Subterranean Biology 17: 133–139 (2016)
doi: 10.3897/subtbiol.17.8451
http://subtbiol.pensoft.net

SHORT COMMUNICATION

A peer-reviewed open-access journal
Subterranean Biology
Published by The International Society for Subterranean Biology

First report of cave springtail (Collembola, Paronellidae) parasitized by mite (Parasitengona, Microtrombidiidae)

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Academic editor: *L. Kováč* | Received 11 March 2016 | Accepted 24 March 2016 | Published 15 April 2016

http://zoobank.org/74DC3A8B-A0C6-47B9-BD11-35BCE802E866

Citation: Oliveira MPA, Bernardi LFO, Zeppelini D, Ferreira RL (2016) First report of cave springtail (Collembola, Paronellidae) Parasitized by mite (Parasitengona, Microtrombidiidae). Subterranean Biology 17: 133–139. doi: 10.3897/subtbiol.17.8451

Abstract

Although mites and springtails are important components of cave fauna, until now there was no report about host-parasite associations between these groups in subterranean ecosystem. Here we present the first record of mite parasitism in *Trogolaphysa* species (Paronellidae), and the first known case of parasitism in the Brazilian cave springtail. The Microtrombidiidae mite was attached on the head of the Collembola by the stylostome. Collembola is not a usual host for Microtrombidiidae mites but it may be related to the lack of reports by researchers or few samplings specific to parasitism studies in these invertebrates. Another possibility relates to the cave environment itself. The oligotrophic condition of these ecosystems could limit the occurrence of the main hosts for these mites and the parasitism in unusual groups, such as Collembola, may have been favored.

Keywords

Parasitengona, Collembola, host-parasite associations, subterranean fauna, parasitism

Introduction

Mites and springtails are important components of soil fauna, being widely distributed throughout terrestrial environments and found in almost all known habitats (Hopkin 1997, Walter and Proctor 2013). In some places, such as tropical rainforests, these groups can represent up to 89% of the species found in soil and leaf litter (Franklin and Morais 2006). Besides being common in epigean ecosystems, they are often found in subterranean environments (e.g. Sharrat et al. 2000, Simões et al. 2014, Prous et al. 2015), including many species restricted to caves (e.g. Culver et al. 2003, Lewis et al. 2010, Niemiller and Zigler 2013, Zeppelini et al. 2014).

The high abundance of these groups and the coexistence of their species in the soil allows the occurrence of a series of interactions between these organisms, such as predation and competition, besides parasitism. According to Christiansen (1964), natural enemies of collembolans include different predatory arthropods, primarily mites. Other records indicate that predatory mites that inhabit the soil often feed on springtails (Berg et al. 1998, Ferguson 2001). Ferguson and Joly (2002), in a study of population dynamics of mites and springtails in Canadian prairie areas, showed that the populations of these groups are more influenced by endogenous factors (e.g. population growth dependent on the density related to resource availability) than exogenous factors such as predation (of mites on Collembola) or climatic conditions. However, alterations in mites and springtail abundance in soil can also be explained by competition for food, since these groups have many scavenging species with similar food preferences (Rieff et al. 2014, Kaneko et al. 1998). Another curious interaction between these groups was reported by Norton and Ryabinin (1994), in which some Oribatid mite nymphs carried disposed Collembola exoskeletons on their backs, presumably as camouflage.

The records of parasitism between mites and springtails relates mainly to the Erythraeidae family with species of the genus Erythrites (*E. womersleyi*) parasitizing *Corynephoria* (Collembola: Bourletiellidae) (Greenslade and Southcott 1980), *Leptus trimaculatus* in species of Arthropleona and Symphypleona (Wendt et al. 1992) and a *Leptus* species in unidentified Collembola (Wohltmann 2001). Some Acaridae family species have also been observed in Collembola: *Michaelopus sminthurus*, *Congovidiella collembolicola* and *Calvolia waldorfae* in specimens of *Sminthurus fuscus* (Collembola: Sminthuridae) (Fain and Johnsthon 1974). However, in the latter case, it was not shown that the interaction between the species was only phoretic or promoting damage to the host.

Despite the large number of parasitic mites among those found in the soil, especially the Parasitengona cohort, which feature a wide range arthropods among their hosts, Collembola are not a frequent host (Gabrys 2011, Wohltmann 2001, Zhang 1998). Therefore, we present the first record of mite parasitism in *Trogolaphysa* species (Paronellidae), and the first known case of parasitism in the Brazilian cave springtail.

