6.8 A POSSIBLE OSMOREGULATORY ORGAN IN THE ALGOPHAGIDAE (Astigmata)

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INTRODUCTION

Species of the astigmatid family Algophagidae range in habitat from semi-aquatic (wading in liquid) to aquatic (fully submerged). One of their major characteristics is a sclerotized band of cuticle located on each side of the propodosoma between legs I and II, for which I propose the name 'axillary organs'. Fain & Johnston (1975) speculated that these organs function as air-chambers serving for both the respiration and flotation of the mites. The present study is an attempt to elucidate the function of the axillary organs in one algophagid species, *Algophagus pennsylvanicus* Fashing & Wiseman, through the use of scanning and transmission electron microscopy (SEM and TEM).

MATERIALS AND METHODS

Specimens of *A. pennsylvanicus* were collected from water-filled treeholes in Pennsylvania, USA. For TEM, specimens were first punctured (to facilitate fixation), and 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 1½ h at 4°C and an additional 1½ h at room temperature in 1% OsO_4 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 with a Zeiss EM 9S–2.

Specimens for SEM were dehydrated in alcohol and transferred to acetone. They were then dried using the critical point procedure and coated with gold in a vacuum evaporator. Microscopy was performed on an AMR–1000.

A total of six adult specimens were examined under TEM (two each in cross-section, frontal section, and longitudinal section), and numerous adults were examined under SEM.

RESULTS

The axillary organs of *A. pennsylvanicus* are paired (Fig. 1), appearing as elevated bands between legs I and II (Fig. 2). SEM indicates that each organ is covered by a convex plate containing numerous small pores (Fig. 3), which is surrounded by a ridge of thickened cuticle (Fig. 4). TEM reveals that the cuticle of the porous plate is different from that of the surrounding idiosoma in being thinner and non-lamellate (Fig. 6). The organ is delimited internally by a thickened band that probably functions as a structural support (Fig. 6). The pores lead inward

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to a shallow cavity at the base of the cuticle which is filled with an amorphous extracellular substance (Figs. 5, 6, 7). In some specimens this substance extends into the pores (Fig. 9). The epicuticle appears to line the inside of the pores and the roof of the cavity. At the bottom of the cavity, it joins a thin, undulating, electron-dense layer that covers the modified epidermal

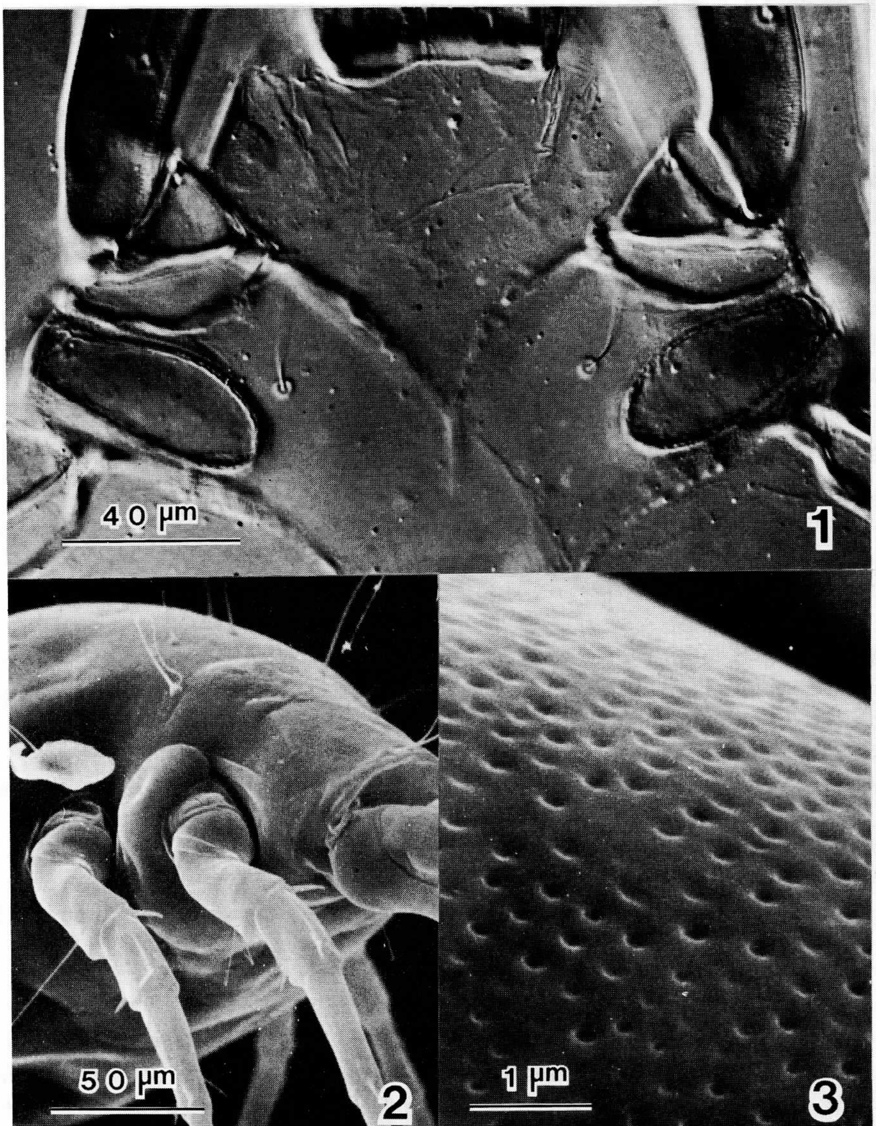

Fig. 1 – Ventral view of the propodosoma with Nomarski differential interference optics.

