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OBSERVATIONS ON THE FINE STRUCTURE OF THE CUTICLE OF TWO DESERT-DWELLING ORIBATID MITES (ACARI: CRYPTOSTIGMATA)

Y. STEINBERGER[1], M. MacQUITTY[2], J. LANGSAM[2] and J.A. WALLWORK[2]

[1]*Dept. of Life Sciences, Bar-Ilan University, Ramat-Gan 52100, Israel and* [2]*School of Biological Sciences, Queen Mary College, London E1 4NS, England*

ABSTRACT

The fine structure of the cuticle of the oribatid mites, *Passalozetes africanus* Grandjean and *Zygoribatula thalassophila* Grandjean collected in the Negev desert of southern Israel, was studied with the aid of scanning electroscopy. These studies revealed the presence of excrescences which may be similar to the waxy blooms recorded from the cuticles of desert-dwelling tenebrionid beetles and other arthropods. The significance of these findings is discussed in relation to water conservation.
KEY WORDS: **Soil mites, oribatidae, cuticle, Israel.**

INTRODUCTION

The presence of an epicuticular layer of lipid on the surface of the integument of many terrestrial arthropods has long been associated with some form of water-proofing mechanism (Wigglesworth, 1945; Beaumont, 1945; Edney, 1957). In a recent review of this topic, Hadley (1981) has pointed out that most of the data available to date regarding the fine structure of this layer relate to desert-dwelling arthropods, notably tenebrionid beetles and scorpions (Hadley, 1977, 1978; Filshie & Hadley, 1979; Hadley & Filshie, 1979; Hadley & Louw, 1980; Toolson & Hadley, 1977,1979).

SEM studies of the fine structure of the cuticle of desert tenebrionid and buprestid beetles (Hadley, 1981; Hanrahan et al., 1984) have shown that the lipid in the epicuticle appears in the form of platelets, long filaments or more consolidated execrescences known as "waxy blooms". Similarly, waxy filaments have been described from the surface of coccinellid larvae and aphids (Pope, 1979, 1983) and from the surface of eggs of various scale insects (Gerson, 1980), although these insects were not peculiar to desert environments. Nor, as far as can be judged, are the cryptostigmatid mites *Oppia coloradensis* and *Gymnodamaeus chalazionus* which have also been recorded to possess epicutilar "waxy blooms" (Brody, 1970; Woolley, 1972).

In a recent study (Steinberger and Wallwork, 1985) on vertical distribution of soil microarthropods in the Negev desert, we found that the Cryptostigmatid mites composite 33% from the total soil microarthropod population. The Cryptostigmatid mites were found in the 6-12 cm layer (stratum) at 6 p.m., towards midnight and early in the morning change in the population was observed due to movement of microarthropods to the upper layer (0-6 cm). This movement of soil microarthropods is made possible by a combination of behavioural, physiological and morphological adaptation.

The present paper reports the occurrence of epicuticular waxy blooms in two species of cryptostigmatid mites, *Passalozetes africanus* Grandjean and *Zygoribatula thalassophila* Grandjean, collected from the Negev Desert near Avdat, in southern Israel.

One of the major avenues of potential water loss from the body of a terrestrial arthropod is across the cuticle. One of the ways in which this water loss may be curtailed is the production of a water-proofing layer of wax or lipid on the surface of the epicuticle. Accordingly, attention was focussed on this structure to ascertain whether such a water-proofing layer could be identified. A scanning electron microscope (JEOL JSM-35) was used for this purpose.

Passalozetes africanus

Gross morphology: Members of the genus Passalozetes are characterized by the possession of a cuticle which is folded in various ways. In *Passalozetes africanus*, the cuticular folds appear, on low magnifications, to have a stellate arrangement (Fig. 1). At rather higher resolutions, however, the pattern assumes a more reticulate configuration (Fig. 2).

