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TINY TRAVEL COMPANIONS: PHORETIC ASSOCIATION BETWEEN CHERNETID PSEUDOSCORPION (PSEUDOSCORPIONES: CHERNETIDAE) AND MOTH *TEPHRONIA SEPIARIA* (LEPIDOPTERA: GEOMETRIDAE)

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Ćato, S.: Tiny travel companions: phoretic association between chernetid pseudoscorpion (Pseudoscorpiones: Chernetidae) and moth *Tephronia sepiaria* (Lepidoptera: Geometridae). Nat. Croat., Vol. 33, No. 2, 391-396, Zagreb, 2024.

Apart from being transferred via substrate samples or human activity, pseudoscorpions can also engage in phoresy. This involves them attaching themselves to more mobile animals and traveling long distances while investing small amounts of energy. Phoretic behaviour of a pseudoscorpion is newly documented in the coastal region of Croatia, marking the first confirmed record of such behaviour within the country. This is the first instance of the moth *Tephronia sepiaria* (Hufnagel, 1767) being identified as a phoretic host. The study entails a succinct discussion of the known lepidopteran hosts, as well as the ecology of the host species and its phoront.

Keywords: Croatia, dispersal, Lepidoptera, phoresy, Pseudoscopiones

Ćato, S.: Sićušni suputnici: foretička zajednica lažištipavca (Pseudoscorpiones: Chernetidae) i noćnog leptira *Tephronia sepiaria* (Lepidoptera: Geometridae). Nat. Croat., Vol. 33, No. 2, 391-396, Zagreb, 2024.

Osim što se prenose uzorcima tla ili ljudskom aktivnošću, lažištipavci također mogu sudjelovati u forezi. To uključuje njihovo prihvaćanje na pokretnije životinje i prelazak velikih udaljenosti ulažući male količine energije. Foretičko ponašanje lažištipavca je nedavno dokumentirano u priobalju Hrvatske, s prvim potvrđenim nalazom takvog ponašanja u zemlji. Zabilježena pojava predstavlja prvi primjer noćnog leptira vrste *Tephronia sepiaria* (Hufnagel 1767) kao foretičkog domaćina. Istraživanje uključuje sažetu raspravu o dosad poznatim domaćinima iz reda Lepidoptera te o ekologiji domaćina i njegovog foronta.

Ključne riječi: Hrvatska, rasprostranjivanje, Lepidoptera, foreza, Pseudoscorpiones

INTRODUCTION

Pseudoscorpions (order Pseudoscorpiones) are diminutive arachnids, ranging in size from 0.7 mm to 12 mm. Found worldwide, they comprise 25 families and 472 genera, with more than 4100 described species (WPC, 2022). The most recent pseudoscorpion checklist for Croatia (Ozimec, 2004) lists 99 species and 10 subspecies (altogether 109 taxa). Since then, a considerable number of new species from the country

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have been described. However, authors often deviate from good taxonomic practice, e.g., taxonomic descriptions lack details, holotypes are not publicly accessible, or the type localities are imprecise, hindering the collection of topotypes. According to the latest version of the WPC (2022), the Croatian pseudoscorpion fauna has expanded to include 146 species and subspecies. Pseudoscorpions inhabit diverse environments, including forests (leaf litter and tree microhabitats) and various other microlocations like compost piles, manure heaps, and various nests, including those of birds, mammals, and different insects (e.g., ant, bee, and termite nests) (Beier, 1948). Additionally, they have high species richness in the subterranean realm (Hlebec *et al*., 2023a).

