

Specific phoretic mites as microclimate originators in special ephemeral soil habitats as presumed co-creators of nutrient-rich soil areas

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INTRODUCTION

In the last decades, different isolated aspects about the life of mites of the Histiostomatidae (Astigmata) have been investigated by various authors. Accordingly, they are predominantly fungus feeders, but in addition to numerous pheromones they also produce fungicides and their phoretic deutonymphs (dispersal stage) transport conidia and asci of various representatives of Ascomycota fungi, for example *Ophiostoma* sp., which the mites seemingly later feed on (Klimov & Khaustov 2018).

Mites of the Histiostomatidae (Astigmata) are good research objects regarding their influence on soil microclimate because they are often easy to breed and can go through many generations in a comparatively short time.

METHODS

Scanning electron microscopy preparations of bare morphology were alcohol-fixed (79%), then critical-point dried. SEM preparations to illustrate behavioral aspects were dripped live in the culture medium with 1.1.1.3.3.3-hexamethyldisilazane, which was evaporated at about 30°C.

Behavioral observations on the use of the mouthparts were recorded on a transparent jelly mass using a Sony Alpha 6300 camera with a light microscope with reflected light and backlight.

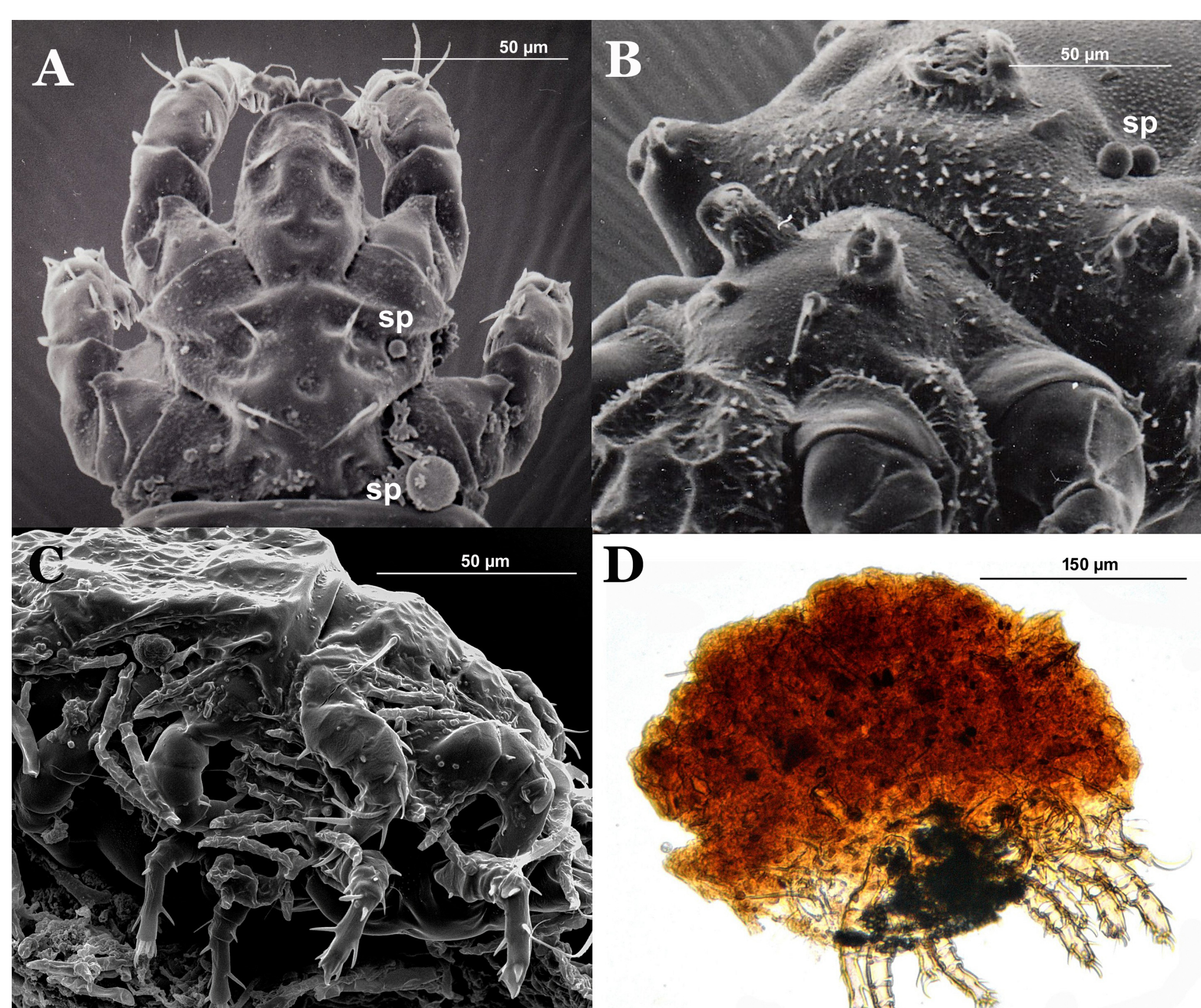


Fig.1 Mites with fungus spores (sp); A: male *Histiostoma piceae*, dorsal front body; B: *H. piceae* female, dorsal view to rear body; C: *H. sp. 1* (soil Amsterdam), side view with copula covered with macro conidia; D: *H. cf. sachsi*, adult with macro conidia and fungal pieces on its backside

RESULTS

Fungal spores on deutonymphs and adults

Different species in all their instars were found to carry fungal spores of different fungus species, single spores or macro conidia. A priori, the spores "stick" to the mites, due to a sticky secretion, but they are mostly found in specific protected areas:

