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5.21 FINE STRUCTURE OF THE AXILLARY ORGANS OF *FUSOHERICIA LAWRENCEI* BAKER AND CROSSLEY (ASTIGMATA: ALGOPHAGIDAE)

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Members of the astigmatid mite family Algophagidae are found in aquatic habitats, ranging from semiaquatic (wading in fluid) to fully aquatic (submerged). Adults and instars other than the deutonymph are characterized by the possession of an axillary organ, a sclerotized band of cuticle located on each side of the propodosoma between legs I and II. Based on ultrastructural studies, Fashing (1984) postulated an osmoregulatory function for these organs. The fine structure of the axillary organs has been described for only *Algophagus pennsylvanicus* Fashing and Wiseman, a fully aquatic member of the subfamily Algophaginae which inhabits water-filled treeholes. We used scanning and transmission electron microscopy to describe the structure of the axillary organs of a second species, *Fusohericia lawrencei* Baker and Crossley, a semiaquatic member of the subfamily Hericiinae inhabiting sap flux on trees.

MATERIALS AND METHODS

Specimens of *F. lawrencei* were collected from sap flux on a Tuliptree (*Liriodendron tulipifera* L.) in eastern Virginia, U.S.A. For transmission electron microscopy (TEM), the integument of the idiosoma was first ruptured to facilitate fixation and specimens then placed in a fixative of 3.5% gluteraldehyde, 2.5% paraformaldehyde, and 2% acrolein in cacodylate buffer (pH 7.4) for 12 h at 4°C. After several brief cacodylate buffer rinses, they were post-fixed for 1 1/2 h 4°C and an additional 1 1/2 h at room temperature in 1% OsO₄ in cacodylate buffer. Specimens were then briefly rinsed in 50% acetone and soaked overnight in 2% uranyl acetate 70% acetone solution at 4°C. Dehydration was completed in acetone, and Spurr's medium used for infiltration and embedding. Thin sections were stained in lead citrate, and TEM was performed on a Zeiss EM 109.

Specimens for scanning electron microscopy (SEM) were dehydrated in alcohol, dried using the critical point procedure, and coated in a sputter coater. Microscopy was performed on an AMR-1810.

RESULTS AND DISCUSSION

The axillary organs of *F. lawrencei* are paired structures homologous to those found in *A. pennsylvanicus*, but much larger. The organs extend dorsally between legs I and II and are expanded somewhat slightly above the trochanters (Fig. 1). Ventrally they surround the base of Leg I and extend posteriorly as a wide band along the lateral margin of the idiosoma to a level just anterior to leg III (Fig. 2). A ridge of thickened cuticle outlines the margins and provides structural support. The posteriorly

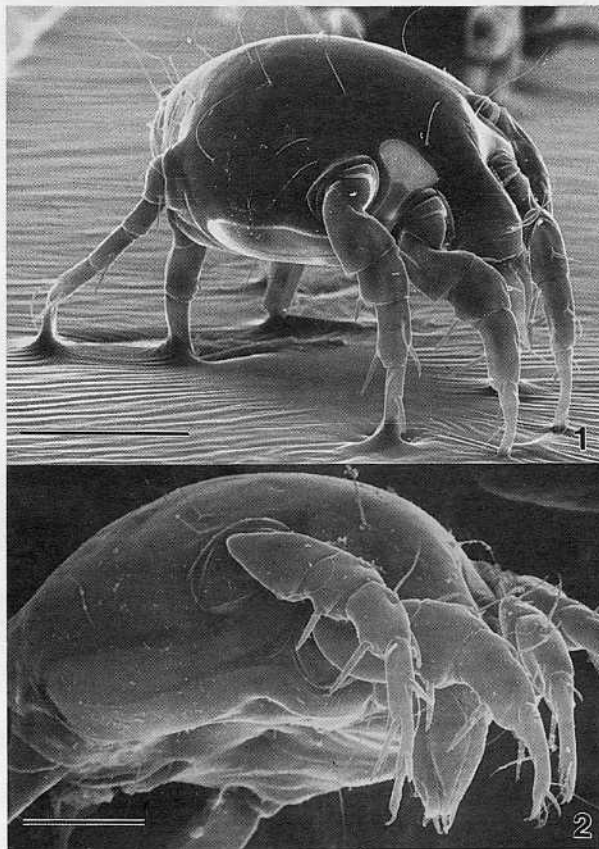


Fig. 1. Frontolateral SEM view. Bar = 100 μ .
Fig. 2. Ventrolateral SEM view. Bar = 50 μ .

