

Notes on the myrmecophilous spider *Mastigusa arietina* (Thorell, 1871)

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Abstract

We provide records of the rarely detected ant-associated spider *Mastigusa arietina* (Thorell, 1871) in northwest Belgium and discuss how to locate and capture this spider. We show that this myrmecophilous spider is much more common than currently presumed but it is often missed in common spider surveys due to its obligate association with ant nests. We also summarise and illustrate the recently gained insights into its ecology, behaviour, and interactions with its host and other ant associates.

Samenvatting

We leveren gegevens van de zelden waargenomen myrmecofiele spin *Mastigusa arietina* (Thorell, 1871) in het noordwesten van België en bespreken hoe deze spin te lokaliseren en te vangen. We laten zien dat deze myrmecofiele spin veel vaker voorkomt dan momenteel wordt aangenomen. Ze wordt echter vaak over het hoofd gezien in inventarisaties van spinnen vanwege haar strikte associatie met mieren nesten. We bespreken en illustreren ook de recent verworven inzichten in haar ecologie, gedrag en interacties met haar gastheer en andere mierengasten.

Résumé

Nous rapportons l'araignée *Mastigusa arietina* (Thorell, 1871) du nord-ouest de la Belgique. Cette espèce, associée de manière obligatoire aux fourmis, est rarement détectée vu son mode de vie et passe donc souvent inaperçue lors des inventaires. Nous discutons de la manière de la localiser et de la capturer, en outre, nous résumons et illustrons les connaissances récemment acquises sur son écologie, son comportement et ses interactions avec son hôte et d'autres fourmis associées.

Introduction

A large group of spiders closely interacts with ants. The best-known representatives of this group are specialist predators of ants (DONISTHORPE 1927, ACEVES-APARICIO & al. 2022) or spiders that morphologically and/or behaviourally mimic co-occurring ants to avoid predation (Batesian mimics) (CUSHING 2012). Lesser-studied ant-associated spiders live inside ant nests and are known as myrmecophiles (DONISTHORPE 1927). Aspects of the life history and ecology of only a few of these myrmecophilous spiders have been studied so far (e.g., CUSHING 1995; WITTE et al. 2009; VON BEEREN et al. 2012; PARMENTIER et al. 2018a; CUSHING et al. 2022). In Western Europe, four species of myrmecophilous money spiders (Linyphiidae): *Thyreosthenius biovatus* (O. Pickard-Cambridge, 1875),

Acartauchenius scurrilis (O.P.-Cambridge, 1872), *Syedra myrmicarum* (Kulczyński, 1882) and *Evansia merens* O. Pickard-Cambridge, 1901 and one myrmecophilous dwarf sheet spider (Hahniidae): *Mastigusa arietina* (Thorell, 1871) are known (FRANC 2005, PARMENTIER et al. 2020). It is commonly believed that these spiders are rare, but it increasingly appears that their numbers and distributions are strongly underestimated (CASTELLUCCI & al. 2022). For example, the myrmecophilous spider *T. biovatus* which is typically associated with mound building *Formica* ants (red wood ants), has been detected in almost every nest mound of these ants in northwest Belgium (PARMENTIER 2016, PARMENTIER et al. 2021). The low number of records of myrmecophilous spiders can probably be explained by the infrequent sampling of their specific ant nest habitat in common diversity surveys. Here, we provide recent records of the myrmecophilous spider *M. arietina* in northwest Belgium and discuss how to locate and capture this spider. We also summarise and illustrate the recently gained insights into their ecology, behaviour, and interactions with their host and other ant associates.

Material and methods

Mastigusa is a Palearctic genus that comprises three species: *M. lucifuga* (Simon, 1898), *M. arietina* (Thorell, 1871) and *M. macrophthalma* (Kulczyński, 1897), of which the last two are closely related (ROBERTS 2001). These two species can only be distinguished by the size of the eyes, no differences can be observed in the male palps or female epigyne (ROBERTS 2001). Therefore, there is discussion on whether they are distinct species and different authors consider *M. arietina* and *M. macrophthalma* rather as different races. Based on the very subtle differences in eye size and the unclear illustrations and descriptions in literature, we also consider them as variations within one species. As *M. arietina* is the oldest valid name, we will use this name to describe the spider.

