

First evidence of parasitisation of a *Bosmina* (Cladocera) by a water mite larva in a karst sinkhole, in Quintana Roo (Yucatán Peninsula, México)

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Short note

ABSTRACT

For the first time a parasitic relationship between a water mite larva and a Cladocera is found and documented by scanning electron microscope (SEM) imaging. A Unionicolidae larva (cf. *Unionicola*) has been found attached to a *Bosmina tubicen* (Cladocera) collected in a karst sinkhole (cenote) in the southeast of the Yucatán Peninsula (México).

Keywords water mites; parasitism; Cladocera; behavior; SEM

Introduction

Water mites have a complex life cycle composed by three active stages: larva, deutonymph and adult and three resting stages: prelarva, protonymph and tritonymph plus the egg (Smith, 1988; Smith *et al.*, 2010). The majority of water mite larvae parasitize adult insects, whereas the free living deutonymphs and adults – with few exceptions – are predators feeding on insect larvae and microcrustacea (Smith and Oliver, 1986; Proctor *et al.*, 2015; Martin, 2005). In general, the hexapod larvae actively seek an appropriate host and become an ectoparasite, which is passively transported while feeding on host fluids. The parasitic / phoretic phase has great importance not only for nutrition, but as well for dispersal of the water mite larvae (Smith and Oliver, 1986; Martin, 2005; Proctor *et al.*, 2015). A host-specific association has been well documented between many water mite larvae and nearly all major groups of aquatic insects as Diptera (mainly Chironomidae), Odonata, Plecoptera, Hemiptera, Coleoptera and Trichoptera (Smith and Oliver, 1986; Martin, 2004). So far, no parasitic relationship with Cladocera has been documented, though deutonymphs and adults of several water mite groups (including the Unionicolidae) can be considered as predators of cladocerans (Proctor and Pritchard, 1989; Proctor *et al.*, 2015). However larva and host range of many taxa is still unknown and a lot of undescribed species (and behavioral patterns) can still be expected – especially, but not only in the tropics (Proctor *et al.* 2015). The observations we present, and document by SEM-images, will certainly contribute to increase the knowledge of larval water mite behavior.

Material and methods

During a faunistic survey of zooplankton composition (Montes-Ortiz and Elías-Gutiérrez, 2018) in the karst sinkhole Cenote Azul (Quintana Roo, México), we found a water mite larva attached to a cladoceran. The specimens were fixed in 96% ethanol and dehydrated subsequently in an ethanol series of 30%, 40%, 50%, 60%, 70%, 80%, 90% and 100% for 15 minutes. The dehydrated sample were critical point dried and gold-coated to be observed under a Scanning Electron Microscope (JEOL-JSM6010) at 10kV (Elías-Gutiérrez *et al.*, 2008).

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Results and Discussion

The water mite larva was tentatively identified as *Unionicola* sp. (Unionicolidae) (Prasad and Cook, 1972; Smith *et al.* 2010; pers. comm. M. Vidrine); the Cladocera could be identified as *Bosmina tubicen* Brehm, 1953 previously found in the area by Elías-Gutiérrez *et al.* (2008). The SEM pictures clearly show, that the water mite larva is attached to the lateral side of the valve of the cladoceran (most probably parasitizing) (Figs. 1 and 2) – a behavior never reported for water mite larvae so far.

The observation is especially remarkable, as so far, the larvae of Unionicolidae are known to parasitize the adult stages of Diptera (Chironomidae) and Trichoptera, and in most cases investigated up to now a defined host specificity has been found (Proctor *et al.* 2015). Although, recently, the exceptional case of a trichopteran larva as host of *Unionicola* larvae has been reported by Martin and Tempelman (2014). Rare similar findings have so far been interpreted as accidental or pure phoretic ("pre-parasitic") associations. However, the authors emphasize that the association they found has to be interpreted as truly parasitic, as the water mite larvae were typically engorged, and suggests evidence for an alternative life cycle of the respective water mite species (Martin and Templemann, 2014). Additionally, Buczyńska *et al.*, (2015) reported the finding of water mite larvae (*Tiphys torris*) attached to a Trichoptera pupa. As well in this case the authors pointed out that the water mite larvae were truly parasitic as they were enlarged. However, in this case the authors interpreted their findings as rather accidental caused by an extended lack of access to a proper host (Buczyńska *et al.*, 2015). Proctor *et al.* (2015) indicate that the opportunities to contact a host occur irregularly in space and time. In this sense, Collins (1975) reported that 75% of *Wandesia thermalis* Viets, 1938 larvae fail to locate a host in a system where the distribution of it is clustered and unpredictable.