A common behaviour observed in this order is phoresy, enabling widespread distribution. Species that exhibit phoretic behaviour typically lack genetic variation both between and within populations (Opatova & Šťáhlavský, 2018; Hlebec *et al*., 2023b). Individuals attach themselves to various animals to be transported to new habitats, gaining access to potentially abundant food sources (Poinar *et al*., 1998). Pseudoscorpion phoresy has been documented on insects, arachnids, and even birds and mammals (e.g., Beier, 1948; Muchmore, 1971; Martens, 1975; Poinar *et al*., 1998). There are two prevailing hypotheses regarding the origin of phoretic behaviour. The predation hypothesis suggests that phoresy is accidental, resulting from unsuccessful predation (Vachon, 1940; Muchmore, 1971). On the other hand, the dispersion hypothesis proposes that phoresy is a deliberate and intentional behaviour (Beier, 1948; Poinar *et al*., 1998). The latter hypothesis seems more plausible, especially considering that the majority of observed phoretic individuals are adult females (Vachon, 1947), which, upon being transported, expand the species' range. The earliest documented case of phoresy was described by Menge (1855), who noted that the Baltic amber species *Dichela berendtii* Menge, 1854 was attached to an unidentified parasitic wasp (Hymenoptera: Ichneumonidae). Pseudoscorpion phoresy is an interesting phenomenon occurring constantly in nature but documentation of such events is sparse, especially in some countries (including Croatia) where research on the matter is lacking. Discovering, reporting, and investigating different phoretic associations of pseudoscorpions and their hosts can provide a better insight and new information about the ecology, life cycle, and behaviour of both the phoront and the host.

MATERIALS AND METHODS

During late night hours in Biograd na Moru (northern Dalmatia) on 19th June 2022 moth attracted to a porch light was discovered with a pseudoscorpion attached to it (Fig. 1A). The observation was photographed using a Nikon D3500 digital camera with a macro lens attached (Sigma 105mm f/2.8 EX DG OS HSM Macro model). Since the pseudoscorpion specimen was not collected, it can be morphologically identified only to the family and genus level using the available identification keys (Harvey, 1992; Christophoryová *et al*., 2011).

RESULTS

The pseudoscorpion was attached to the moth by holding onto its abdomen, possibly using both of its pedipalps (Fig. 1B). The moth was identified as *Tephronia sepiaria* (Hufnagel, 1767), a widely distributed species of the family Geometridae occurring from central-southern Europe to Asia Minor, Transcaucasia, and northern Africa (Fiu-

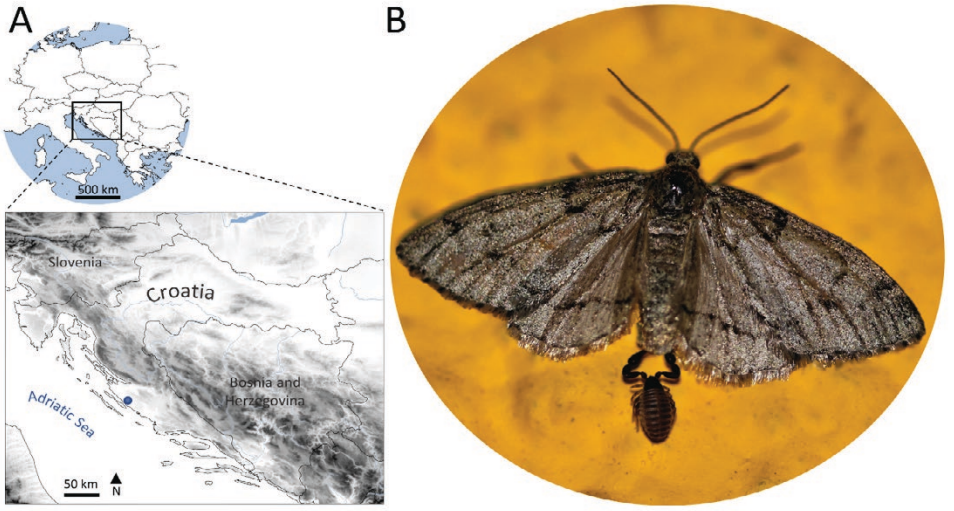

Fig. 1A. The map of Croatia, with a blue dot indicating the locality where phoresy was recorded. B. Chernetid pseudoscorpion phoretic on the moth *Tephronia sepiaria*.

mi *et al*., 2013). Identification was confirmed by Dr. Stanislav Gomboc. Based on the image, the pseudoscorpion was identified as a member of the genus *Chernes* Menge, 1855, family Chernetidae. The exact species cannot be confirmed since microscope examination was out of the question, but based on the habitus it is likely to have been either *Chernes cimicoides* (Fabricus, 1793) or *C. hahnii* (C.L. Koch, 1839).

