

## Phoresy of *Uropoda orbicularis* (Acari: Mesostigmata) by beetles (Coleoptera) associated with cattle dung in Poland

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**Abstract.** Of 31 species of coprophagous beetles from the following families: Aphodiidae, Geotrupidae, Scarabaeidae, individuals of 25 species carried deutonymphs of *Uropoda orbicularis* (Müller, 1776). The mite's preferences for attaching to specific parts of an insect's body were determined by examining 4,318 specimens of beetles from the following families: Aphodiidae, Geotrupidae, Scarabaeidae, Hydrophilidae and Histeridae. We recorded 14,507 cases of phoresy (5,822 deutonymphs and 8,685 of pedicels without mites) on 2,056 insects. Elytra and the third pair of legs were the areas most frequently occupied by the mites. The mite's preferences for attaching to specific parts of an insect body are reported for the first time.

### INTRODUCTION

Phoresy is a phenomenon in which an animal actively seeks and attaches to another animal in order to disperse (Athias-Binche, 1994). This is common in gamasid mites of the families: Macrochelidae, Parasitidae, Laelapidae, Ascidae, Eviplididae, uropodid mites and some families of Actiniedida: Scutacaridae and Anoetidae. These mites show different degrees of morphological and physiological adaptation to phoresy. The stadium adapted for dispersal also varies.

In the case of mites from the suborder Uropodina, the deutonymph is the phoretic stage; however, in some species all deutonymphs are phoretic whereas in others phoretics only develop in certain habitats. The morphological adaptation to phoresy in the uropodid mites is the anal pedicel (Fig. 1A, B), which enables them to attach themselves to the cuticle of arthropods, especially insects.

Phoresy in this group of mites is frequently observed (Faasch, 1967; Ramsey, 1967; Gordh & Barrows, 1976; Moser, 1976; Chmielewski, 1977; Domrow, 1981; Desender & Vanechoutte, 1984; Philips, 1984; Gordh, 1985; Athias-Binche & Habersaat, 1988; Rubink et al., 1991; Wiśniewski & Hirschmann, 1992; Athias-Binche, 1993; Athias-Binche et al., 1993; Maśán, 1993; 1994; Fain et al., 1995; Häitlinger, 1999; Gwiazdowicz, 2000). Because of the complex taxonomy some authors did not determine the mites to species but to taxa of a higher order. This is also true of the insects carrying the deutonymphs. *Uropoda orbicularis* is a wide spread European species. In Poland it was found in several localities in the southern and central parts of the country. Adult specimens were rare in soil samples collected in different types of habitat. It seems that certain non-stable microhabitats are suitable for this species e.g. compost, cattle manure or mammal nests. In such habitats *U. orbicularis* is usually abundant and over 80% of the populations consist of immature individuals. In habitats like forest detritus and soil immatures constitute less than 30%. Therefore, phoresy in this species seems to be extremely important for dispersal, i.e. the colonization of new, non-stable island-like habitats (Błoszyk et al., 2002b).

### MATERIAL AND METHODS

The beetles were collected using pitfall traps (Bunalski, 1996) emptied at 9–10 day intervals, from April to the middle of November in 2000 and 2001. All traps were in pasture and the lure was cow dung. The research area was located at Krzyszkowo (Wielkopolska province, about 20 km north – west of Poznań, Poland). Thirty one species and 22,403 individuals of coprophagous beetles belonging to the families Scarabaeidae, Geotrupidae and Aphodiidae were examined for phoretic deutonymphs of *U. orbicularis*.

To analyze the distribution of *U. orbicularis* on the body surface, 4,318 beetles, belonging to the following families: Aphodiidae, Geotrupidae, Scarabaeidae, Hydrophilidae and Histeridae, collected from July to September 2000 were examined. During this period, a total of 14,507 cases of phoresy (5,822 phoretic deutonymphs of *U. orbicularis* and 8,685 pedicels) on the bodies of 2,056 (48%) coprophagous and coprophilous beetles were recorded\*.

This material is deposited in the authors' collection (The Department of Animal Taxonomy and Ecology Adam Mickiewicz University in Poznań). Terminology and systematics of the coprophagous beetles (Coleoptera, Scarabaeoidea) is that of Bunalski (1999), who verified our determination.

### RESULTS

Of the 31 species of coprophagous beetles examined from the following families: Aphodiidae, Geotrupidae, Scarabaeidae, of 25 (80%) carried deutonymphs of *Uropoda orbicularis* (see Table 1).