- Deutonymphs: in the region of the proximal forelimbs, under the modified folded hindlimbs (Fig. 1A), on top in the furrow between proterosoma and hysterosoma (front/rear body)

- Adults: e.g. dorsally between the base of the second legs and the edge of the posterior proterosoma shield. (Fig. 1A). Or in "dimples", near the front corners of the hysterosoma (Fig. 1B). Ventral as in deutonymphs. *Histiostoma* sp. 1 carry macro conidia around their bodies (Fig. 1C). *H. cf. sachsi* (ex compost, SW Germany) carry parts of the last juvenile cuticle on their backs with a mixture of fungal hyphae and macro-conidia (Fig. 1D).

Food quality and food size

Species use their fragile chelicerae endings (digitus fixus) to scrape substrate from a flat surface (Fig. 2B), but also to dig into suitable substrate mounds of fungal material (Fig. 2A). Video recordings show that the chelicerae cannot penetrate solid substrates due to their fragility.

The food is a food paste consisting of dead or dying fungus hyphae that are in the process of bacterial decomposition (Fig. 2B). The size of particles is limited by the filter feeding mouthparts (Fig. 2D).

Feeding mechanism

Video analysis of a larva of *H. ruehmi* (Italy, Vesuvio, 2012) on a thin film of liquid emulsion with food: The mite presses the front pedipalp surfaces increasingly firmly against the subsoil, whereby a negative pressure is visibly generated by membranes around the front pedipalps. The negative pressure is applied gradually on both sides, starting with the outermost areas of the distal pedipalps. This moves the underlying food emulsion towards the center of the mouthparts (Fig. 2C, SEM of *H. sp. 2*). Then the chelicereae, surrounded by cuticula ridges, preventing a negative pressure in that area, transport the food to the mouth.

