Kinetosomes in Insect Epidermal Cells and Their Orientation with Respect to Cell Symmetry and Intercellular Patterning

Abstract. *Paired flagellar basal bodies or kinetosomes are described for tarsal, pulvillar, wing, proboscis, ptilinum, and tracheal epithelial cells in the fly* Sarcophaga bullata. *Evidence suggests that in every diploid epidermal cell their orientation is specific with respect to (i) cell symmetry and cuticular patterning, and (ii) intercellular positioning and polarity. Microtrichia may be homologous with the flagella of other organisms.*

Flagellar basal bodies have not been reported previously for cuticle-secreting epidermal cells in insects. They are described here for tarsal, pulvillar, wing, proboscis, ptilinum, and tracheal diploid epithelial cells in the fly *Sarcophaga bullata*. The pair of basal bodies or kinetosomes is positioned in all of the cell types, with the exception of the tracheal cells, near the base (Fig. 1B) of a fine cuticular covered process or microtrichium that emerges from the center of a hexagonal area of cuticle, which covers the cell surface of the same shape (Fig. 1A). At no time during development does the fine process contain cell organelles such as mitochondria and endoplasmic reticulum, but only microfilaments and microtubules. The relative positioning and the structure of these processes, together with the close association of basal bodies, suggest that they may be vestiges of flagella, now nonmotile and covered by cuticle. Larger hairs and bristles would not classify as flagellar homologs, as they are cellular extensions of polytene, not diploid cells, and contain the full complement of cytoplasmic organelles such as mitochondria and endoplasmic reticulum.

Of particular significance would seem to be the fact that the orientation of the kinetosomes is closely correlated with the symmetry of the individual cell, and with the positional relationships existing between adjacent cells. The ventral tenent hair cells of the pulvillus, the hair cells of the wing, and the microtrichia-forming cells of the tarsi and other body regions are all small diploid cells, arranged with perfect regularity in alternating rows (Fig. 1, A and B). In consequence, each cell has an inner surface in contact with the hemocoel, an outer cuticle-secreting surface, and six sides in close contact with six adjacent cells—the two cells on either side and in the same row, two cells of the row in front, and two cells of the row behind. In some areas the processes are noticeably bilaterally symmetrical, as is the case with the ventral tenent cells (*1*) of the pulvillus or footpad. Where this is so, the orientation of each process is identical with that of its neighbors. Likewise, the orientation of the kinetosomes is identical with that of their neighbors (*2*). The pair of kinetosomes lies close to the cell surface, and one is angled with the other to form a V, with the closed end of the V facing the surface and the open end facing the more distant nucleus. The kinetosome pairs of adjacent cells of the same row are in a straight line, and are parallel with those of the rows in front and behind. It would seem therefore that each cell is specifically oriented with respect to its neighbors, and that at least one set