Methods

The specimens evaluated in this study were sampled in the Clarabóias Cave (20°06.63'S, 43°39.45'W), in the municipality of Rio Acima, Minas Gerais, Brazil. This cave comprises a small iron ore cavity (28 meters of linear development and 58 square meters in area) inserted in the Atlantic Forest domain, in an important mineral production region known as the Iron Quadrangle (Figure 1). Collembola specimens were fixed in 70% ethanol and slide-mounted in Hoyer's solution for identification. The specimen was identified according to Bellinger et al. (1996–2016). Before being removed from the host, the mite was photographed using the Leica S8APO stereomicroscope with attached Leica DFC camera (Leica, Germany). The specimen was then cleared in Nesbitt's fluid and mounted on slides in Hoyer's solution (Walter and Krantz 2009). The specimens were identified with the Leica MDLS phase-contrast microscope (Leica, Germany).

The Collembola is deposited in Collembola and Conservation Systematics Laboratory Collection of the State University of Paraíba (CRFS-UEPB # 4824), and the mite in Subterranean Invertebrate Collection of the Federal University of Lavras (ISLA-UFLA # 11710).

Results

The springtail comprises an undescribed species of *Trogolaphysa*, and the mite was determined as an unidentified genus and species of Microtrombidiidae. This is the first report of this mite family in Brazilian caves. Unfortunately, the only mite specimen collected had some deformities in the legs, and due to uncertainty about the number

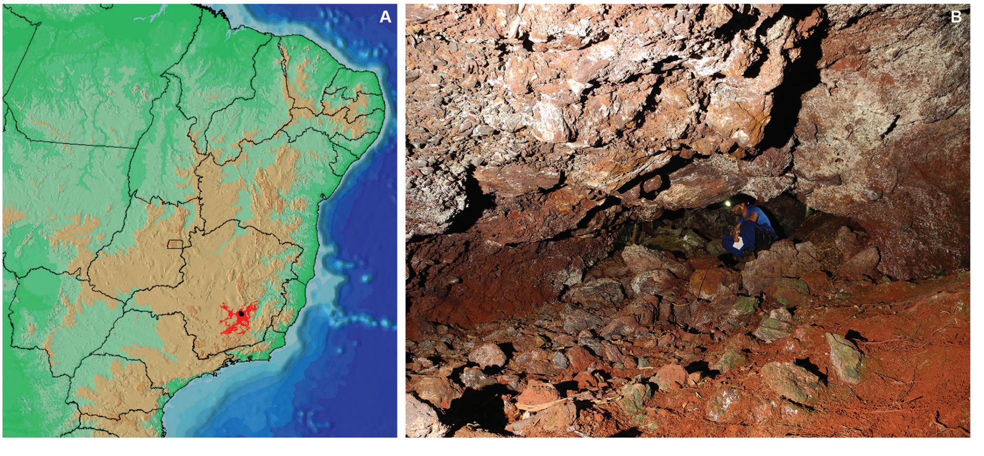

Figure 1. A Location of the Clarabóias Cave (black point) in the Brazilian ferruginous area denominated Iron Quadrangle (red area) **B** General aspect of the cave interior.

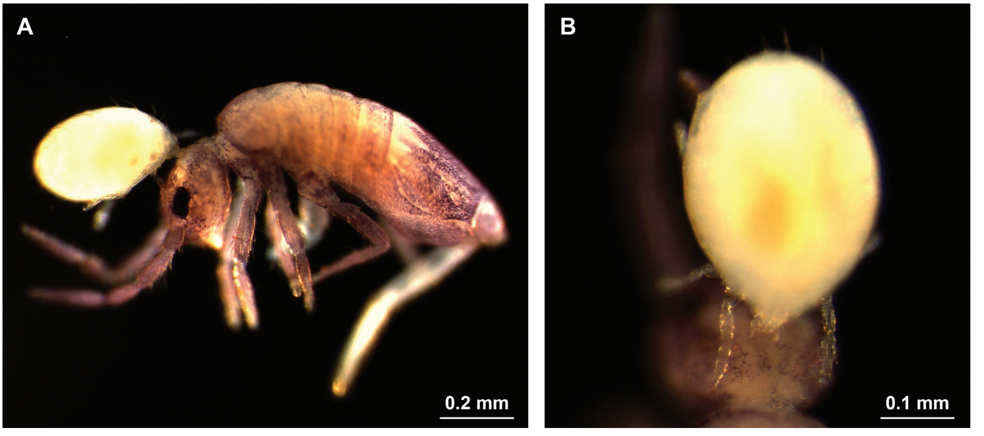

Figure 2. A *Trogolaphysa* sp. n. (Collembola: Paronellidae) parasitized by larvae of an unidentified Microtrombidiidae (Trombidiformes) species **B** Dorsal view of the mite on the springtail's head.