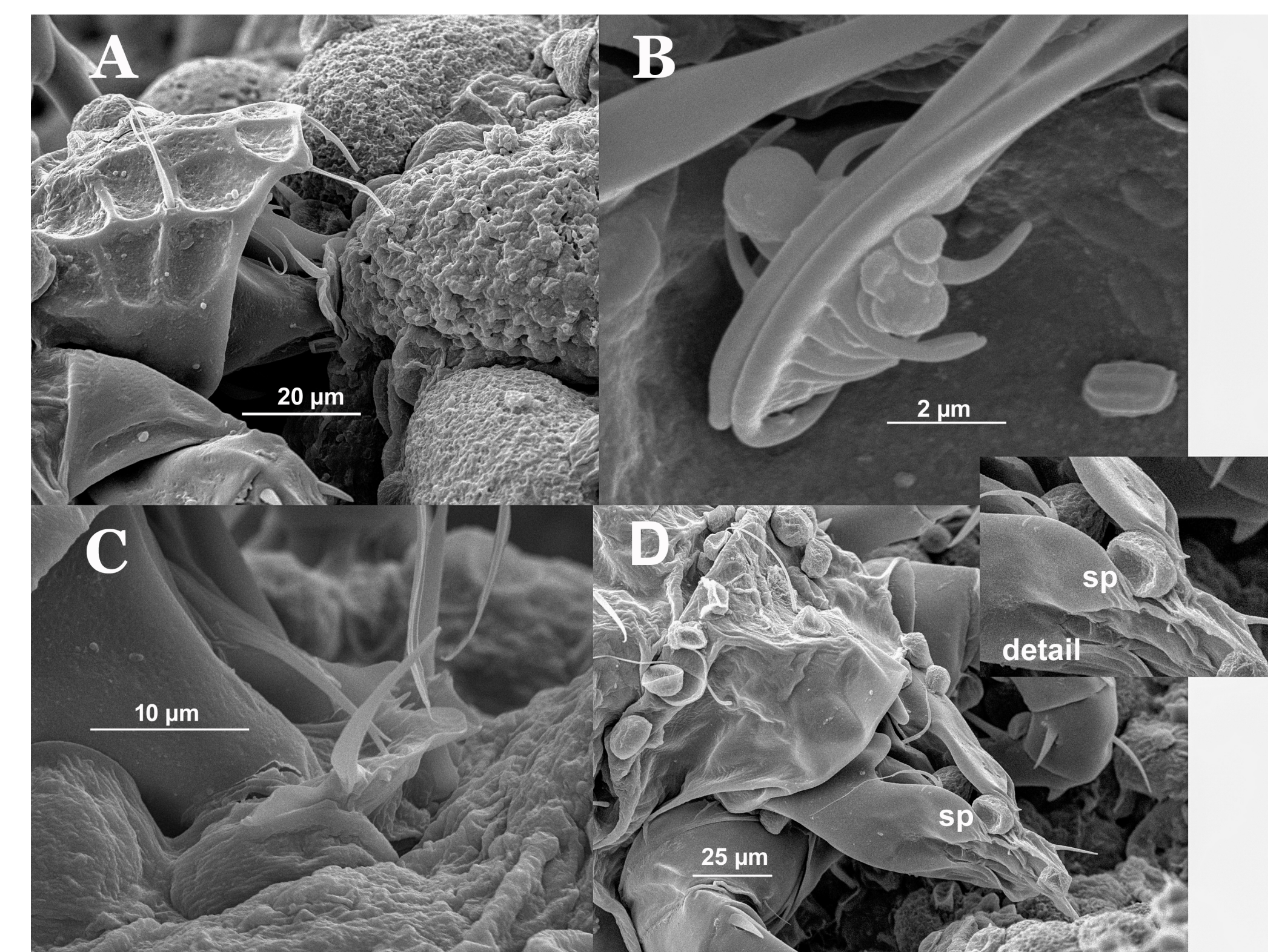


Fig.2 Mites in feeding action; A: *Histiostoma* sp. 2, side view with chelicereae digging into food, B: its digitus fixus with food paste, C: gnathosoma endings pressed on a food surface; D: *Bonomoia opuntiae*, dorsal mouthparts filtering too big particles (spores, sp) out with enlarged photo detail

CONCLUSIONS

Different mite species appear to be tied to different fungal species. I extend the food fungus transportation thesis of Klimov & Khaustov (2018), which they related to bark beetle mites only, as follows:

Also phoretic deutonymphs of soil mites hyperphoretically carry fungus spores into their final habitat. There they germinate and serves as food for the mite. In the habitat, mostly adults spread the fungus further around by its spores or even by viable fungal hyphae. Mites form fungicides that inhibit the growth of the food fungus, so that it becomes stunted and partially dies. Bacterial based decomposing fungus is actual food, a fungus-bacteria mixed diet. With help of their complex chemical secretions and the introduced fungi, the mites have a significant influence on the microclimate in their habitats (e.g. Wirth & Moser, 2008). This might affect the soil quality in soil-dwelling species.

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Theme 1
Status and trends
of global soil
nutrient budget