Mastigusa arietina is a small spider (female 3-3.5 mm; male 3-3.5 mm). It is smaller than its larger bodied ant hosts (e.g., *Formica*), but larger than some of its smallest ant hosts (e.g., *Lasius*). The spider is rather inconspicuous and difficult to detect against a background of organic soil (Fig. 1a). Nevertheless, the males are very distinct by their spectacular palps with very long whip-like extensions that curve back over the cephalothorax (Fig. 1b). A total of 14 ant species has been reported as hosts for *M. arietina* (FRANC & FAŠANGA 2017; PARMENTIER et al. 2020; CASTELLUCCI et al. 2022), mainly mound building *Formica* species (Fig. 1c) and tree nesting *Lasius* ants such as *Lasius brunneus* and *L. fuliginosus*. The spider may also associate with ants that build a subterranean earth nest such as *Tetramorium caespitum*, *Camponotus ligniperda* and *L. niger* (FRANC & FAŠANGA 2017; PARMENTIER & al. 2020). Occurrences of this spider are very scattered and numbers are very low across Europe (BRITISH SPIDERS 2022; GBIF database), but they can be locally abundant (see HÄRKÖNEN & SORVARI 2014: 43 individuals distributed over 10 red wood ants nests in Finland). Most info on their distribution is found in detailed faunistic studies on myrmecophiles (DONISTHORPE 1927; HÄRKÖNEN & SORVARI 2014; CASTELLUCCI et al. 2022).

Over the last 10 years, we thoroughly inventoried the myrmecophile communities of red wood ants (*Formica rufa* group) in different small forest sites in northwest Belgium. An overview of the recent records of the species in Belgium is discussed below.

Results and discussion

We regularly found individuals of the spider *M. arietina* in red wood ant nests (Fig. 1c-d). An overview of these nests, the number of observed spider individuals and the sampling technique are given in Table 1. All 15 nests belong to the red wood ant species *Formica polyctena*. A maximum number of 35 individuals was found in a nest in De Haan. Since males, females and juveniles were found together and in all seasons (Table 1), they probably live in permanent association with their ant hosts and with overlapping generations. We initially collected the spiders associated with red wood ant nests by spreading out a sample of the organic thatch nest material in a large tray, but numbers were typically low (Table 1). Red wood ants mostly built their nest around a tree stump, on fallen wood or against a living tree. In the nest you often find pieces of bark or wood. Beating or shaking wood and bark found

in the nest above a tray proved to be a much more successful sampling technique for this species than sieving a sample of the fine thatch material (Table 1). *Mastigusa* females also attach their characteristic flat and discoidal egg sac to these wood pieces or under the bark of the tree stump in the nest (Fig. 1e). These white egg sacs strongly contrast with the darker wood and bark. Therefore the presence of *Mastigusa* is often first noted by these egg sacs on nest material rather than by spiders darting away (pers. observations TP; CASTELLUCCI et al. 2022; DEPAEPE 2022).

