelsinneskuppeln bei Lepidipteren. *Ztschur. f. Morph. u. Ökol. der Tiere.* 32:1-46.

BERLESE, A. 1909. *Gli insetti.* Vol. 1. Milano, Societá Editrice-Libraris.

BRNCIC, D. and S. K. SANTIBATILDEEZ. 1957. The mesophragmatica group of species of *Drosophila. Evolution.* 11:300-310.

EASTHAM, L. E. S. 1936. The sensillae and related structures on the gills of nymphs of the genus *Caenis* (*Ephemeroptera*). *Roy. Ent. Soc. London,* Trans. 85:401-414.

HAMRUM, C. L. 1957. *Taxonomic significance of certain sensilla on the wings of Diptera.* (Unpublished Ph.D. Dissertation). Iowa State University Library, Ames.

LEES, A. D. 1941. Homology of the campaniform organs on the wing of *Drosophila melanogaster. Nature* (London). 150:375.

MCINDOO, N. E. 1917. The olfactory organs of Lepidoptera. *Journ. Morph.* 29:33-54.

MELIN, D. 1941. *Contributions to the knowledge of the flight of insects—Especially of the function of the campaniform organs and halteres.* Uppsala Univ. Årsskrift. 1941, no. 4.

PATTERSON, J. T. and W. S. STONE. 1952. *Evolution in the Genus Drosophila.* New York. The Macmillan Co.

SNODGRASS, R. E. 1935. *Principles of insect morphology.* New York, McGraw-Hill Book Co.

VOGEL, R. 1911. Über die Innervierung der Schmetterlingsflügel und über die Bau und die Verbreitung der Sinnesorgane . . . *Ztschr. wiss. Zool.* 98:68-134.