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Serendipitous discovery of mites in the eye cavity of *Asota caricae* Fabricius, 1775 (Lepidoptera: Erebidae)

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Abstract

Natural history collections face threats of deterioration from various quarters especially arthropod pests. Identifying the breeding and hiding sites of such pests is imperative in maintaining museum collections. We report a serendipitous discovery of mites belonging to genus *Suidasia* from the eye of a recently dry-preserved moth during investigations with SEM. The discovery of a known pest of museum specimens hidden inside the insect highlights the extra care needed to preserve valuable natural history collections.

Keywords: Lepidoptera, SEM, *Suidasia*, dried specimens, mites

Introduction

Natural history repositories have documented biodiversity since their inception and now, due to loss of natural habitat, have become valuable resources for tracking these changes, often holding the only known specimens of threatened or little-known species (Shaffer *et al.*, 1998; Freedman, 2021). Yet despite this, government support for maintaining these repositories has decreased. Trained and enthusiastic replacements for retiring experts are few due to lack of opportunity caused by this lack of funding. The problem is critical in countries like India where environmental conditions, especially high humidity, speed up the deterioration of specimens. Trematerra and Pinniger (2018) mention many arthropods causing damage to museum specimens and suggested various preventive methods. Among these, astigmatan mites (Acari: Sarcoptiformes: Astigmata) are most important, with several species feeding on various stored products, including insect collections (O Connor, 2007).

The presence of live mites on dried insect collections is undoubtedly cause for concern. However, mites have formed numerous associations with insects and their dead bodies are often found still associated with museum specimens. In this manner, insect collections are rich resources for species discovery, and Lepidoptera are no exception, with numerous groups of mites found on moths. Larval Parasitengonina are most common (Felska *et al.,* 2018) but notable other groups include the otopheidomenines (e.g., Prasad, 1975, Lindquist *et al.,* 2020) and *Dicrocheles* (Treat, 1970), as reviewed by Treat (1975). However, the mite pests of stored products – which primarily comprise the Astigmata – are very rarely found on

Lepidoptera. This is especially true for any stage that is not a phoretic deutonymph, a life stage specifically adapted for transport on a carrier, usually an insect (Treat, 1975; O Connor, 2007). Thus, their presence is generally regarded as a contaminant: mites moving from the general environment onto dead insects. In this article we report and discuss our serendipitous discovery of mites from the eye cavity of the moth *Asota caricae* Fabricus,1775 (Erebidae; Lepidoptera).

Report

We were microscopically examining the compound eye of five lepidopteran species [*Asota caricae* Fabricius, 1775, *Daphnis nerri* Linnaeus (1758), *Micronia aculeata* Guenée, 1857, *Catopsilia pomona* (Fabricius, 1775) and *Euthalia aconthea* Cramer, 1779].as part of another study during August 2019. All the specimens (three to five per species) were examined destructively, spread and dried for a week following standard protocols (Krogmann and Holstein, 2010). The specimens were stored in insect boxes and transported over 277 km to Trivandrum from Thrissur (Kerala State, India). They were taken out in the SEM chamber at Sree ChitraTirunal Institute for Medical Sciences & Technology. None of the specimens showed any external signs of deterioration. For SEM analysis, the intact compound eyes were dissected out of the heads using a razor blade. The extracted compound eyes were pressed carefully over a stub with double sided tape. The stub was placed into the sample chamber in the SEM-EDX and pictures of the compound eyes at different scales and angles were taken.

The surface of the eye from all examined specimens appeared unbroken (Fig.1) but the inside of the eye from one *A. caricae* specimen showed at least eleven mites and clusters of what seemed to be eggs (Fig. 2 and 3). As the point of reference for identification was SEM images, only those identifying features presented clearly in the images could be considered. The mites are *Suidasia* (Suidasiidae), which have distinctive body ornamentation that is clearly visible in our SEM images (Figures 4-5). The dorsal body patterning suggests the species is *Suidasia nesbitti* Hughes, 1948. Other features for species identification are not visible (Hughes 1948, 1976; Fain and Philips 1978).