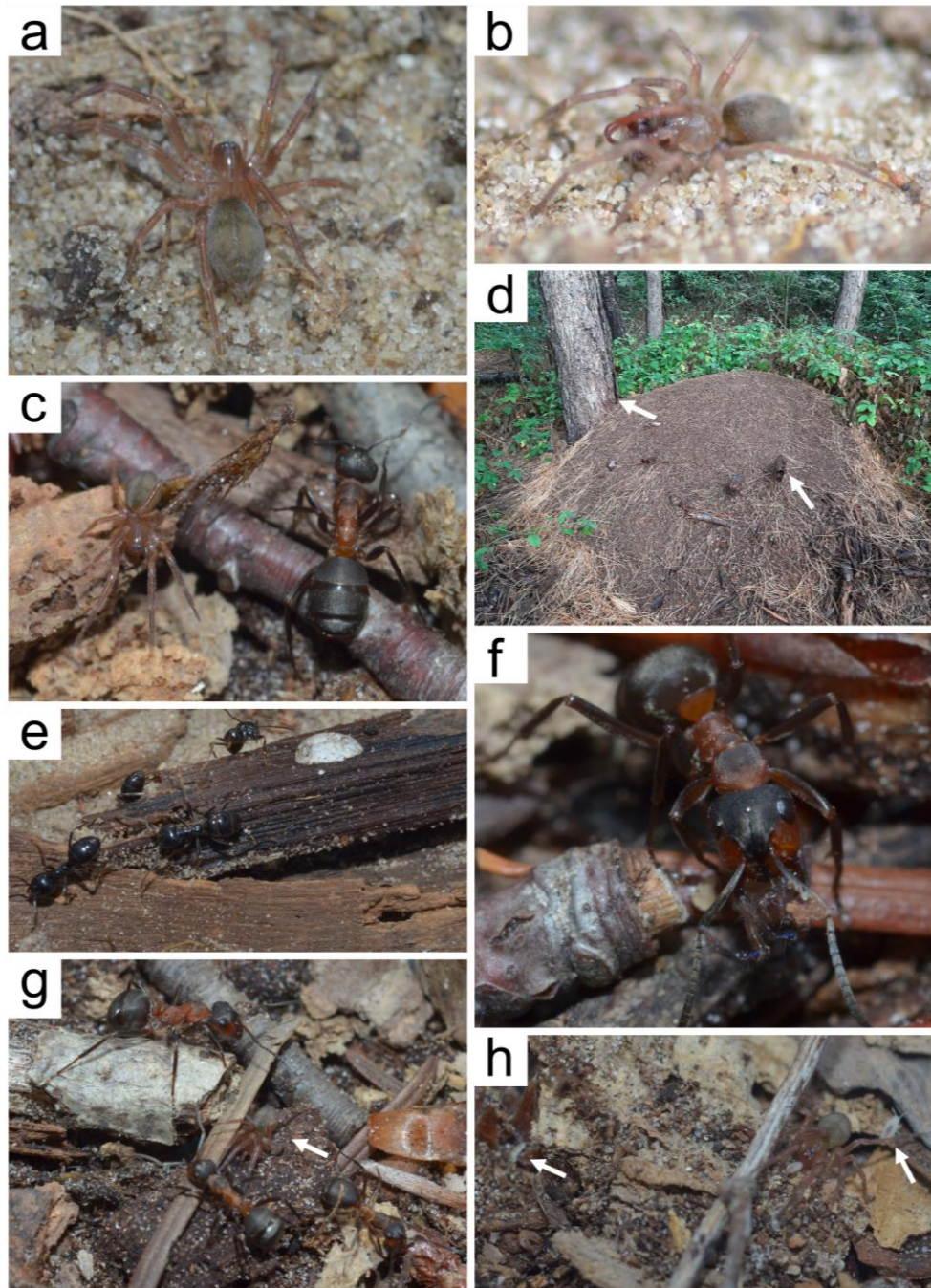


Figure 1: Overview of the myrmecophilous spider *Mastigusa arietina* and its interaction with the host ants. a) A female spider. b) A male with the very characteristic whip-like palps. c) A female with its red wood ant host. d) A large red wood ant nest where the spider was found by beating the wood found in the nest and under the bark of the pine tree against which the nest leaned. e) The white egg sacs of the spider are found in the nest attached to wood pieces or under bark. This egg sac was found in a *Lasius fuliginosus* nest. f) A red wood ant worker grabs a female *M. arietina* between its mandibles. g) A spider hides between some thatch to avoid direct interaction with the host ant. h) A spider captured the white myrmecophilous springtail *Cyphoderus albinus*. Other individuals of this prey can be seen as well (indicated by arrow).

Table 1: Records and number of individuals (Ind.) of *Mastigusa arietina* with the red wood ant host *Formica polyctena* (15 different nests in total). Site id corresponds to the site letter codes in Fig. 2.