DISCUSSION

With this record, pseudoscorpion phoresy is confirmed for Croatia. The observed phoront belongs to the genus *Chernes* and the phoretic host is a geometrid moth, *Tephronia sepiaria* which is documented for the first time in that role (Fig. 1). There are at least ten families of pseudoscorpions confirmed to exhibit phoretic behaviour (Poinar *et al*., 1998). In Europe, the most frequently observed phoretic species belong to the families Chernetidae and Cheliferidae (Poinar *et al*., 1998). For example, *Lamprochernes nodosus* (Schrank, 1803) (Chernetidae) is often observed as phoretic, primarily on Diptera (Poinar *et al*., 1998; Christophoryová *et al*., 2018b), while phoretic behaviour is not commonly documented for the genus *Chernes*, with only a handful of existing records (e.g., Wagner, 1892; Jones, 1978; Bloxham & Smart, 2001; Christophoryova & Krásenský, 2022). Apart from Diptera, other common hosts include the insect orders Coleoptera, Hemiptera, and Hymenoptera (Haack, 1987; Castillo & Villegas-Guzmán, 2016). Some of the less common hosts are, among others, Lepidoptera families such as Erebidae, Geometridae, Hesperidae, Noctuidae, Riodinidae, and Sphingidae (Aguiar & Bührnheim, 1998; Magro 2013; Christophoryová *et al*., 2021). Berland (1932), without providing specific details or references, also mentions the observation of a pseudoscorpion being transported by a microlepidopteran. Reviewing the literature, one can conclude that the most frequently reported lepidopteran host family is Noctuidae, while records of Geometridae are scarce. This makes the current observation rather significant, not only report-

ing an uncommon phoront but also a rare phoretic host, with *T. sepiaria* being observed for the first time as a host in pseudoscorpion phoresy.

The larvae of *T. sepiaria* feed on lichens inhabiting various trees and shrubs, as well as other surfaces including stumps, poles, boards, wooden fences, and stone walls (Fiumi *et al*., 2013). Overwintering occurs in the larval stage, while the imago flies between May and August (Fiumi *et al*., 2013), which aligns with the date of the current observation. Both potential species of the genus *Chernes* (*C. cimicoides* and *C. hahnii*) are widespread in most of Europe, particularly in central Europe (WPC, 2022). Both are closely associated with the subcortical habitat (under tree bark) of various tree genera such as *Betula* L., *Fagus* L., *Pinus* L., *Platanus* L., and *Quercus* L. (Christophoryová *et al*., 2017: 2018a), while the larvae of *T. sepiaria* feed on lichens commonly found on the bark of those trees (see above; Fiumi *et al*., 2013). The adult life stage of the moth (May-August) aligns with the activity and mating period of *Chernes* (e.g., Christophoryova *et al*., 2018), creating the most common scenario in which individuals seeking mates and/or tending to disperse can find their carriers and engage in phoresy. In this specific case, there are multiple possibilities for how exactly the phoront and the host came into contact. It could have happened shortly after the host's emergence from the pupa, with the moth found resting by the phoront. Another possibility is that it happened while the host was laying eggs (the moth is a female, having simple, unbranched antennae) on lichens in the vicinity of the pseudoscorpion. The third possibility is that the interaction was purely accidental, with the moth landing somewhere near the phoront, or with the pseudoscorpion wandering the tree bark long enough to encounter the moth and attach to it.

This record of pseudoscorpion phoresy is a confirmation that the phenomenon also occurs in this part of the world, and this gives us an additional reason to be more alert during the future field work for possible new observations of this kind.

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