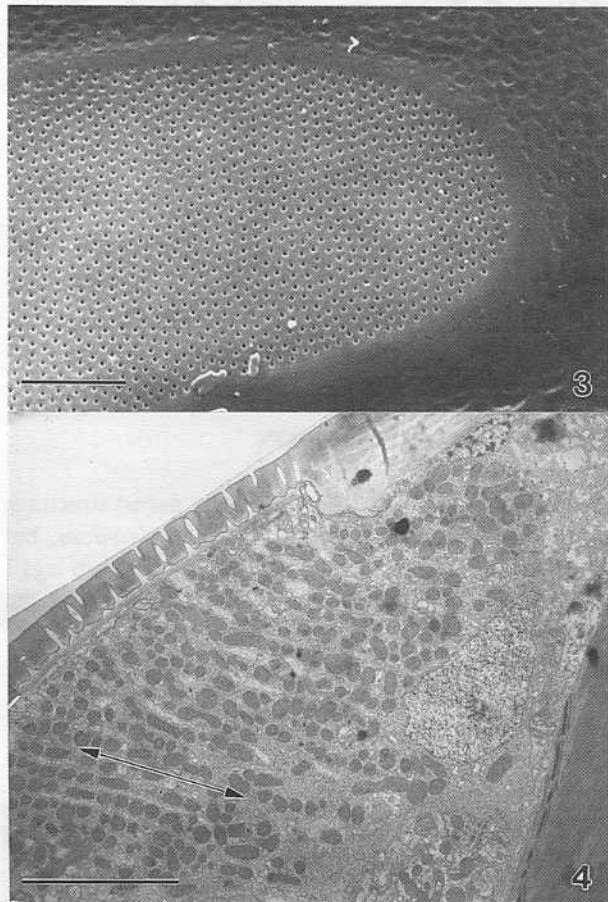


Fig. 3. SEM of axillary organ porous plate. Bar = 5μ . **Fig. 4.** TEM of axillary organ and adjacent cuticle. Note the orientation of mitochondria and plasma membrane plications. Bar = 5μ .

directed ventral band gains additional support by a central ridge of thickened cuticle (Fig. 2). Comparable to *A. pennsylvanicus*, each organ is covered by a cuticular plate containing numerous pores (Fig. 3). The plate is non-laminate and thinner than normal cuticle (Fig. 4). A narrow cavity occurring between the plate and the underlying epidermal cells is occupied by a layer of extracellular material (Figs. 5,6). On close examination, however, this material appears to be organized in coherent layers (Figs. 5,6) rather than amorphous as found in *A. pennsylvanicus*. In both species, the epicuticle appears to line the inside of the pores as well as the roof of the cavity, and the epidermal cells are covered by a thin electron-dense layer (Figs. 5,6). Both species are characterized by the presence of epidermal cells with inward extending plasma membrane plications in close association with numerous mitochondria (Figs. 4,7). In *F. lawrencei*, however, the mitochondria are present in much larger numbers, especially in the apical region. In

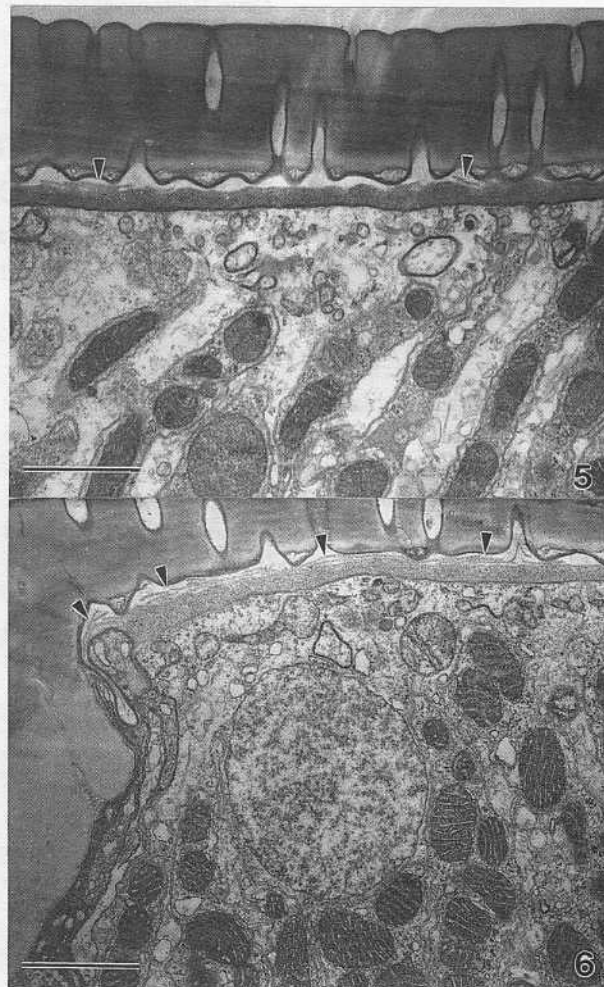


Fig. 5. TEM of axillary organ sectioned longitudinally through pores. Note the layering of the electron dense substance below the porous plate (arrows). Bar = 1μ . **Fig. 6.** TEM of the edge of axillary organ sectioned longitudinally through pores. Note layering of the electron dense substance below the porous plate (arrows). Bar = 5μ .

addition, they are aligned in rows that are approximately perpendicular in orientation to the porous plate (Fig. 4). These rows appear to be enclosed by plasma membranes on all sides, and are often separated by mitochondria-free areas of lesser electron density which contain microtubules and small vesicles (Fig. 7). In contrast, the mitochondria of *A. pennsylvanicus* cells occur in a largely random pattern rather than rows. We observed only one type of epidermal cell in *F. lawrencei*; that with numerous plasma membrane plications and mitochondria. The type B cell of *A. pennsylvanicus* containing few membrane infoldings and mitochondria appears to be lacking.