Period	Site id	Site	Nest	Ind.	Sampling technique
June-September 2017	d	De Haan - Duinbossen	d-1	31	beating bark and wood from the nest
November 2014	d	De Haan - Duinbossen	d-1	5	spreading out of 2 L organic nest material
June-September 2017	d	De Haan - Duinbossen	d-2	7	beating bark and wood from inside the nest
June-September 2017	d	De Haan - Duinbossen	d-3	35	beating bark and wood from inside the nest
11/7/2018	e	Oudenburg - Hoge Dijken	e-1	3	pitfall in nest without solvent
3/9/2022	f	Zedelgem - Aatrijksesteenweg	f-1	1	spreading out of 2 L organic nest material
5/9/2022	g	Jabbeke - Waterwinning	g-1	4	beating bark and wood from inside the nest
23/9/2022	g	Jabbeke - Waterwinning	g-2	16	beating bark and wood from inside the nest
5/8/2019	g	Jabbeke - Waterwinning	g-3	3	beating bark and wood from inside the nest
9/8/2012	h	Bruges - Beisbroek	h-1	2	spreading out of 2 L organic nest material
4/9/2012	i	Beernem - Aanwijs	i-1	1	spreading out of 2 L organic nest material
4/9/2012	i	Beernem - Aanwijs	i-2	4	spreading out of 2 L organic nest material
14/8/2012	j	Beernem - Lindeveld	j-1	7	spreading out of 2 L organic nest material
4/9/2012	j	Beernem - Lindeveld	j-2	7	spreading out of 2 L organic nest material
14/8/2012	j	Beernem - Lindeveld	j-3	2	spreading out of 2 L organic nest material
6/9/2012	k	Beernem - spoorweg	k-1	2	spreading out of 2 L organic nest material

Mastigusa spiders were never collected in the core of the nests with the ant brood and they tend to avoid dense groups of workers. In contrast to the co-occurring spider *T. biovatus*, *Mastigusa* prefers the periphery of the nest or places where they can optimally hide such as wood pieces or under bark. *Mastigusa* do not chemically deceive their host and are rapidly detected in experimental arenas (PARMENTIER et al. 2017). They provoke one of the strongest levels of ant aggression of all red wood ant associates (PARMENTIER et al. 2016). It is very striking that in the absence of hiding places, they often are grabbed by wood ants, are wounded and eventually are devoured (Fig. 1f, PARMENTIER et al. 2016, PARMENTIER et al. 2018a). Lethal interactions with their host were not observed in other myrmecophiles (beetles, spiders, isopod) associated with red wood ants. So it appears that this spider mostly resorts to efficient hiding (Fig. 1g) and swift escape movements to survive in ant nests, similar to many other unspecialised myrmecophiles (PARMENTIER et al. 2018b).

We mostly surveyed red wood ant nests for myrmecophiles, explaining the biased records of *Mastigusa* with this host. But this host generalist spider was also found with other ants in northwest Belgium. We discovered the spider and egg sacs in two carton tree nests of the ant *Lasius fuliginosus* (Fig. 1e) (pers. observations TP: two adults, DEPAEPE 2022: 20 and 28 egg sacs respectively). These nests were within 20 m from a red wood ant nest which also supported the spider. This finding underlines the generalist nature of the spider, it possibly can easily switch from one ant host to another in its distribution range. The spider was also found at the Belgian coast: it was once recorded in a *Tetramorium caespitum* nest (LEHOUCK 2002), a total of 9 females was found outside ant nests in pitfall traps placed in three dune (grassland and dune moss vegetation) sites at the Belgian coast (BONTE et al. 2000, Fig. 2). These trapped individuals were likely coming from *Lasius* and *Tetramorium* nests which dominate the site. From these records from pitfalls installed outside ant nests, it is clear that the spiders often leave the nest, either to forage, mate or to hunt. This extranidal mobility is further confirmed by some direct observations of the spider outside the nest (DONISTHORPE 1927). We mapped our records of *Mastigusa* in northwest Belgium in Fig. 2. Other records in Belgium are extremely rare, the citizen science website waarnemingen.be (2022) only lists one verified observation of a female in Geel and unverified records of two adults in Hoboken (reported as *M. macrophthalma*). There is one other record of a female in a *F. rufa* nest listed in the database of Arabel (Chaumont-Gistoux in 1966) (ARADAT 2022).