Fig. 2 – Lateral view of the propodosoma with SEM.

Fig. 3 – SEM of porous plate of the axillary organ.

cells of the organ (Figs. 5, 7). The epidermal cells consist of two types, designated type A and type B. Type A is the most common and is characterized by plasma membrane plications extending inward from its apical region in close contact with numerous mitochondria (Figs. 7, 8). Microvilli appear to be absent. In cell type B, plasma membrane infoldings and mitochondria are not as abundant, and special apical projections can be seen extending into the cavity below the porous plate (Figs. 7, 9).

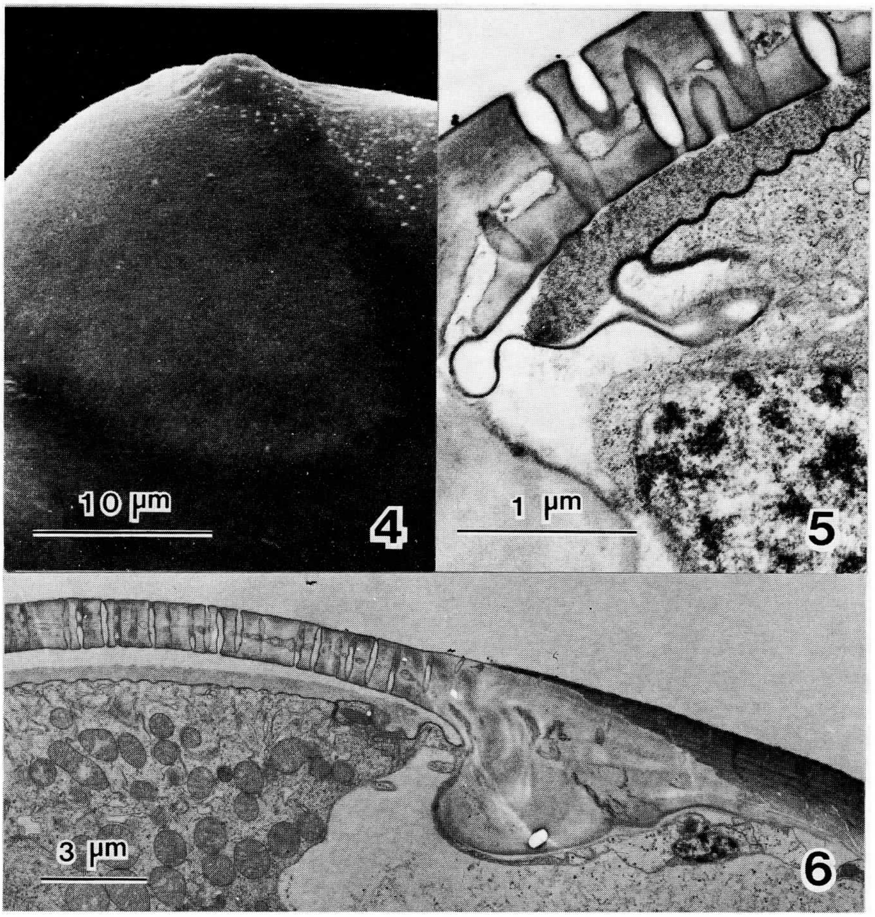

Fig. 4 – SEM of the axillary organ. Note the surrounding ridge.

Fig. 5 – TEM of the edge of the axillary organ sectioned longitudinally through pores.

Fig. 6 – TEM of the axillary organ and adjacent cuticle.

