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New observations of the social parasitic ant *Myrmica karavajevi* (Arnoldi, 1930) (Hymenoptera: Formicidae) in Belgium

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Abstract

In nature reserve Vorsdonkbos-Turfputten (Aarschot, Belgium) gynes of the very rare and parasitic ant species *Myrmica karavajevi* (Arnoldi, 1930) were discovered during two consecutive years, suggesting the presence of a *M. karavajevi* population in the area. In 2018 a gyne was collected with pitfall traps and in 2019 a gyne was collected in the nest of *Myrmica scabrinodis* Nylander, 1846. In both cases the records are from wet nutrient-poor sites: a *Molinia* grassland and transition mire respectively, located almost 200 m from each other and separated by forest. In addition, we give a short overview of the taxonomic status of *M. karavajevi*.

Keywords: *Molinia* grasslands, social parasite

Samenvatting

In natuurgebied Vorsdonkbos-Turfputten (Aarschot, België) werden gynes van de zeer zeldzame en parasitaire mierensoort *Myrmica karavajevi* gevonden tijdens twee opeenvolgende jaren wat suggereert dat het om en duurzame *M. karavajevi* populatie gaat. In 2018 werd een gyne ingezameld met een bodemval en in 2019 werd een gyne gevonden in een nest van *Myrmica scabrinodis*. In beide gevallen werden de waarnemingen gedaan in natte voedselarme plaatsen, met name respectievelijk een blauwgrasland en laagveen, een kleine 200 meter van elkaar gelegen en gescheiden door bos. Bovendien bespreken we kort de taxonomische status van *M. karavajevi*.

Résumé

Dans la réserve naturelle de Vorsdonkbos-Turfputten (Aarschot, Belgique), des gynes de la très rare espèce *Myrmica karavajevi* (Arnoldi, 1930), fourmi parasite social, ont été observées pendant deux années consécutives, ce qui suggère la présence d'une population établie de *M. karavajevi* dans la région. En 2018, une gyne a été récoltée à l'aide de pièges à fosse et en 2019, une gyne a été capturée dans le nid de *Myrmica scabrinodis* Nylander, 1846. Dans les deux cas, les captures proviennent de milieux humides et pauvres en nutriments : respectivement une prairie à Molinia et une tourbière de transition, distantes d'environ 200 m l'une de l'autre et séparées par une forêt. En outre, nous donnons un bref aperçu du statut taxonomique de *M. karavajevi*.

Introduction

Myrmica karavajevi (Arnoldi, 1930) is a workerless ant species of which the gynes are obligatory social parasites. This species was first found by Arnoldi (ARNOLDI, 1930) together with individuals of *M. scabrinodis* Nylander, 1846. As more localities and individuals of *M. karavajevi* were found during the following decades, it became clear that also *M. sabuleti* Meinert, 1861, *M. gallienii* Bondroit, 1920, *M. rugulosa* Nylander, 1849 and *M. lonae* Finzi, 1926 can function as host species (PISARSKI, 1962; RADCHENKO & ELMES, 2010). This indicates that *M. karavajevi* parasitises on a wide range of ant species from the *scabrinodis*-group. Both the *M. karavajevi* gyne and the gyne of the host queen coexist together and brood of both species can be found (COLLINGWOOD, 1979).

This social parasitic ant species has a widespread distribution within the Palearctic region. Despite this wide geographical occurrence, only a limited number of records of *M. karavajevi* exists (www.GBIF.org). The first discovery in Belgium was in 1951 by Joseph van Boven and Albert Raignier. They found a dealate gyne inside a nest of *M. scabrinodis* in the Hautes Fagnes region in the east of Belgium at Baraque Michel. This individual was described by van Boven as a new species, *Myrmica faniensis* (VAN BOVEN, 1970), named after the location where it was found. However, later it appeared to be a junior synonym of *Myrmica karavajevi* (KUTTER, 1973; SEIFERT, 1994; RADCHENKO & ELMES, 2003). The Hautes Fagnes region is a high plateau characterised by a relatively high amount of rainfall (1500-1700 mm/y) and an extensive area of (mostly degenerated) raised bog and wet heathland (MORMAL & TRICOT, 2008).