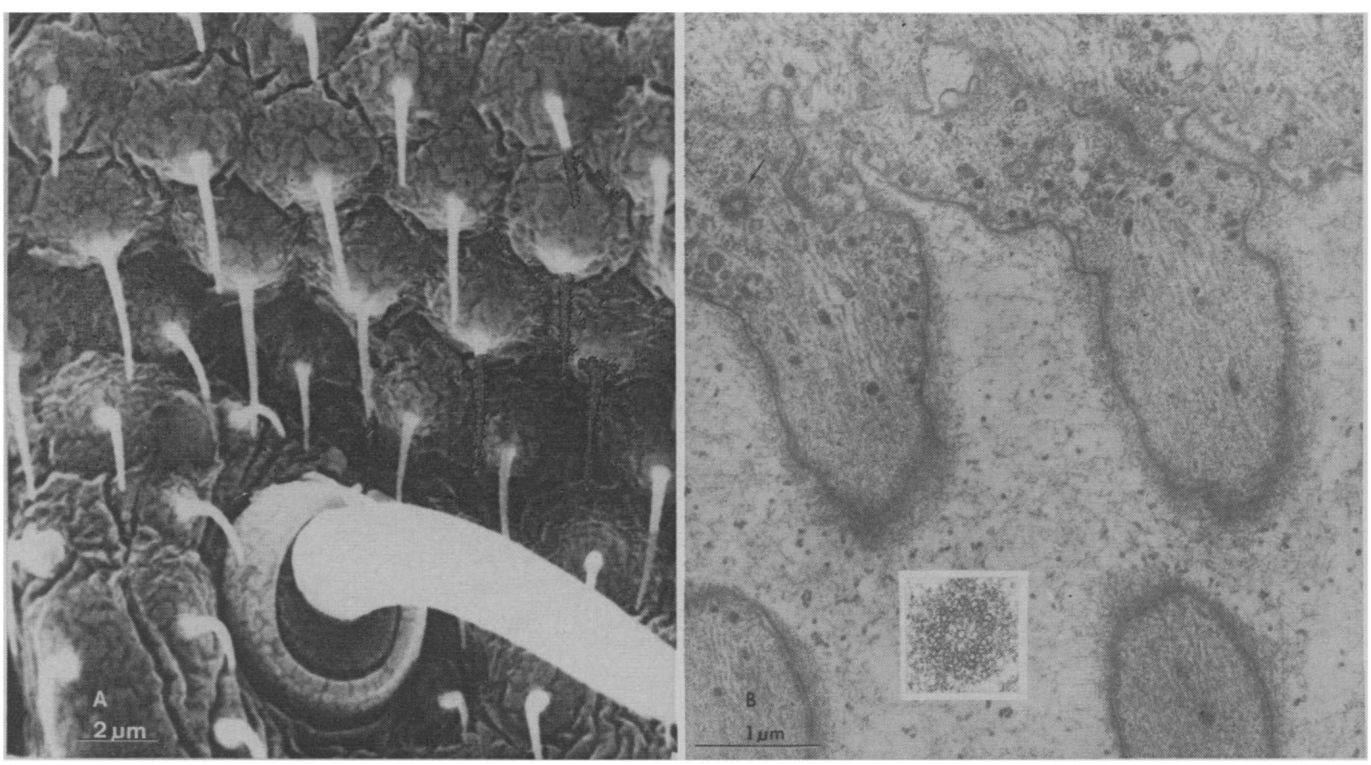

Fig. 1. (A) Stereoscan micrograph (Jeol JSM-U3 scanning electron microscope) of a region of the proboscis of the fly *Sarcophaga bullata*, containing one hair complex and numerous small microtrichia emerging from hexagonal areas of cuticle. Each microtrichium is the product of a diploid cell; the cells are arranged in precise rows, with each of the six sides in close contact with adjacent cells. (B) Transmission electron micrograph (Hitachi 11E microscope) of tenent hair cells from the ventral region of the pulvillus or footpad of *S. bullata*. The sections are cut longitudinally and slightly obliquely so that the cell processes of several rows are seen. Note one of the pair of kinetosomes situated at the base of the process in the upper left of the micrograph (arrow). Also seen is the precise alternation of the processes of adjacent rows of cells. (Inset) Enlarged view of a kinetosome. Day 5 of pupal development.

of organelles—the kinetosomes—reflects this in its ultrastructural organization.

Apart from the homology of microtrichia with flagella (which is apparently a suggestion not previously made in the literature), several important questions arise from these findings. One is whether there are kinetosomes in the numerous larger polytene cells of the fly and whether the possible loss, duplication, or modification of centriolar structures are important factors in the inability of polytene cells to divide. There has recently been renewed interest in the role of centrioles both in cell division and in the control of cell polarity (*3*), and it is in this respect that the findings reported here may have their greatest potential significance. A considerable amount is known about insect epidermal cells in general, and pattern formation has been (*4*) and continues to be (*5*) a primary concern. The findings reported here would be the first definite indication of ultrastructural organization reflecting intercellular positional relationships in the insect epidermis.