The deutonymphs and pedicels (without deutonymphs) of the mite were found on the following parts of the bodies of the beetles: head, pronotum, elytra (Fig. 1C), legs I, legs II, legs III (Fig. 1D), ventral surface of the abdomen and the area between the legs.

Most mites were on the elytra and the third pair of legs. There were fewer mites on legs II, the ventral surface between the legs, legs I, abdominal sternites, pronotum and head. The

\* As only one species of uropodid mite (*U. orbicularis*) was recorded, it is highly probable that all the pedicels without deutonymphs on the beetles' body also belonged to the same species of mite.

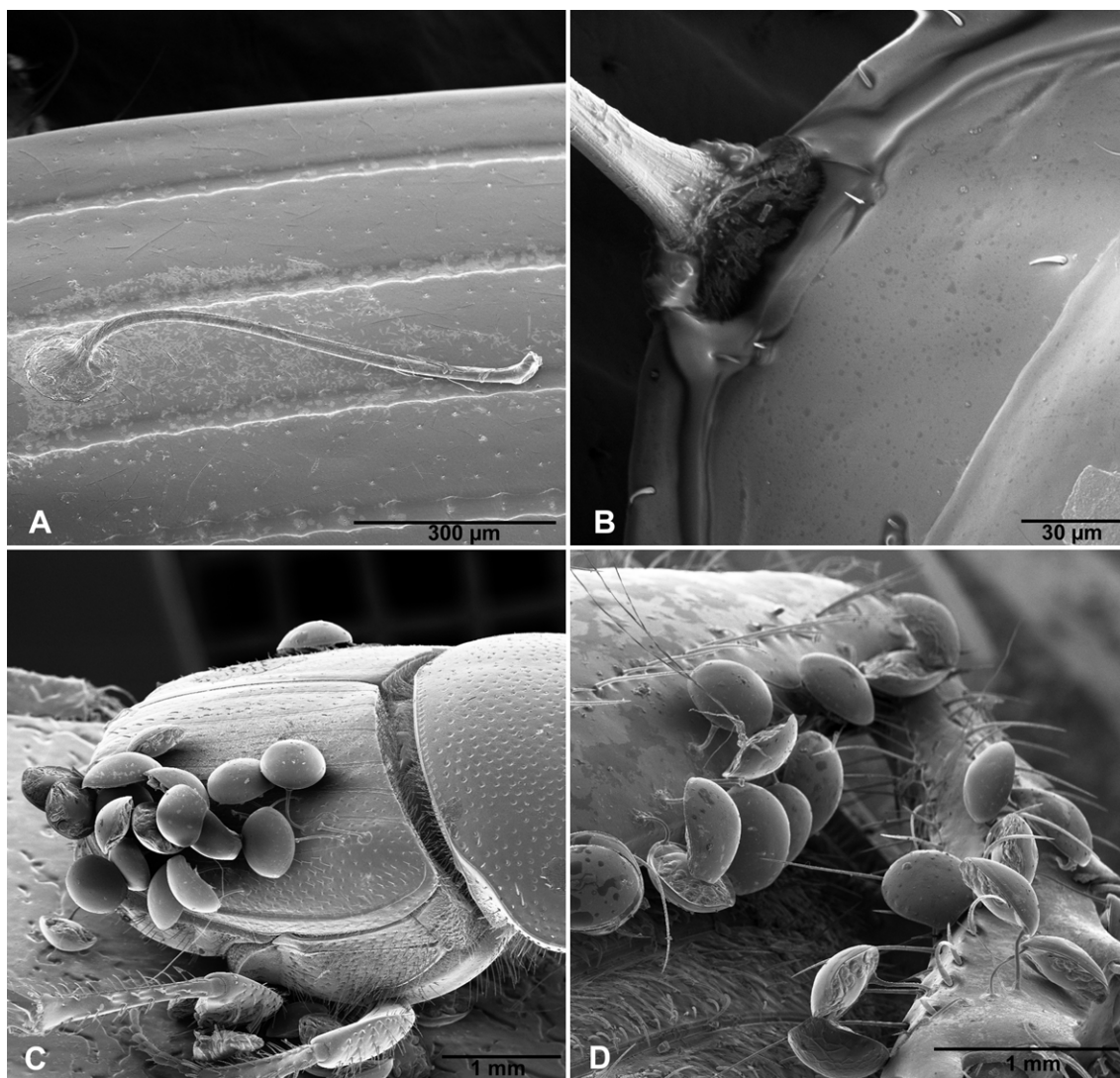


Fig. 1. A – the pedicel of a *Uropoda orbicularis* deutonymph on the elytra of a beetle; B – ventroanal region of deutonymph with detail of pedicel base; C – deutonymphs of *U. orbicularis* on elytra of the beetle *Onthophagus similis*; D – mites on the third pairs of legs of a *Geotrupes* beetle.