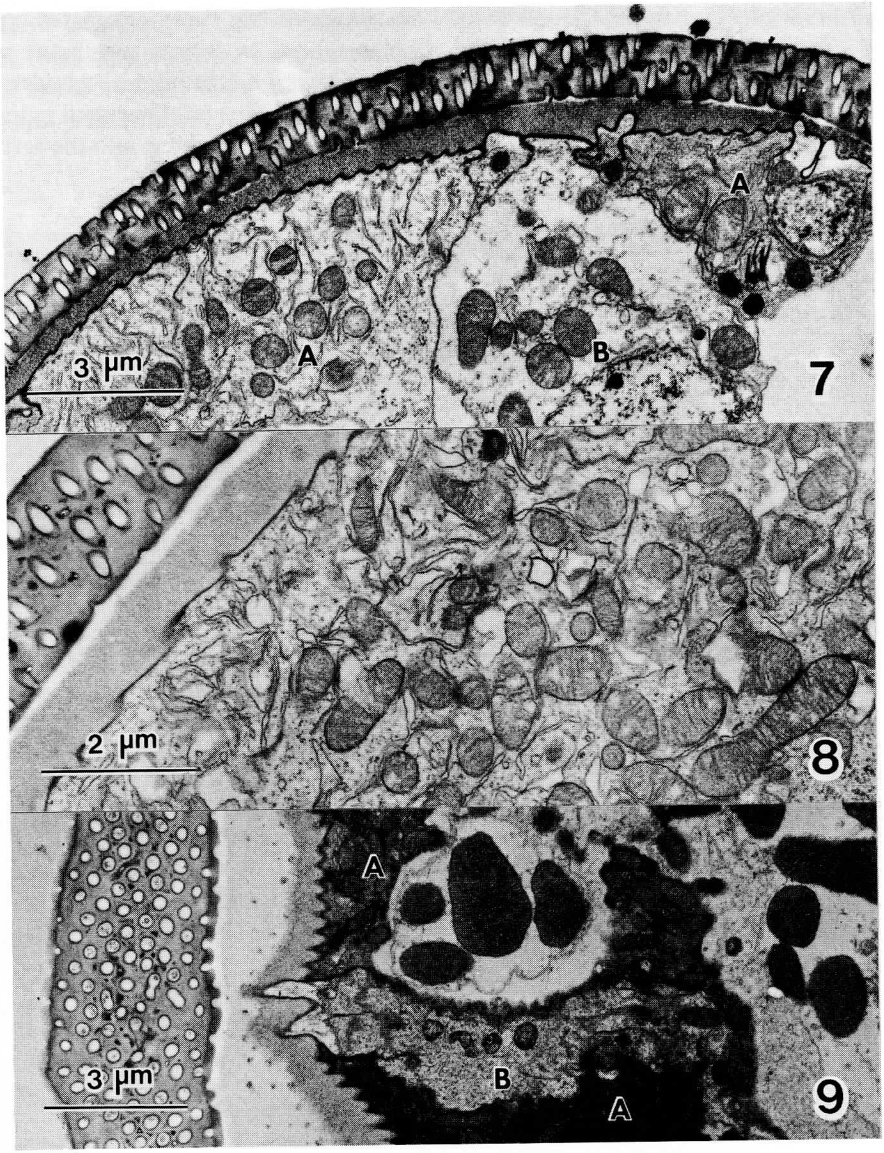

Fig. 7 – TEM of the axillary organ sectioned slightly off the longitudinal axis of pores. Note the membrane plications of cell type A.

Fig. 8 – TEM of cell type A sectioned tangentially through pores. Note the membrane plications in close contact with mitochondria.

Fig. 9 – TEM of axillary organ sectioned perpendicular to pores. Note the substance in pores, and finger-like projections of cell type B.

DISCUSSION

The fine structure of the axillary organ has many similarities to the chloride cells and organs of aquatic insects (see review article by Komnick (1977)). For example, all insect chloride cells are covered by a modified cuticle, and in many species this takes the form of a porous plate. In several species, chloride cells possess an apical cavity containing extracellular material. Some species have two types of cell, with one type containing fewer membrane plications and mitochondria than the other. However, the most predominant feature shared by all chloride cells is the prevalence of mitochondria in close contact with plasma membrane plications. This is a characteristic of cells with active transport functions. Much evidence has been accumulated to support the hypothesis that the chloride cells of aquatic insects function in osmoregulation (Komnick 1977). In fresh-water arthropods aquatic life demands special adaptations for osmoregulation, as active ion absorption is generally necessary for hyperosmotic regulation (Komnick 1977). *Algophagus pennsylvanicus* is found only in water-filled treeholes (Fashing & Wiseman 1980), and the chloride cells of the axillary organs probably provide this function both in this species as well as in the other members of the Algophagidae.

In the Acari, the only other examples of chloride cells are given by Alberti (1977, 1979). He found the fine structure of the genital papillae and Claparède organs of various members of the Actinotrichida, especially the Hydrachnellae, to be analogous to that of insect chloride cells. The Hydrachnellae are aquatic, and he concluded that these structures function in osmoregulation. It is probable that when the fine structure of other aquatic mites is investigated, new examples of chloride cells and organs will be found.

SUMMARY

The astigmatid family Algophagidae is characterized by the presence of axillary organs – elevated sclerotized bands of cuticle on each side of the propodosoma between legs I and II. Studies on the fine structure of these organs in *Algophagus pennsylvanicus* (a species found in water-filled treeholes) reveals a porous plate covering specialized epidermal cells. The latter contain plasma membrane plications in close contact with numerous mitochondria. Such cells are typically involved in active transport. Structurally, the axillary organs are analogous to certain osmoregulatory cells and organs found in aquatic insects, and it is therefore probable that they function in osmoregulation in this group of aquatic mites.

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