of setae on some of its segments, it was not possible to determine the genus. However, the possibility of this belonging to an as yet undescribed genus in not yet ruled out.

The Microtrombidiidae mite was attached on the head of the Collembola by the stylostome (Figure 2). The estimated mite size is 0.39 mm, almost one third of the springtail body size (20.01 mm).

Discussion

The diversity of habitats and wide distribution of the *Trogolaphysa* genus qualifies it as potential host for mites, although this is the first report of parasitism for this group. The genus consists of 40 species worldwide, and 37 of these are present in the Americas (Soto-Adames and Taylor 2013). In Brazil, it is the richest genus of Paronellidae, with five described species, which corresponds to one third of the species known for this family in the country (Da Silva and Bellini 2015). It is widely distributed in Brazil, being present in areas of the Atlantic Forest, Cerrado and the Amazon rainforest. In these biomes they are often found in leaf litter, soil, forest humus and near flooded areas (Oliveira 2013), habitats similar to those described for the parasitic larvae of Parasitengona (Wohltmann 2001). According to Palacios-Vargas and Thibaud (1997), *Trogolaphysa* can be considered one of the most popular genera in Collembola, due to morphological adaptations (troglomorphisms) often observed in species in the subterranean environment. There are at least nine species of troglomorphic and subterranean environment-restricted *Trogolaphysa* (Palacios-Vargas 2002). In addition, new species have been sampled in South American caves, mainly in Brazil, which will further increase the representation of this group in the hypogean environment (Brito et al. unpublished results).

For Microtrombidiidae, there are the no reports of parasitism on springtails. Some groups of arthropods, such as Hemiptera, Orthoptera and Diptera, are the most common host for larval stages of this family (Heath and Snell 2006, Stroiński et al. 2013). The absence of Collembola and other potential groups amnog the hosts may be related to the lack of reports by researchers or few samplings specific to parasitism studies in invertebrates, especially in tropical areas. The absence information can also be related to the duration of the parasitic larval phase of Parasitengona, ranging from 3-14 days in most species, temporally limiting sampling of parasitized individuals (Wohltmann 2001). Another possibility relates to the cave environment itself, which may be the result of a characteristic oligotrophic association condition of these ecosystems. Since the absence of primary production in caves limits the occurrence of the main hosts for these mites, the parasitism in unusual groups, such as Collembola, may have been favored. However, these assumptions are speculative, and future studies and observations are needed to confirm or refute these hypotheses.

The presence of the mite on the head of the Collembola probably facilitated the development of the parasite. According to Wohltmann (2001), field observations of some Microtrombidiidae have indicated their preference to parasitize on the dorsal parts and the first abdominal segments of the hosts. However, subsequent observations in the laboratory have shown that, indeed these mites anchor on all parts of the body, but most are removed by cleaning movements of the host. The exception are those present in dorsal areas not reached by the host appendages (Wohltmann 2001).

The successful development of the larval stage allows the mite a 10 to 576 fold freshmass increase (Wohltmann 1999), possibly even exceeding the host size (Wohltmann 2001). Despite the excessive growth, there are few studies about the influence of Parasitengona parasitism on their hosts. For some aquatic species of this cohort late ontogenetic development besides reduced host fertility and longevity were demonstrated (see Wohltmann 2001). In aphids, the presence of a few Parasitengona larvae can be lethal to parasitized individuals (Zhang 1992).

This work revealed an interesting association between springtails and Microtrombidiidae mites, indicating that the chances of hosts for this family should be much more diverse than is currently known. New reports on host-parasite interactions will be important to improve the understanding of the group and its spectrum of host. For subterranean environments such research is even more relevant, since data on the effect of these environments on the parasitism relationships is nonexistent.

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