First record of phoresy of *Dendrochernes cyrneus* (L. Koch, 1873) (Pseudoscorpiones, Chernetidae) on *Cerambyx cerdo* Linnaeus, 1758 (Coleoptera, Cerambycidae) and their potential value as bioindicators

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Abstract

First record of phoresy of Dendrochernes cyrneus *(L. Koch, 1873) (Pseudoscorpiones, Chernetidae) on* Cerambyx cerdo *Linnaeus, 1758 (Coleoptera, Cerambycidae) and their potential value as bioindicators.*— The first evidence of phoresy of *Dendrochernes cyrneus* (L. Koch, 1873) on *Cerambyx cerdo* Linnaeus, 1758 is documented. A critical review of all known literature reports of phoresy involving *D. cyrneus* is also presented. Two of these reports relate to the same observation and are the result of the systematic turmoil within the family Cerambycidae. Both species are treated as primeval forest relics and their isolated populations live in the scattered remains of the ancient forests that covered Europe in the past. We provide new information about the ecological relationships of *D. cyrneus* with saproxylic beetles, and discuss the ecological preferences of the two species and their role as indicators of the quality of the environment.

Key words: Phoresy, Pseudoscorpions, Longhorn beetles, Saproxylic invertebrates, Indicator species, Primeval forest relics

Resumen

El primer registro de foresía de Dendrochernes cyrneus *(L. Koch, 1873) (Pseudoscorpiones, Chernetidae) en* Cerambyx cerdo *Linnaeus, 1758 (Coleoptera, Cerambycidae) y su valor potencial como bioindicadores.*— Se documenta la primera prueba de foresía de *Dendrochernes cyrneus* (L. Koch, 1873) en *Cerambyx cerdo* Linnaeus, 1758. También se presenta una revisión crítica de todos los informes científicos publicados sobre la foresía relacionados con *D. cyrneus*. Dos de estos informes guardan relación con la misma observación y son el resultado de la confusión sistemática existente en la familia Cerambycidae. Ambas especies se tratan como vestigios del bosque primigenio y sus aisladas poblaciones viven en las zonas residuales dispersas de los bosques antiguos que cubrían Europa en el pasado. Aportamos nueva información sobre las relaciones ecológicas de *D. cyrneus* con escarabajos saproxílicos y analizamos las preferencias ecológicas de las dos especies y su función como indicadores de la calidad del ambiente.

Palabras clave: Foresía, Pseudoescorpiones, Escarabajos longicornios, Invertebrados saproxílicos, Especies indicadoras, Vestigios de bosques primigenios

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Introduction

Pseudoscorpions have a limited ability to disperse to new environments. In the course of evolution, the phenomenon of phoresy on hosts from different systematic groups evolved in order to accelerate dispersion. This behavior arose very early and is known from Cretaceous amber (Schawaller, 1991).

Pseudoscorpions are organisms that inhabit almost all types of biotopes and many of them are characterized by a strong attachment to a particular habitat. Some species live in the nests of social insects such as bees or ants, or in the burrows of rodents, or in the nests of birds (Beier, 1963; Christophoryova et al., 2011; Krajčovičová et al., 2015; Turienzo et al., 2010).

Both the pseudoscorpion *Dendrochernes cyrneus* (L. Koch, 1873) and the longhorn beetle *Cerambyx cerdo* Linnaeus, 1758 are treated as primeval forest relics (Beier, 1963; Bily & Mehl, 1989; Bussler et al., 2005; Muster, 1998; Müller et al., 2005). Their isolated populations live in the scattered remains of the ancient forests that once covered Europe.

From the ecological point of view, pseudoscorpions are not considered to be proper bioindicators on a large scale, but they may be useful to assess the condition of specific microbiotopes (Gerlach et al., 2013). However, according to Dajoz (2000) as cited in Gobbi et al. (2012), longhorn beetles might be an excellent indicator species of the health of saproxylic assemblages in wood because of their habitat specificities and because they are relatively easy to identify (Sama, 2006; Speight, 1989). Phoresy was observed during research on the naturalness of forests in a designated area. The aim of this work is to contribute to knowledge of the ecology and phoretic relationships within saproxylic invertebrates.