Consequently, a possible explanation for the unusual association reported here is that the larva did not find an appropriate host and therefore attached to the Cladocera. Though

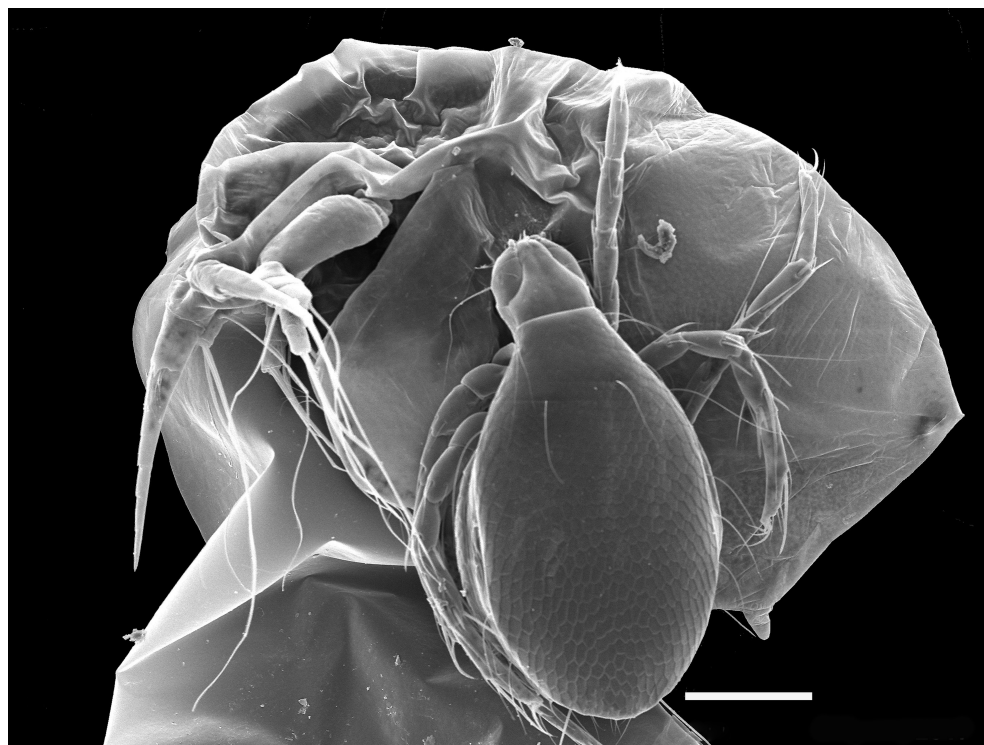


Figure 1 Water mite larva (*Unionicola* sp.) attached to a water flea (*Bosmina tubicen*). The scale bar indicates 50 μ m.