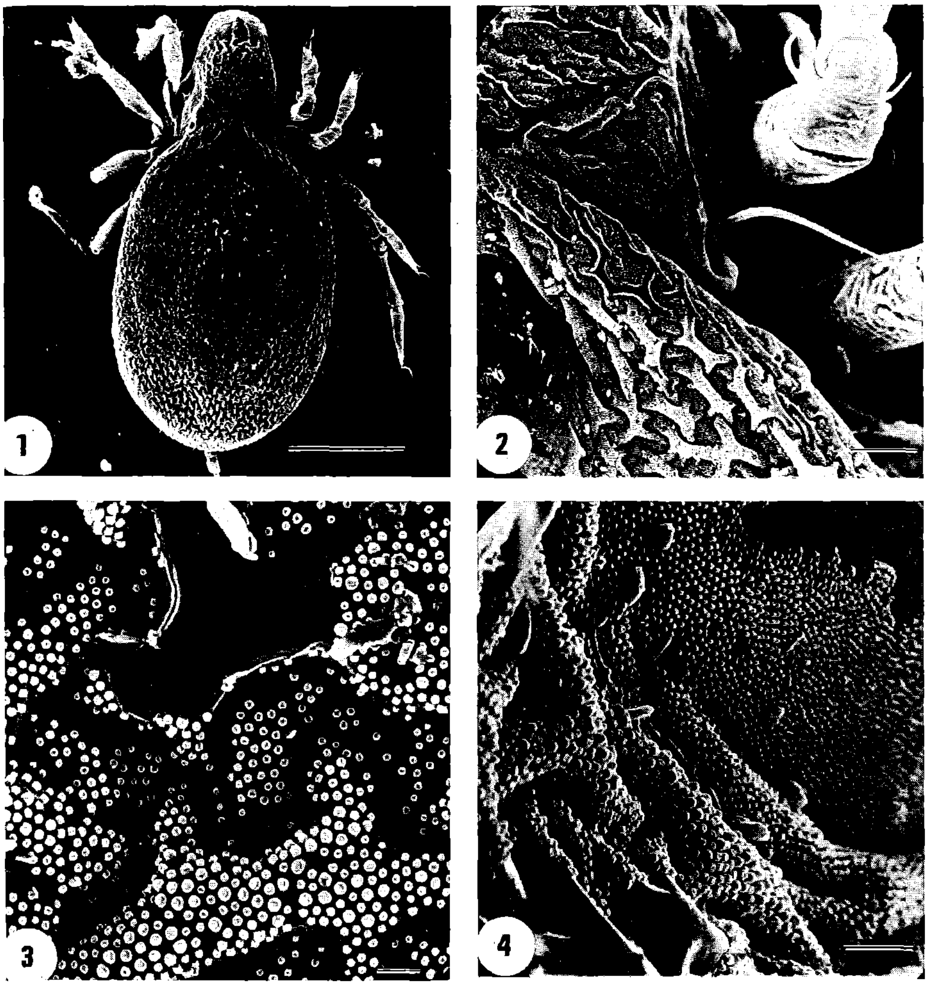
Fine structure: It seems clear that the cuticular folds of *Passalozetes africanus* are covered by a surface film (generally referred to as a 'cerotegumen').

Figure 3 shows a portion of the cuticle from which the cerotegument has been removed. It also reveals the presence, on the intact parts of the cerotegument, of numerous, rounded surface structures which can be interpreted as exudations from the surface of the cuticle. These exudations are widespread over the body, occurring over the lenticulus (Fig. 4) and in the bothridium (Fig. 5). A closer examination of the cuticle reveals a second set of exudations, more regularly arranged than the first (Fig. 6), and smaller in size. The larger excrescences appear to have a structure which consists of a series of segments (rather like those of an orange) grouped around a central canal. The number of segments appears to vary from 5 to 7 or 8. This arrangement is not inconsistent with their formation by means of an eruption of some liquified material, possibly lipid, through a cuticular pore. The smaller protuberances are more uniform, without segmentation or a central canal. They appear to have been formed by exudation rather than eruption. The larger protuberances have a diameter varying between 0.3 and 0.5 μm.