Material and methods

Phoresy of *D. cyrneus* on *C. cerdo* was observed in the environs of the village of Oława (Poland) (coordinates of the plot: 50° 56' 46.7" N; 17° 19' 33.9" E). The study area is located at the edge of the Zwierzyniec Nature Reserve. This reserve is part of a large forest complex with an area of about 2,000 ha, located within the Natura 2000 Special Area of Conservation for habitats (PLH020017) Grądy w Dolinie Odry. The main target of protection in the reserve is the fragment of a deciduous forest with oak trees that are more than 200 years old, and which phytosociologically belong to the elm–ash riparian forest *Ficario–Ulmetum minoris* Knapp 1942 *em. J. Mat.* 1976. The tree stand is dominated by oak and linden but also contains hornbeam, elm, maple, ash and spruce.

The large tree–chernes *Dendrochernes cyrneus* (L. Koch, 1873) is a widely distributed pseudoscorpion species of the family Chernetidae. It is found in Algeria, in most of Europe, and also in the Asian part of Russia, extending to Nepal and Pakistan (Harvey, 2013). It lives exclusively in forests and represents old forest fauna (Kew, 1906). It is a rare species in the entire area of its distribution (including Poland) (Jędryczkowski, 1987; Rafalski, 1967) and is considered a relic of primeval forests (Jones, 1978; Legg & Jones, 1988; Muster, 1998). In view of its limited mobility, like other pseudoscorpions, it sometimes attaches itself to winged insects to colonize new microhabitats.

The great capricorn beetle *Cerambyx cerdo* Linnaeus, 1758 is a xylophagic species of the Cerambycidae family. It develops under the bark and in the wood of old oak trees (*Quercus robur*, *Q. petraea*), attacking living trees in which the physiological processes have been disturbed. It often inhabits old forest stands, where it usually chooses the exposed and warm forest edges. Adults emerge between May and September depending on local climatic conditions and latitude, but mainly in June. During this period, they are mainly active in the evening and at the night, when they fly to neighboring trees where they copulate (Gutowski, 2004).

In Poland, *C. cerdo* is a rare and strictly protected species, listed in the *Polish Red Data Book of Animals* (Głowaciński & Nowacki, 2004) and in the *Red List of Threatened Animals in Poland* (Pawłowski et al., 2002). It is also protected under international law; it is listed in Annex II of the Habitats Directive, Annex II of the Bern Convention, the *IUCN Red List of Threatened Species* and in the *European Red List of Saproxylic Beetles* (Nieto & Alexander, 2010).

The population of the great capricorn beetle in the Grądy w Dolinie Odry Natura 2000 site is relatively large. There is no shortage of trees that are inhabited by *C. cerdo*, although there are more (about 50 trees) in the Zwierzyniec Nature Reserve.

Results and discussion

On 22 V 2014 at 23:30, we observed a male *C. cerdo* while attracting insects to an artificial light source. We found three female D. *cyrneus* on its right legs (one each on the tibia and tarsus of the second pair of legs and one on the tarsus of the third pair of legs, fig. 1). During field work in the Grądy w Dolinie Odry Natura 2000 site, the presence of *D. cyrneus* was also confirmed on 19 VI 2014 and 30 VIII 2014, which may indicate a wider occurrence of this species in this area. In both cases, a specimen of this pseudoscorpion was observed on an old oak, in one case in the Zwierzyniec Nature Reserve on a tree inhabited by *C. cerdo*, and in the second case in a managed forest ca. 4 km E of the reserve on the base of a tree scar.

Although the phoresy of pseudoscorpions on the hosts from the various systematic groups is known, it is still a poorly explored phenomenon. In the case of pseudoscorpions that are non–parasitic, time–limited phoront–host association is used by the phoronts to colonize appropriate new habitats (Beier, 1948; Zeh & Zeh, 1992).

Many of the European records concern the phoresy of *Lamprochernes nodosus* (Schrank, 1803) on Diptera, but the spectrum of hosts is much wider and consists of arachnids, myriapods, insects and even mammals. This topic was the subject of several works

