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Short Communication

Observations on Pollen Processing by *Pneumolaelaps longanalis* (Acari: Laelapidae), a Mite Associate of Bumblebees[1]

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ABSTRACT

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Pneumolaelaps longanalis feeds on nectar and surface compounds of bumblebee-collected pollen grains by dissolving these materials in salivary secretions applied to the grain as it is manipulated by the mite's mouthparts. Observations suggest that sugars applied to the pollen grain during bee-processing serve as a feeding stimulus for the mite.

INTRODUCTION

Pneumolaelaps longanalis Hunter and Husband is a common laelapid mite inhabitant in the nests of several bumblebee species in the Pacific Northwest region of the United States. The mite may be found in great numbers in active bee colonies, moving rapidly over the nest floor and exploring nectar pots and brood cells. Female mites become phoretic on bumblebee queens in older degraded nests, and overwinter with the queens in sheltered sites.

When bumblebees visit flowers, pollen that adheres to their body pelage is raked off with a tarsal comb on legs I and packed into the pollen basket, or corbiculum, on the hind tibia. Nectar regurgitated onto the tarsal comb hairs coats the pollen grains so that they form a sticky ball when they are transferred to the corbiculum. The pollen-nectar ball is then transported to the nest where it is fed to the developing brood.

Wandering *P. longanalis* display an inordinate interest in the bee larvae during brood provisioning, congregating in considerable numbers on the brood cells and appearing at times to actually feed on the larvae. However, it is not

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the larvae but rather the presence of fresh bee-collected pollen that attracts the mites. Hunter and Husband (1973) noted that *Pneumolaelaps* species are attracted to pollen, and that pollen and honey may serve as their food source. Pollenophagy by *P. longanalis* has been verified in a series of laboratory observations described below.

MATERIALS AND METHODS

Mites from a laboratory-maintained colony of *Bombus occidentalis* Greene were isolated on a plaster-of-paris/charcoal substrate for 24 h at 20°C and placed individually in cavity-slide depressions. A coverslip smeared on one side with pollen or with a 2:1 sucrose solution was placed pollen- or sugar-side down over the depression so that mite activity on the underside of the coverslip could be monitored with a dissecting microscope. The primary pollen species used in these observations was *Hypochaeris radicata* L. (Compositae). A fiberoptics lamp provided necessary illumination.

RESULTS AND DISCUSSION

Pneumolaelaps longanalis in test cells rapidly moved to the pollen smear, tapping it with the ambulacra of legs I. When an individual pollen grain was chosen, the gnathosoma (Fig. 1a) was depressed ventrally relative to the opisthosoma and the grain removed from its sticky substrate by the combined action of the palps and chelicerae. The nectar-coated grain was held in the region of the hypostome under the encircling palpi and anterad from the tritosternal laciniae, and rapidly rotated with the help of the chelicerae (ch). During the manipulation, the nectar coating (Fig. 2a) applied earlier by the foraging bee was stripped from the pollen grain surface, exposing the toothed ridges and deep pits characteristic of unembellished *H. radicata* pollen (Fig. 2b). In addition, the manipulated grain lost its normal bright-yellow color within 5–10 s and became pale yellow and more or less translucent. We believe that the color loss was due to removal by the mite of much of the surface pollenkitt (Stanley and Linskens, 1974), a lipoidal substance that covers the pollen grain surface and is incorporated to some extent in the outer wall (exine). The coincident appearance of yellow pigment in the gut of feeding mites supports the assumption that surface pollenkitt was ingested along with the overlying nectar coating. Following feeding, the stripped pollen grain was discarded and another quickly chosen for manipulation. Females were found to process pollen grains twice as rapidly as either males or deutonymphs: (10 s for females ($n=6$) vs. 23 s for males ($n=12$) and deutonymphs ($n=7$)). All three stages utilized remarkably large numbers of grains during each feeding episode. Females stripped an average of 51 per feeding episode (42–85), males averaged 25.5 (8–89), and deutonymphs 26 (9–60).