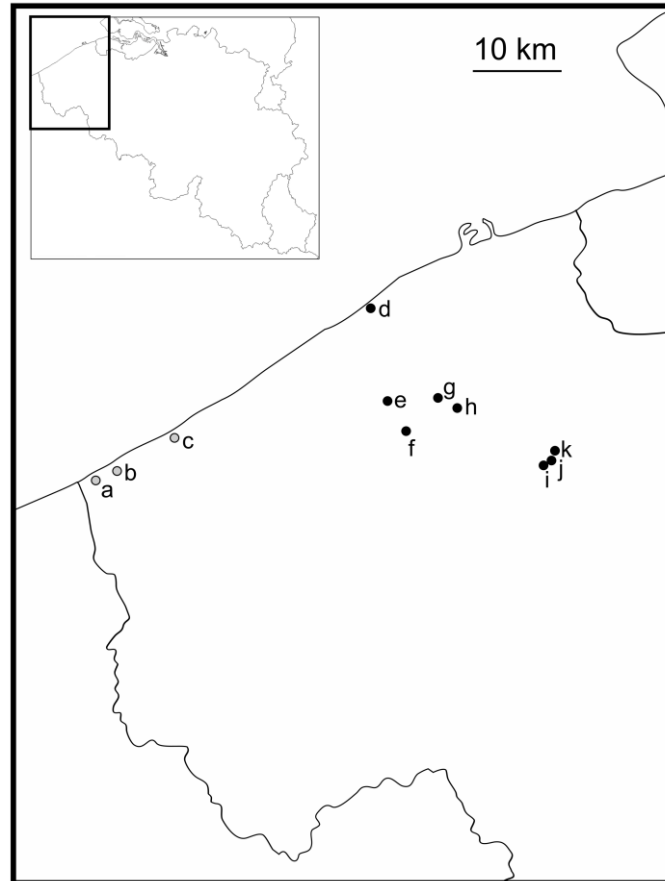


Figure 2: Overview of sites with *Mastigusa arietina* in northwest Belgium. Grey dots (a, b and c) represent sites with records from pitfalls outside ant nests. Black dots show sites with records from within ant nests. In one site, *Mastigusa* was found in different neighbouring nests. Site d and j: spider found in three *F. polycтена* nests; site g: three *F. polycтена* nests and two *L. fuliginosus* nests; site i: two *F. polycтена* nests; site e, f, h and k: one *F. polycтена* nest, details see Table 1.

Mastigusa does not attack the host ants, nor does it feed on dead corpses. Although the spider occasionally fed on ant brood and larvae in lab conditions, it is primarily a predator of other arthropods that live in the ant microcosm (PARMENTIER et al. 2016). Tests showed that they fed on springtails, mites, isopods, beetles, beetle larvae and spiderlings that co-occur in the ant habitat (PARMENTIER et al. 2016). They are predators that occupy the top of the food webs in ant nests (PARMENTIER et al. 2016). The white and blind ant springtail *Cyphoderus albinus* thrives in the nests of almost all European ants, and seems to be one of the preferred prey species (Fig 1h). Interestingly, the spider captures this prey less efficiently in nest chambers with high worker densities (PARMENTIER et al. 2018a). The increasing harassment by higher ant densities is likely to promote hiding behaviour at the expense of hunting. This is another indication that high worker densities are stressful for this spider. Overall, the research at hand shows that the enigmatic spider *M. arietina* is much more widespread in Belgium than currently known. A special focus on the survey of ant nests is needed to gain a better understanding of its distribution and host range.

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