Discussion and Conclusion

After the serendipitous discovery of mites inside the eye of one specimen of *A. caricae*, other specimens of *A. caricae* were examined, but no other infestations were found. However, a single mite and a few Psocoptera (book lice) were observed from the external body surface of a freshly collected *A. caricae*. The discovery of book lice, as well as a mite, on the external surface suggests that the mites were already present prior to the insects being examined, and moved to these specimens as a fresh food source. However, one intriguing possibility is necromeny, a relationship where phoretic mites, instead of moving to new habitats, stay with their host until they die (e.g., Wirth, 2009; Badhran and Ramani, 2019). While we do not expect this to occur in *Suidasia*, the presence of necromeny in other Astigmata suggests that utmost care should be taken with insect specimens immediately after collection.

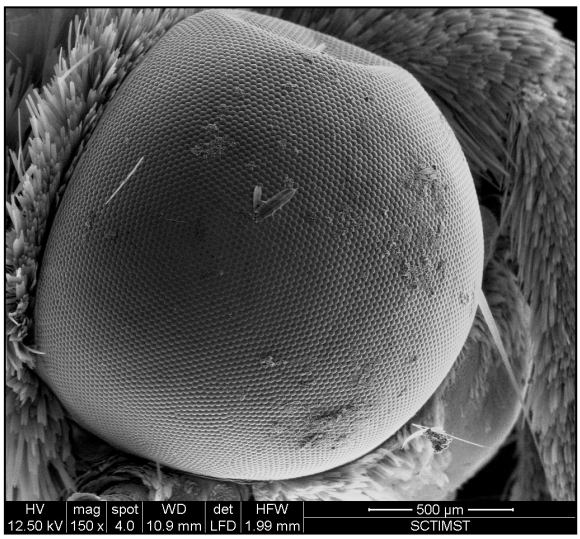

Figure 1. Unbroken eye surface of Asota caricae.

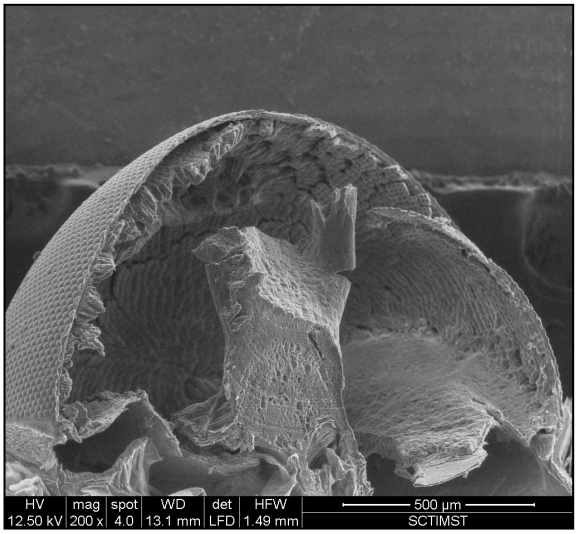

Figure 2. Eye cavity without mite infestation.

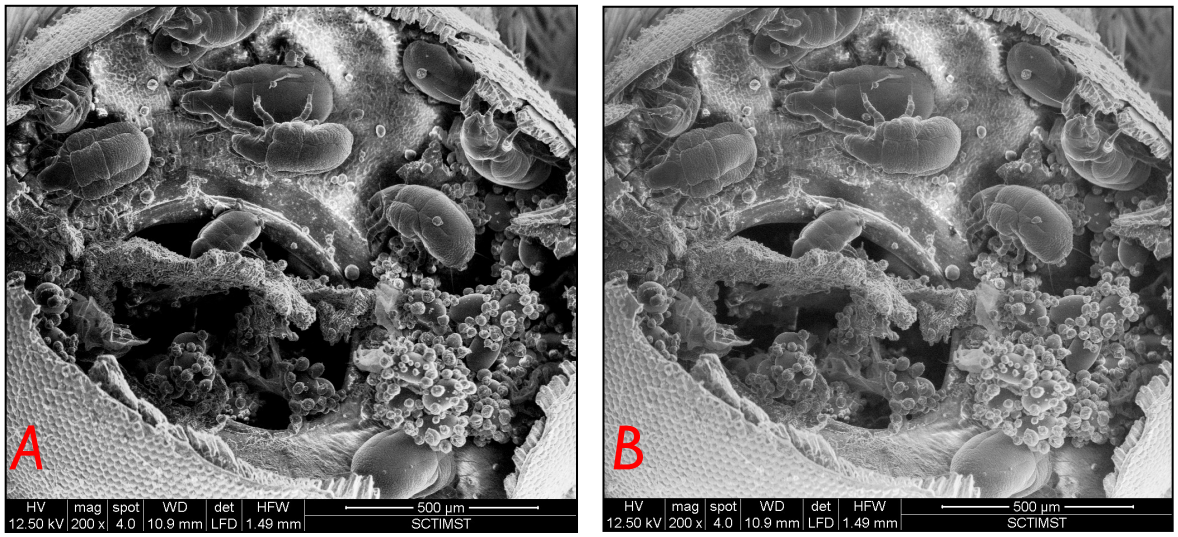

Figure 3. a, b and c: Eye cavity with mite infestation from different angles.