number and percentage of deutonymphs on individual parts of a beetle's body are given in Table 2.

The number of mites recorded on one beetle varied between 1–135 and was on average seven.

## DISCUSSION

Since there is little published information on phoresy in *U. orbicularis*, this research both supplements the list of carrier species and reports the distribution of deutonymphs on the body surface of the carriers.

Phoretic deutonymphs of *U. orbicularis* have been found on *Anoplotrupes stercorosus* (Hartmann in Scriba, 1791) (Chmielewski, 1977; Haitlinger, 1999; Gwiazdowicz, 2000), *Trox hispidus* (Pontoppidan, 1763) (Maśán, 1993), *Aphodius rufipes* (Linnaeus, 1758) (Błoszyk et al., 2002a), *Carabus convexus* Fabricius, 1775, *Pterostichus niger* (Schaller, 1783), *Agriotes obscurus* (Linnaeus, 1758), *Cercyon impressus* (Sturm, 1807), *Lepersinus fraxini* (Panzer, 1799) (Kofler & Schmölzer, 2000), *Copris lunaris* (Linnaeus, 1758), *Trypocopris vernalis* (Linnaeus, 1758), *Onthophagus gibbulus* (Pallas, 1781), *Onthophagus ovatus* (Linnaeus, 1767), *Hister* sp. and Staphylinidae

(Maśán, 2001). Moreover, the presence of phoretic deutonymphs of other Uropodina has been recorded on the following beetles: *Geotrupes mutator* (Marsham, 1802) (Chmielewski, 1977; Haitlinger, 1999), *Oryctes nasicornis* (Linnaeus, 1758), *Silvanus unidentatus* (Fabricius, 1792), *Silpha thoracica* Linnaeus, 1758, *Silpha obscura* Linnaeus, 1758, *Aphodius niger* (Panzer, 1797), *Aphodius* sp., *Hister fimetarius* Linnaeus, 1758, *Hister unicolor* Linnaeus, 1758, *Hister quadrimaculatus* Linnaeus, 1758 (Chmielewski, 1977), *Nicrophorus* sp. (Gwiazdowicz, 2000), *Trox sabulosus* (Linnaeus, 1758), *Trox scaber* (Linnaeus, 1767) (Maśán, 1993), *Copris lunaris* (Linnaeus, 1758) (Maśán, 1994), *Lucanus cervus* (Linnaeus, 1758), *Dorcus parallelipedus* (Linnaeus, 1758) (Athias-Binche, 1993), *Agonum assimile* (Paykull, 1790), *Bembidion lunulatum* Fourcroy, 1785 and *Bembidion femoratum* Sturm, 1825 (Fain et al., 1995).

That phoretic deutonymphs of *U. orbicularis* were found on 25 out of 31 species of beetles, from three families (Geotrupidae, Aphodiidae, and Scarabaeidae), proves that this mite does not prefer a particular carrier species, but uses any carrier present in its habitat, which in this case was cattle

TABLE 1. The list of species of coprophagous beetles (Geotrupidae, Aphodiidae and Scarabaeidae) collected and classified according to whether they carried deutonymphs of *U. orbicularis* (+) or not (-).