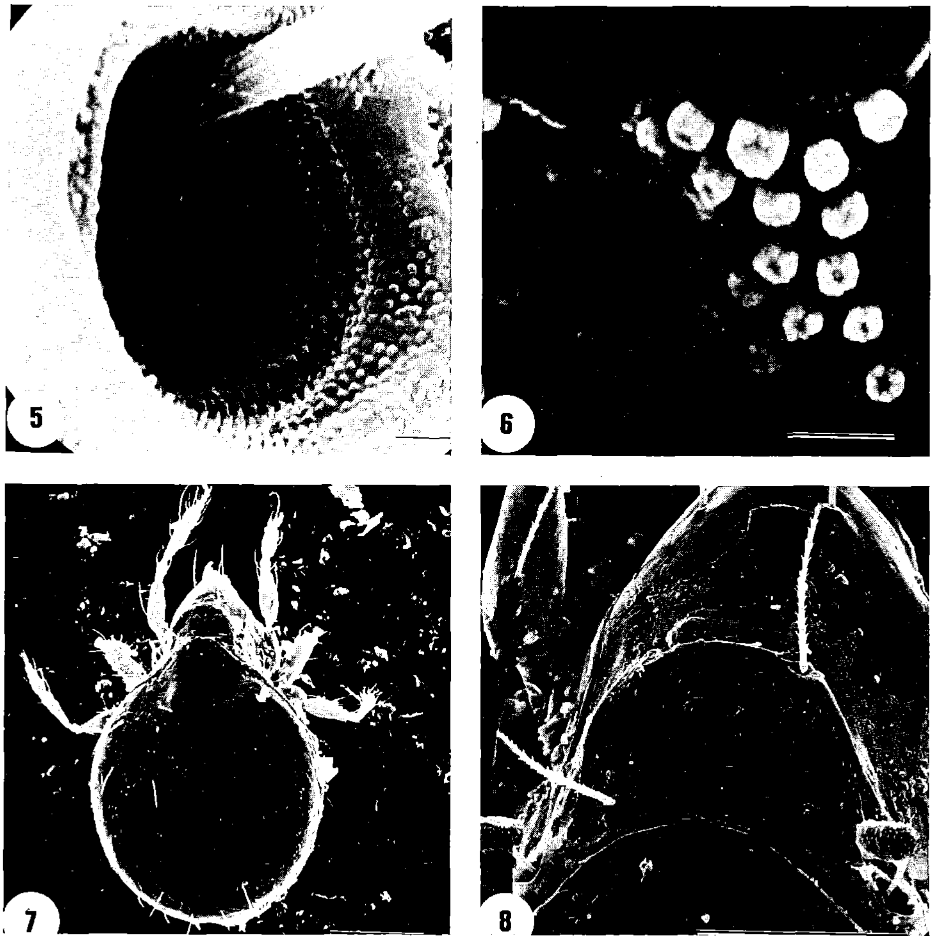
Zygoribatula thalassophila

Gross morphology: The cuticular surface is mainly smooth but areas of cerotegument occur on the prodorsum, podosoma and along the dorso-sejugal suture (Fig. 7). On the prodorsum, cerotegument is found lateral to the lamellae and within and around the bothridium (Figs. 8 and 9).

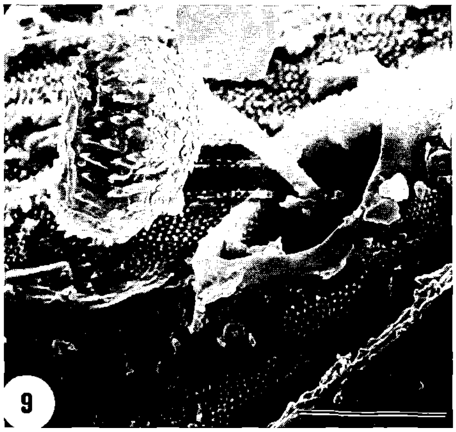
Fine structure: High magnification shows that the cerotegument consists of a lattice of rods which coalesce to form platforms surmounted, in each case, by a flattened spheroid tubercle (Fig. 10). The diameter of the tubercles varies from 0.2 to 0.4 μm.

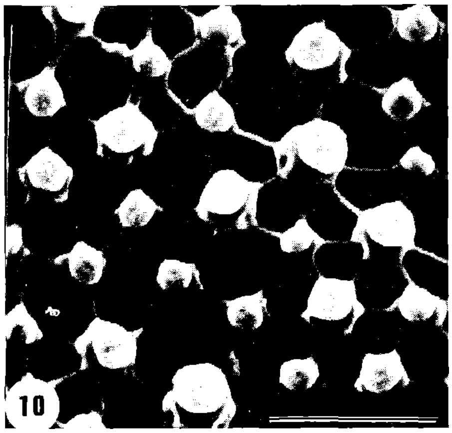


Figs. 1-4. *Passalozetes africanus.* 1. Dorsal view (Bar = 100 μm). 2. Detailed configuration of the stellate arrangement in the humeral region (Bar = 10 μm). 3. Cuticle with and without cerotegument (Bar = 1 μm). 4. Microsculpture of lenticulus (Bar = 2 μm).



Figs. 5-8. *Passalozetes africanus.* 5. Microsculpture of oostridium (Bar = 1 µm). 6. Detail of epicuticular blooms (Bar = 0.5 µm). Figs. 7-8. *Zygoribatula thalassophila.* 7. Dorsal view (Bar = 100 µm). 8. Detailed configuration of lamell region (Bar = 50 µm).





Figs. 9-10. *Zygoribatula thalassophila.* 9. Detail of oostridium region (Bar = 10 μm). 10. Detail of epicuticular blooms (Bar = 1 μm).

DISCUSSION

The presence of so-called "waxy blooms" on the surface of the cuticle has been reported in other desert-dwelling arthropods, notably certain of the tenebrionid beetles inhabiting the Namib desert of southwest Africa (Hanrahan et al., 1984), such as *Onymacris plana* and *O. rugatipennis albotessalata*. In *O. plana*, at least, these "blooms" are developed as long filaments and their degree of development on the cuticle appears to be related to the degree of aridity to which individual beetles are exposed; they are lacking, for example, in specimens of *O. plana* occurring in the foggy coastal zone, but increase in prominence on individuals living further inland in the sand sea. The function of these "blooms" in Namib tenebrionids is still the subject of some speculation. It is possible that they provide a kind of water-proofing layer which controls the loss of transpirational water across the cuticle. Alternatively, they may increase the reflectivity of the cuticle and, thereby, reduce the heat load of the body. Chemical analysis of these filaments indicates that they are composed of proteins, lipids and pigments. In a series of studies carried out in conjunction with the work reported here, various oribatids were treated with xylene to determine if the epicuticular blooms could be removed by a wax solvent. Specimens of *Passalozetes californicus* Wallwork and *Jornadia larreae* Walwork were treated in this way. *P. californicus* has an arrangement of epicuticular tubercles which is very similar to that of *P. africanus*. *Jornadia larreae* belongs to the same family, the Oribatulidae, as *Zygoribatula thalassophila* and has an identical arrangement of tubercles. In neither case did treatment with xylene destroy the integrity of these epicuticular structures (Wallwork, unpubl.). It would appear unlikely, then, that these "blooms" are simply lipid secretions.

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