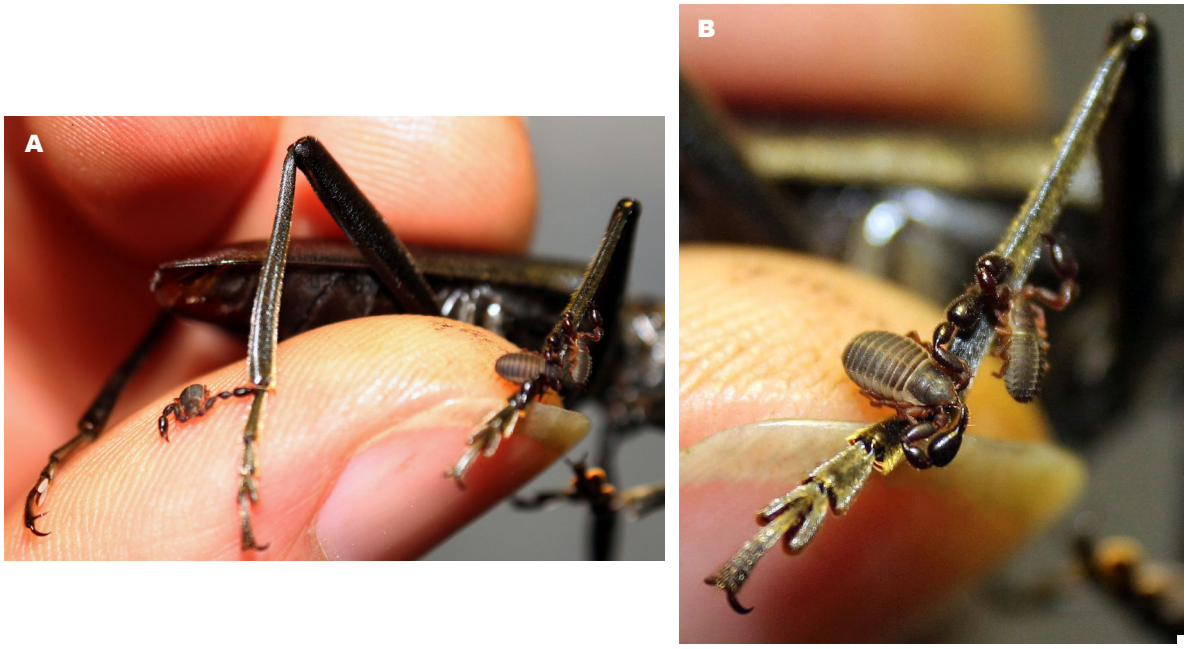

Fig. 1. A. Specimens of *Dendrochernes cyrneus* attached to the legs of *Cerambyx cerdo*. B. Details of the attachment. (Photos by L. Karpiński.)

Fig. 1. A. Especímenes de Dendrochernes cyrneus *sujetados a las patas de* Cerambyx cerdo. *B. Detalle de la sujeción. (Fotografías de L. Karpiński.)*

that summarized known reports (*e.g.,* Beier, 1948; Muchmore, 1971; Poinar et al., 1998).

The published data describe only eight records of the phoresy of *D. cyrneus* on beetles, including six on representatives of the family Cerambycidae: on *Asemum striatum* (Linnaeus, 1758) (Beier, 1929), twice on *Phymatodes testaceus* (Linnaeus, 1758) (Jones, 1978; Kew, 1929 as *Callidium variabile*), *Saperda scalaris* (Linnaeus, 1758) (Kew, 1929), *Clytus arietis* (Linnaeus, 1758) (Duchač, 1993) and *Clytus lama* (Mulsant, 1847) (Huber, 2014). Other data relate to an unidentified beetle (Lohmander, 1939) and *Melandrya caraboides* (Linnaeus, 1760) (Melandryidae) (Vachon, 1954). The only cases that were not associated with beetles are phoresy on parasitic wasps —*Helcon nunciator* (Fabricius, 1793), from the family Braconidae (Ressl, 2007 as *Helcon unicolor*, det. M. Schwarz —this synonym does not exist and should be treated as a lapse— Martin Schwarz, pers. comm.) and *Ephialtes manifestator* (Linnaeus, 1758) from the family Ichneumonidae (Legg, 2015). Similar phoretic relationships with other longhorn beetles and parasitic wasps were observed in the case of *Dendrochernes morosus* (Banks, 1895) in the United States (Haack & Wilkinson, 1987).

Most existing records refer to phoresy on saproxylic beetles —or all–lack of data on the species in the work of Lohmander (1939)— and their parasite (*H. nunciator, E. manifestator*). Citing Kew's report of phoresy on *Phymatodes testaceus,* Jones (1978) did not quote his work (Kew, 1929). Because of that, in the latest summary by Poinar et al. (1998), the same claim has been treated as two separate records of two different species —*P. testaceus* (Jones) and *Callidium variabile* = *P. testaceus* (Kew). The reports from the works of Vachon (1954) and Duchač (1993) have been completely overlooked. In the South of Spain, the cerambycid species *Cerambyx welensii* (Küster, 1846) and *Prinobius myardi* (Mulsant, 1842) and their phoretic interactions with the large pseudoscorpion *Mesochelifer fradei* Vachon, 1940 have been intensively studied in field and laboratory (Domínguez et al., 2008).