No. Coprophagous beetles species	Phoresy
<b>Geotrupidae</b>	
1 <i>Geotrupes spiniger</i> (Marshall, 1802)	+
2 <i>Anoplotrupes stercorosus</i> (Hartmann in Scriba, 1791)	+
3 <i>Trypocopris vernalis</i> (Linnaeus, 1758),	+
<b>Aphodiidae</b>	
1 <i>Aphodius arenarius</i> (Olivier, 1789)	-
2 <i>Aphodius ater</i> (De Geer, 1774)	+
3 <i>Aphodius coenosus</i> (Panzer, 1798)	+
4 <i>Aphodius contaminatus</i> (Herbst, 1783)	-
5 <i>Aphodius depressus</i> (Kugelann, 1792)	+
6 <i>Aphodius distinctus</i> (O.F.Müller, 1776)	+
7 <i>Aphodius erraticus</i> (Linnaeus, 1758)	+
8 <i>Aphodius fasciatus</i> (Olivier, 1789)	-
9 <i>Aphodius fimetarius</i> (Linnaeus, 1758)	+
10 <i>Aphodius foetens</i> (Fabricius, 1787)	+
11 <i>Aphodius fossor</i> (Linnaeus, 1758)	+
12 <i>Aphodius granarius</i> (Linnaeus, 1767)	+
13 <i>Aphodius haemorrhoidalis</i> (Linnaeus, 1758)	+
14 <i>Aphodius prodromus</i> (Brahm, 1790)	+
15 <i>Aphodius punctatosulcatus</i> Sturm, 1805	-
16 <i>Aphodius pusillus</i> (Herbst, 1789)	+
17 <i>Aphodius rufipes</i> (Linnaeus, 1758)	+
18 <i>Aphodius rufus</i> (Moll, 1782)	+
19 <i>Aphodius sordidus</i> (Fabricius, 1775)	+
20 <i>Aphodius sticticus</i> (Panzer, 1798)	-
21 <i>Aphodius subterraneus</i> (Linnaeus, 1758)	+
22 <i>Oxyomus sylvestris</i> (Scopoli, 1763)	+
<b>Scarabaeidae</b>	
1 <i>Onthophagus coenobita</i> (Herbst, 1783)	+
2 <i>Onthophagus fracticornis</i> (Preyßler, 1790)	+
3 <i>Onthophagus nuchicornis</i> (Linnaeus, 1758)	+
4 <i>Onthophagus ovatus</i> (Linnaeus 1767)	+
5 <i>Onthophagus semicornis</i> (Panzer, 1798)	-
6 <i>Onthophagus similis</i> (Scriba, 1790)	+

manure. These species of beetles belong to different phenology and generation groups, which means that the species composition of the coprophagous community studied changed during the pasture season. Species characteristic of, e.g., the spring season were replaced by other species late in the season.

Phoretic deutonymphs on 6 species of beetles may be absent because they were rare in the habitat studied. It is, therefore, impossible to determine if these species were avoided by mites in the process of dispersal. Only one individual of each of *Aphodius arenarius*, *Aphodius fasciatus* and *Aphodius punctatosulcatus* and several of *Aphodius contaminatus*, *Aphodius sticticus* and *Onthophagus semicornis* were collected. Moreover *Onthophagus semicornis* is a rare species in Wielkopolska province. Its typical habitat is rodent burrows (Bunalski, 1999) and it is rarely found in manure.

Uropodid mite preferences for attaching to specific parts of beetles are poorly known (Costa, 1963). The analysis of the large data set presented here indicates that phoretic deutonymphs of *U. orbicularis* do not randomly attach themselves to the body surface of beetles. The reason why they are rarely found on the head is clear. Their presence would interfere with a beetle's sense of direction and negatively affect its flight, as was affirmed earlier by Athias-Binche (1994). In addition, beetles of the family Aphodiidae, which were the most numerous in the community, can pull their head back under the pronotum. This

TABLE 2. The number and percentage deutonymphs and pedicels of *U. orbicularis* found attached to various parts of beetles (DN - the number of deutonymphs, PN - the number of pedicels (without deutonymphs), DN+PN - the total number of deutonymphs and pedicels, % - overall percentage).

Part of beetles' body	DN	PN	DN+PN	%
head	3	2	5	> 0.1
pronotum	28	67	95	1
elytra	1728	3826	5554	38
legs I	204	86	290	2
legs II	1050	1650	2700	19
legs III	2427	2397	4824	33
ventral surface*	281	494	775	5
abdominal sternites	101	163	264	2
TOTAL	5822	8685	14507	100%

\*surface between legs

would result in the deutonymph's pedicel being cut off if a mite attached to the head. It is still unknown why most mites were found on elytra and on the underside of a beetle's body on the third pair of legs, and why the numbers declined significantly on the second and first pair of legs. It is assumed that this deployment of phoretic deutonymphs of *U. orbicularis* only slightly affects the locomotion of the beetles, and that deutonymphs climb onto the back to beetle and move forward. This hypothesis needs to be confirmed.

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