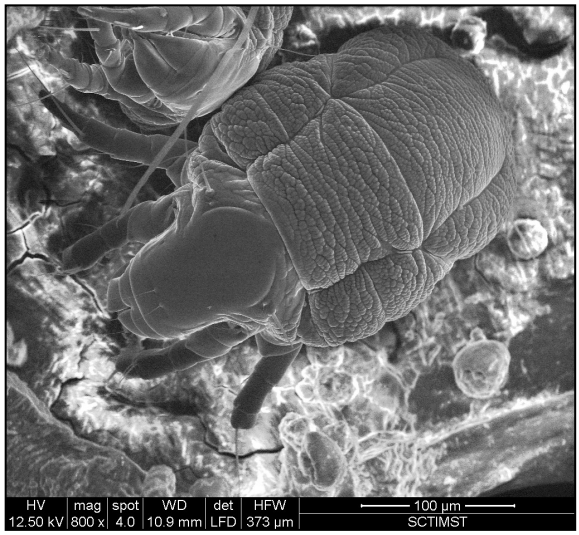

Figure 4. Eye cavity with mite infestation- dorsal view.

Suidasia species are mycophagous species with an astonishing range of habitats. While typically inhabiting a variety of stored products and peridomestic habitats, they have been found invading beehives and nests of solitary bees (*Xylocopa*), on rodents and bats, in bird quills, causing dermatitis in humans and even entering human ears (Fain and Philips, 1978; Koeniger *et al.,* 1983; Ho and Wu, 2002; Samung *et al.,* 2006; Klimov *et al.*, 2016). These mites also appear frequently on dead insects, such as dead mosquitoes (Fox 1950), wasps and beetles (Manson, 1973; OS, pers. obs.). Thus, *Suidasia* is a potential pest of museum collections as they show a remarkable ability to find and exploit recently killed insects. However, as they are mycophagous (Sinha, 1968), decreasing mite infestation requires limiting or eliminating fungal growth on drying insects.

Identifying infestations of mites in museum specimens can be difficult as they tend to target internal soft tissues, which can be completely destroyed, causing smaller specimens to decay or fall apart (Samsinak and Dlabola, 1980). Infestations are likely limited at first, but as life cycles are about two weeks and fecundity over 150 eggs per female (Chmielewski, 1991; Mercado *et al*., 2001), mites can spread quickly through a collection. Thus, appropriate conditions in natural history collections, as well as treatment of specimens, is essential. Of these conditions, humidity control is paramount. *Suidasia* prefers humid environments (Hughes, 1976; Chmielewski, 1991) and many stored-product mites die below 70% RH (e.g. Sánchez-Ramos, 2007). Therefore, when specimens are stored in a dry environment, damage may be limited to the microclimate of the infested specimen. Furthermore, if the insects are

dried quickly then the mites may not complete development. Regarding treatments, freezing specimens may work, but only when frozen for long periods, as most eggs survive at -40 °C for five hours (Edrees, 2014). Likewise, eggs show remarkable resistance to high temperatures (Edrees, 2014). Chemicals are also unlikely to be effective as mites can avoid contact by living within an insect's body. Therefore, we recommend movement of specimens to a dry environment soon after collection.

How did mites gain access behind the eye of a moth in a relatively undamaged week-old specimen? We presume these mites entered the body through natural openings (e.g., tympanal openings, spiracles, genital and anal openings) and therefore no obvious entry points are visible. Thus, infestations can be cryptic. Therefore, even if infestations are short-lived and do little damage, museum specimens may have cadavers of these mites within the bodies of pinned insects. If museum conditions cannot completely suppress fungal growth – especially in hot and humid tropical conditions – these mites could irreversibly damage valuable insect collections. We encourage collectors to move specimens to climate-controlled environments with humidities as close to 50% or below as quickly as possible and curators to show utmost care in taking in new insect collections.

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