Fashing (1984) postulated that the axillary organs of members of the Algophagidae function in osmoregulation based on the ultrastructural similarities of *A. pennsylvanicus* axillary organs with osmoregulatory cells of aquatic insects (*i.e.*, chloride cells, see Komnick 1977 for a review). This work reinforces that hypothesis since, although *F. lawrencei* and *A. pennsylvanicus* demonstrate differences in ultrastructure, they share the basic ultrastructural attributes of chloride cells.

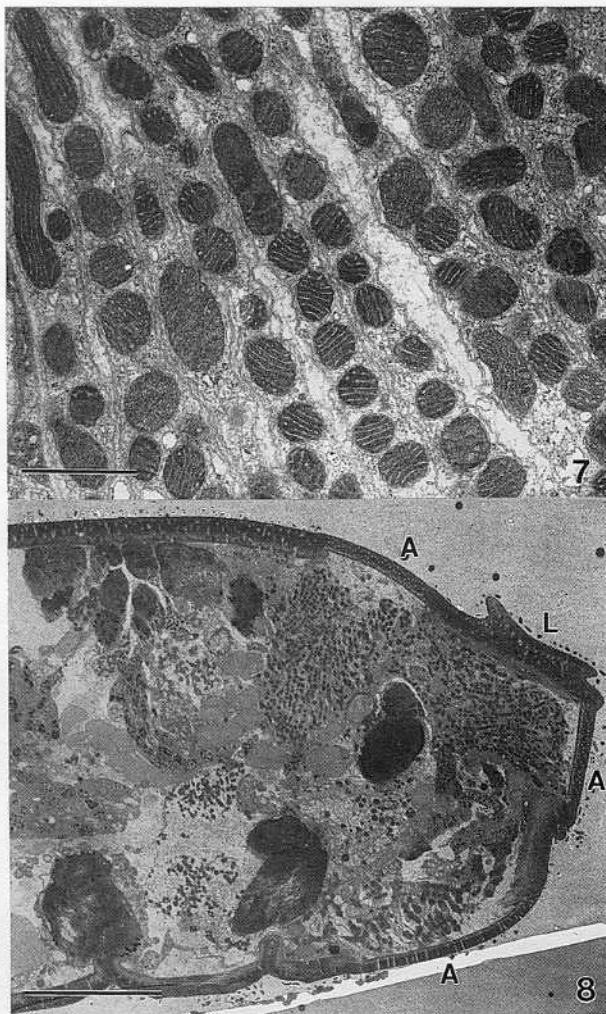


Fig. 7. TEM of axillary organ below the porous plate. Note the linear orientation of the mitochondria and plasma membrane. Bar = 1 μ .

Fig. 8. TEM cross section at the level of leg II. Note large area of idiosoma devoted to the axillary organ. L=leg II; A=axillary organ. Bar = 20 μ .

Other correlative evidence supporting an osmoregulatory function involves the Claparedes organs and genital papillae. Alberti (1977, 1979) postulated that these structures function as chloride cells in the Prostigmata, especially the Hydrachnellae, and Fashing (1988) found the ultrastructure of the Claparedes organs and genital papillae of *Naiadacarus arboricola* Fashing (Astigmata) to be consistent with that of chloride cells. It is interesting that, with the exception of the deutonymph (hypopus), the genital papillae of adults and nymphs of algophagids are vestigial, and that their larval homologue, the Claparedes Organs, are absent. A logical explanation would be that their function has been taken over by the axillary organs and, since axillary organs are not found in the deutonymphs of algophagids, this instar has retained well developed genital papillae.

It is also interesting that so much of the idiosoma is devoted to axillary organs in *F. lawrencei*. Such large size would imply that their function is extremely important in the biology of this species. It could be that living in sap flux imposes excessive demands on osmoregulatory tissues resulting in an increase in size, however the axillary organs of species in the genus *Hericia*, another algophagid inhabitant of sap flux, are much smaller. In addition, the axillary organs of an undescribed species of *Fusohericia* which inhabits the water-filled bracts of plants of the genus *Heliconia* are also quite extensive. Perhaps as more is learned concerning the chemistry of the fluids from the various habitats in which algophagid species live, an explanation will be found for the inter-specific differences in the size of axillary organs.

SUMMARY

Although differences occur, the axillary organs of *F. lawrencei* are similar in ultrastructure to those of *A. pennsylvanicus*. Axillary organs are structurally analogous to certain osmoregulatory cells found in insects, and it is therefore probable that they also serve this function in algophagid mites.

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