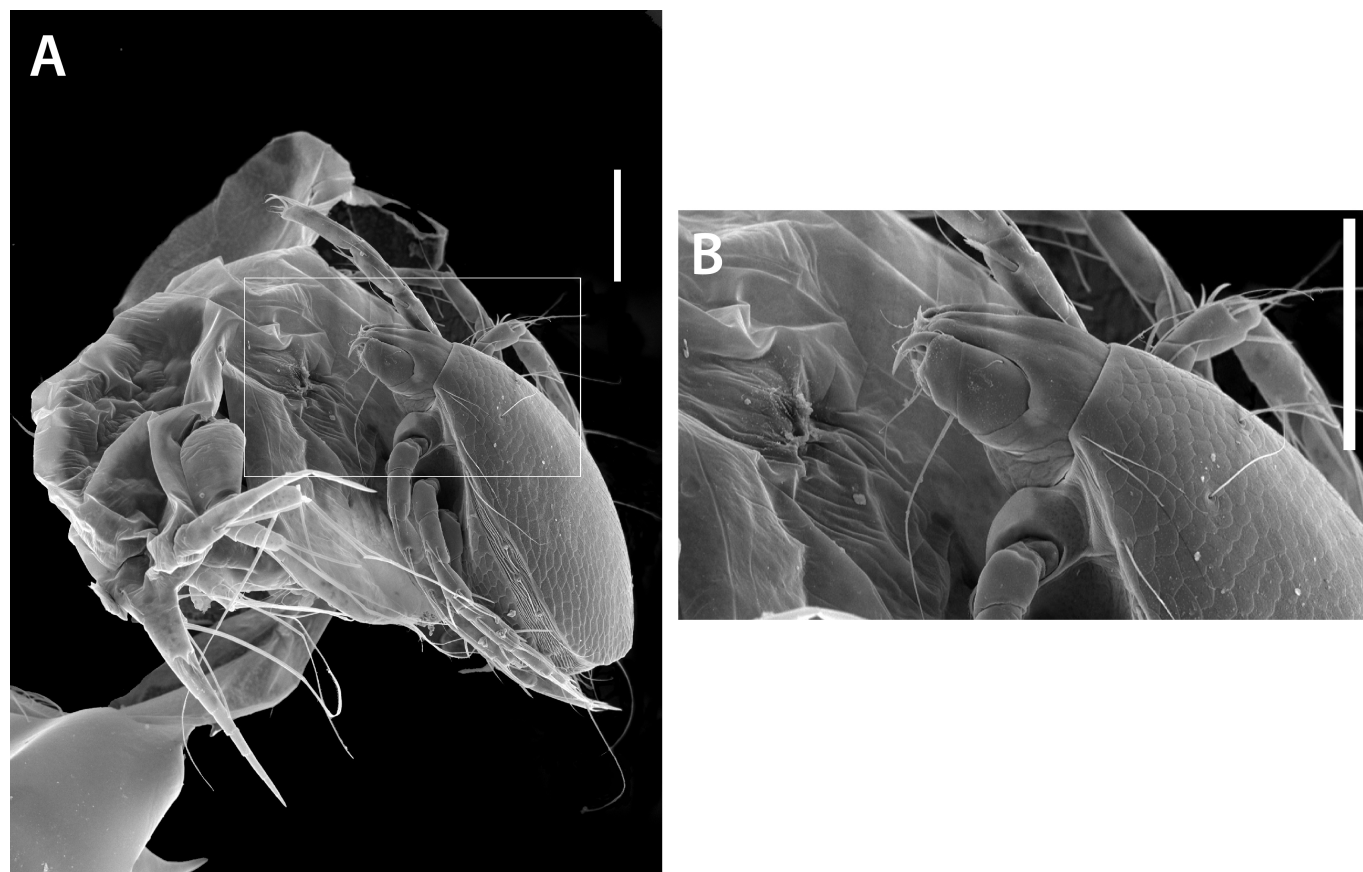


Figure 2 A – Lateral view of the *Unionicola* larva, frontal view on the *Bosmina*. B – Close up of perforations made by pedipalps and chelicerae of the water mite in the valve of the water flea. Scale bars indicate 50 μm .

Chironomidae (a registered host for *Unionicola*) are an abundant and diverse group in the system (Montes-Ortiz y Elías-Gutiérrez, 2018). Another explanation for the documented finding could be that the larva has attacked the cladocera in order to feed on it for a short time before the continuation of its search for a proper host – a behavior as well never documented. Even though the larva is not enlarged, clear traces of the attack are visible (Fig. 2A).

In both possible cases the discovery reported here provides an important contribution to the extension of the existing concept and knowledge on water mite life cycles and their interaction with other members of the invertebrate fauna. Furthermore it has to be emphasized, that the knowledge and understanding of water mite life cycles is still fragmentary and even more limited in the tropics.

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