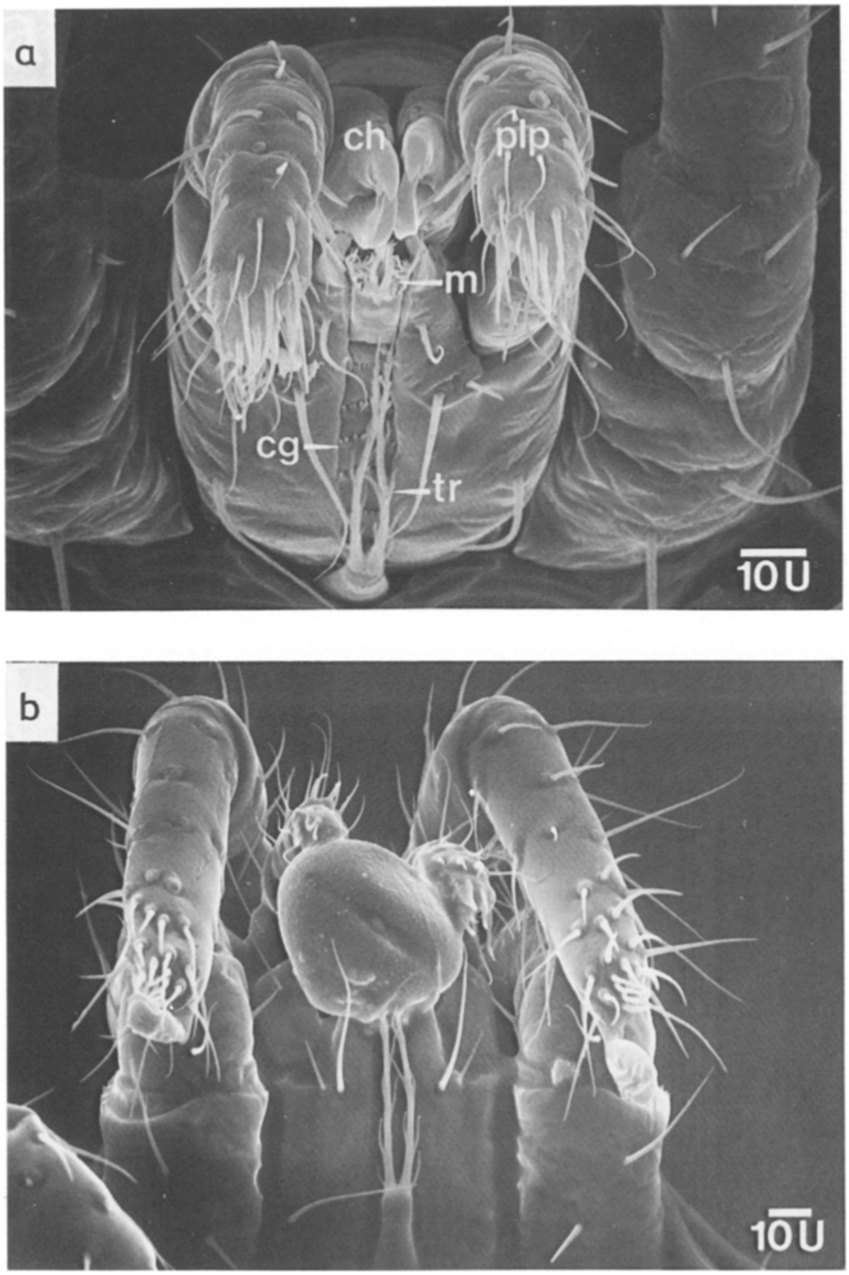

Fig. 1. a. Gnathosoma of *Pneumolaelaps longanalis*, ventral aspect (cg, capitular groove; ch, chelicera; m, malar process; plp; palp, tr, tritosternum).
b. Gnathosoma of *P. longanalis*, ventral aspect, with pollen grain of *Delphinium* between the palpal extremities (SEM; scale bar = 10 μm).