Dendrochernes cyrneus is a species that is associated with old forests. It is found mainly under the loose bark of old oak trees and in galleries of Cerambycidae and Scolytinae (Beier, 1963). Because of its large size, strong palpal chelae and toxic venom, it can crush and consume smaller saproxylic beetles and other insects that live in its feeding grounds. Kew (1929) reported its feeding on beetles such as *Dryocoetes villosus* (Fabricius, 1792) (Curculionidae: Scolytinae) and *Bitoma crenata* (Fabricius, 1775) (Zopheridae). On 12 VI 2015, a specimen of *D. cyrneus* was observed while hunting for *Ptilinus pectinicornis* (Linnaeus, 1758) females (Ptinidae) (M. Przewoźny, pers. comm.) (fig. 2). The observation was made in the Rogalin Landscape Park. One of the largest con-

Fig. 2. *Dendrochernes cyrneus* hunting for *Ptilinus pectinicornis* females (photos by M. Przewoźny).

Fig. 2. Dendrochernes cyrneus *cazando hembras de* Ptilinus pectinicornis *(fotografías de M. Przewoźny)*.

centrations of monumental oaks in Europe occurs in this part of the Warta River valley. It is noteworthy that this area is one of the most important refuges of the great capricorn beetle in Poland, which may suggest a broader relationship between these two species. The occurrence of large tree–chernes in this region was reported earlier by Rafalski (1967). It is believed that due to its poor dispersion capability, *D. cyrneus* sometimes spreads phoretically on beetles, mainly on Cerambycidae (Beier, 1963). The deciding factor when choosing a host is probably its co–location in the same habitat. For this reason, it was mentioned by many authors as a potential primary forest relic (Drogla & Lippold, 2004; Esser, 2011; Legg & Jones, 1988; Muster, 1998; Muster & Blick, 2015).

Based on the occurrence of *D. cyrneus*, its foraging behavior and known phoretic relationships with saproxylic insects, it should be considered an indicator species for saproxylic assemblages and the health of a forest. As a species that lives under bark and in the feeding grounds of beetles, in a certain sense, it is also complementary to related species such as *Anthrenochernes stellae* Lohmander 1939, which is included in Annex II of the EC Habitats Directive. *A. stellae* inhabits the rotten and decaying wood of deciduous trees and is mainly observed in the material sampled from the inside of a tree hollow (Gärdenfors & Wilander, 1995). According to Ranius & Wilander (2000) another pseudoscorpion species — *Larca lata* (Hansen, 1884) — also shows similar habitat preferences.

One of the weakest points of using pseudoscorpions as indicator species is the difficulty of properly identifying them in the field (Gerlach et al., 2013). However, because *D. cyrneus* is one of the largest European species and definitely the most robust, it is easy to identify.

Cerambycidae are considered appropriate indicators to determine the diversity of saproxylic organisms or the condition of a forest, but not to determine forest diversity as a whole (Gerlach et al., 2013). According to Holland's (2007) study, some cerambycid species are closely associated with specific forest habitats and are very good indicators of high biodiversity sites. The results also indicate that monophagous and oligophagous species are better bioindicators than strong polyphagous. This was also confirmed by the study in European beech woods (Lachat et al., 2012), in which the family of Cerambycidae ranked among the top few in terms of number of species that are good bioindicators.

One of the longhorn beetle species that may serve as a model indicator for saproxylic assemblages is *Cerambyx cerdo*. This is primarily because of its habitat selectivity — it usually selects very old (more than a hundred years old) English or sessile oaks, which are often classified as natural monuments. Furthermore, there are usually quite a large number of individuals per plot, and their large body size makes it easy to identify this species. Additionally, it is monophagous of oak trees in most of its range. Moreover, its presence in a habitat can easily be re-

cognized due to its very characteristic feeding grounds of up to 100 cm in length and 45 mm in width. They are also easily visible from a relatively long distance and are usually situated on the most exposed middle and lower parts of the trunk.

In conclusion, our finding of the phoresy of this rare pseudoscorpion species on the great capricorn beetle is an interesting case of a previously underreported relationship between two endangered and increasingly rare species. In addition to the observation of the phoresy, the fact that *D. cyrneus* was frequently found in the habitats of *C. cerdo* may suggest a significant ecological relationship between this pseudoscorpion and the family Cerambycidae. The presence of these two species, which are considered to be primeval forest relics, may indicate good preservation of the Odra River elm–ash riparian forests in this part of Poland. For a better knowledge and understanding of the phoretic relationship between *D. cyrneus* and saproxylic beetles, it is important to document all cases recorded in the field and to encourage interdisciplinary cooperation between coleopterologists and arachnologists.

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