Cell dissociation and reaggregation studies have been carried out extensively with dipteran cells (*6*). Similar reaggregation studies, with special attention to kinetosome orientation in relation to the reestablishment of patterns by dissociated cells, may throw light on problems of cell recognition and pattern formation. Similarities are evident between the simple patterning of epidermal cells in a fly, described here, and the arrangements found in simple colonial flagellates. In *Volvox* the colony is integrated by cytoplasmic strands connecting the individuals; these individuals form hexagonal arrangements and, according to Gerisch (*7*), the cells are arranged in an orderly pattern with respect to (i) the plane of flagellar insertion (and hence of the flagellar bases), (ii) the plane of flagellar vibration, and (iii) the plane of cell division. Perhaps these are features characteristic of a basic pattern originating in the colonial flagellates and retained even in animals, such as the insects, in which motile flagella are lost but their basal bodies retained. Considerations of pattern formation in insects (*4, 5*) have not previously involved hexagonal cell arrangements or the presence of specifically orientated flagellar structures.

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References and Notes

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Adolescent Marihuana Use: Role of Parents and Peers

Abstract. *In order to examine the relative influence of parents and peers on marihuana use among adolescents, independent data have been obtained from adolescents, their parents, and their best school friends in a sample of secondary school students in New York State. The data indicate that drug use by peers exerts a greater influence than drug use by parents. Friends are more similar in their use of marihuana than in any other activity or attitude. Parental use of psychotropic drugs has only a small influence, mostly related to maternal use. Peer and parental influences are synergistic; the highest rates of marihuana usage are observed among adolescents whose parents and friends are drug users.*

A social interpretation of adolescent drug use has been proposed, according to which drug use on the part of the young is assumed to develop in response to parental consumption of psychoactive drugs (*1*). According to this view, adolescent use of illegal drugs is a juvenile manifestation of adult behavior. This hypothesis has received apparent support from surveys that suggest a relationship between use of illegal drugs by young people and use of legal psychoactive drugs by their parents (*2*). Adolescents who use marihuana, LSD, and other hard drugs are more likely to report that their parents use tranquilizers, amphetamines, or barbiturates. These conclusions have so far been based exclusively on the youths' perceptions of their parents' drug use, not on usage reported directly by the parents. I find, on the basis of parents' self-reports, that the relationship between parental and adolescent drug use in matched parent-adolescent dyads is reduced, although it is still positive. Peer influence on adolescent drug use is stronger than parental influence. Peer and parental influences are synergistic, however, and marihuana use occurs most frequently in triads in which both friend and parents are drug users.

This report is based on a survey in which independent data were obtained from adolescents, their parents, and their best school friends. The basic adolescent sample ($N = 8206$) is a multiphasic random sample representative of public secondary school students in New York State, drawn from 18 schools throughout the state. The sample selection was based on a two-stage sampling procedure involving the selection of (i) a stratified sample of high schools and (ii) a sample of students clustered by homerooms and stratified to represent the different grades within a high school. In fall 1971, structured, self-administered questionnaires were given in a classroom situation to a random sample of homerooms in 13 schools and to the entire student body in five schools. Therefore, in these five schools, it was possible to collect data from the student's best school friend so as to obtain a relational sample of matched student-friend dyads. Within each of the 18 schools, all homerooms were surveyed simultaneously. The student sample was weighted to reflect the variable probabilities of selection of schools and homerooms and the absentee factor in each school. Two to three weeks after a school was surveyed, a questionnaire was mailed to one parent of each student, alternately mothers and fathers. A maximum of three follow-up contacts were involved. Usable questionnaires were returned by 5574 parents or 61 percent of the initial group contacted. Since the behavior investigated is illegal, the respondents did not sign the questionnaires; identification of records was accomplished through the use of self-generated identification numbers (*3*). Using these codes, we were able to match 49 percent of all the students to their parents and 38 percent of the students in the five schools to their best school friends.