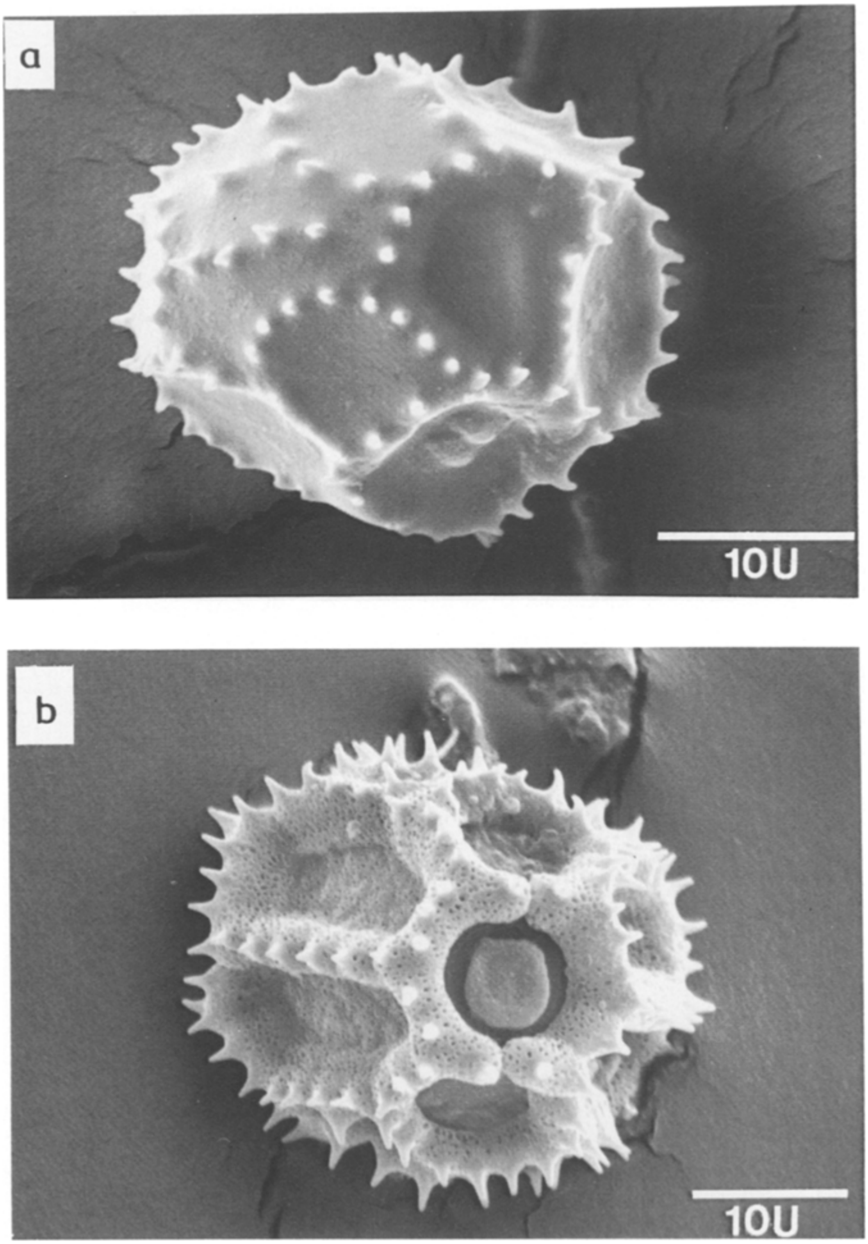

Fig. 2. a. Bee-processed *Hypochaeris radicata* pollen grains showing nectar coating.
b. Bee-processed *H. radicata* pollen grain following feeding by *P. longanalis* (SEM; scale bar = 10 μm).

Pollen of *H. radicata* that had not been bumblebee-collected and coated with nectar was ignored by *P. longanalis*, suggesting that the pollen itself serves only as a vehicle for the attractive surface sugars provided by the bumblebee. Thus, although pollenkitt is ingested by the mites and may supply important nutrients for their development, it does not trigger feeding in the absence of nectar. On the other hand, sucrose sugar crystals applied as a 2:1 aqueous solution to the coverslip feeding platform and allowed to dry were sought out and dissolved in situ by questing mites, which left a mosaic of tiny clear dots in the coated surface to mark their passage. Clearly, sugar is an important feeding stimulus for *P. longanalis*.

The means by which *P. longanalis* removes the nectar and pollenkitt from pollen grains is not entirely clear. Based on earlier research on feeding mechanisms in gamasid mites (Wernz and Krantz, 1976), it appears that these substances are dissolved by salivary secretions that are directed over the rotating pollen-grain surface, and then recaptured and redirected to the preoral cavity via the fluid transport system formed by the capitular groove (Fig. 1a, cg) and overlying tritosternum (tr).

We found that *P. longanalis* accepts a variety of pollens in addition to that of *H. radicata*, including *Delphinium* (Fig. 1b) and *Vicia*. The mites may rupture many of these grains during the feeding process, and it is possible that nutrients are acquired from the pollen core in this way. The thick-walled pollen grains of *H. radicata* generally retain their shape after puncturing, while grains with thin walls such as those of *Vicia* often are completely collapsed following feeding.

The relationship between *P. longanalis* and its bumblebee benefactor is a unusual one in that the bee not only gathers and conditions the mite's food supply, but provides the mite with transport to a protected overwintering site at the end of the brood cycle.

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