A second discovery of this species in Belgium, near the municipality of Houthalen-Helchteren, was discussed in VANKERKHOVEN *et al*. (2011). They found multiple workers of *M. scabrinodis* and a dealate gyne of *M. karavajevi* in a pitfall trap. The location where the pitfall traps were placed was a relatively humid area consisting of an abandoned former heathland with purple moor grass (*Molinia caerulea*). At the moment of the discovery of *M. karavajevi* the site was dominated by grasses, mosses and scattered trees and shrubs.

In this paper we describe the records and sampling site of the third and fourth observation of *M. karavajevi* in Belgium.

Material and methods

Sampling & Sampling area

The nature reserve Vorsdonkbos-Turfputten is situated in the alluvial valley of the river Demer. The southern part, where *M. karavajevi* was found, consists of a historical river meander filled with peat and is influenced by upwelling of iron-rich groundwater. The area consists of alluvial alder and willow forests alternated with wet grasslands, including transition mires and quaking bogs (European habitat type 7140), *Molinia* meadows (6410) and wet *Nardus* grassland (6230). The grasslands are mowed twice a year, with removal of the hay. Dependent on the site, the first mowing date falls in May to mid-summer, the second in autumn. At each mowing date, some grasslands parts are left uncut (phased mowing) in function of butterflies and other insects. More to the north the reserve consists of alluvial grasslands and partly forested sandy historical river dunes and sand bars.

In 2018, pitfall traps were placed in two grasslands in the nature reserve in the framework of the FWO-SBO project Future Floodplains - Ecosystems services of floodplains under socio-ecological change (www.futurefloodplains.be), being VOTU1 (lat. 50.970662, lon. 4.793742, UTM1 FS2548) and VOTU2 (50.972832, 4.797225, FS2648). The vegetation on the first location concerns a *Molinia* grassland (Fig. 1), the second the transition between *Nardus*

grassland and transition mire. On both locations, two glass jars were dug in the soil and filled for two thirds with a 4% formaldehyde solution. Water surface tension was broken with a few drops of detergent. A small cage consisting of an iron grate and a plexiglass cover was placed over the trap for protection and to avoid catching small vertebrates. The traps were installed on 30-03-2018 and removed on 27-10-2018. They were emptied more or less every 3 weeks. The pitfalls were both placed near an existing piëzometer, VOTP001B and VOTP020A respectively (www.watina.inbo.be). In addition, a vegetation survey was made at each location in a 4×2 m plot using the semi-quantitative Londo scale (LONDO, 1976). The most dominant plants in the VOTU1 vegetation survey plot were *Succisa pratensis* Moench (1794) and *Equisetum palustre* L. (1753), followed by *Juncus articulatus* L. (1753), *Potentilla erecta* (L.) Raeusch. (1797) and *Luzula multiflora* (Retz.) Lej. (1811).

Fig. 1. *Molinia* grassland in early spring where *M. karavajevi* was found at nature reserve Vorsdonkbos-Turfputten (Aarschot, Belgium). Pitfall trap VOTU1 (indicated by a red circle) was placed a few meters to the right of the central ditch. © Luc Vervoort.

In 2019, a transition mire in Vorsdonkbos-Turfputten (Fig. 2), located around 200 m east from VOTU1, was checked for multiple insect groups. Different spots of the grassland were randomly chosen and sampled with use of an aspirator. The collected insects were stored in 70% ethanol.

Results

Observation in 2018

One gyne of *M. karavajevi* was found in the VOTU1 pitfall sample taken on July 14th 2018 (Fig. 3). Given that the previous sample was taken on June 23th 2018, the gyne has entered the trap between these two dates. The gyne is in the private collection of François Vankerkhoven. In the VOTU2 pitfall, *M. karavajevi* was not found.

Observation in 2019

One dealate gyne of *M. karavajevi* was found on May 4th 2019 in a nest of *Myrmica scabrinodis* (Fig. 3). The gyne of *M. karavajevi* (Fig. 4) and workers of *M. scabrinodis* were simultaneously collected and deposited in the RBINS collection (I.G.: 34.162). The record of this specimen as well as the record of the specimen collected in 2018 will be included in the Belgian database FORMIDABEL (BROSENS *et al.*, 2013).

Fig. 2. Transition mire with flowering *Menyanthes trifoliata* in early spring where *M. karavajevi* was found, nature reserve Vorsdonkbos-Turfputten (Aarschot, Belgium). The exact location is left of the picture at a slightly elevated site near a solitary oak tree. © Luc Vervoort.

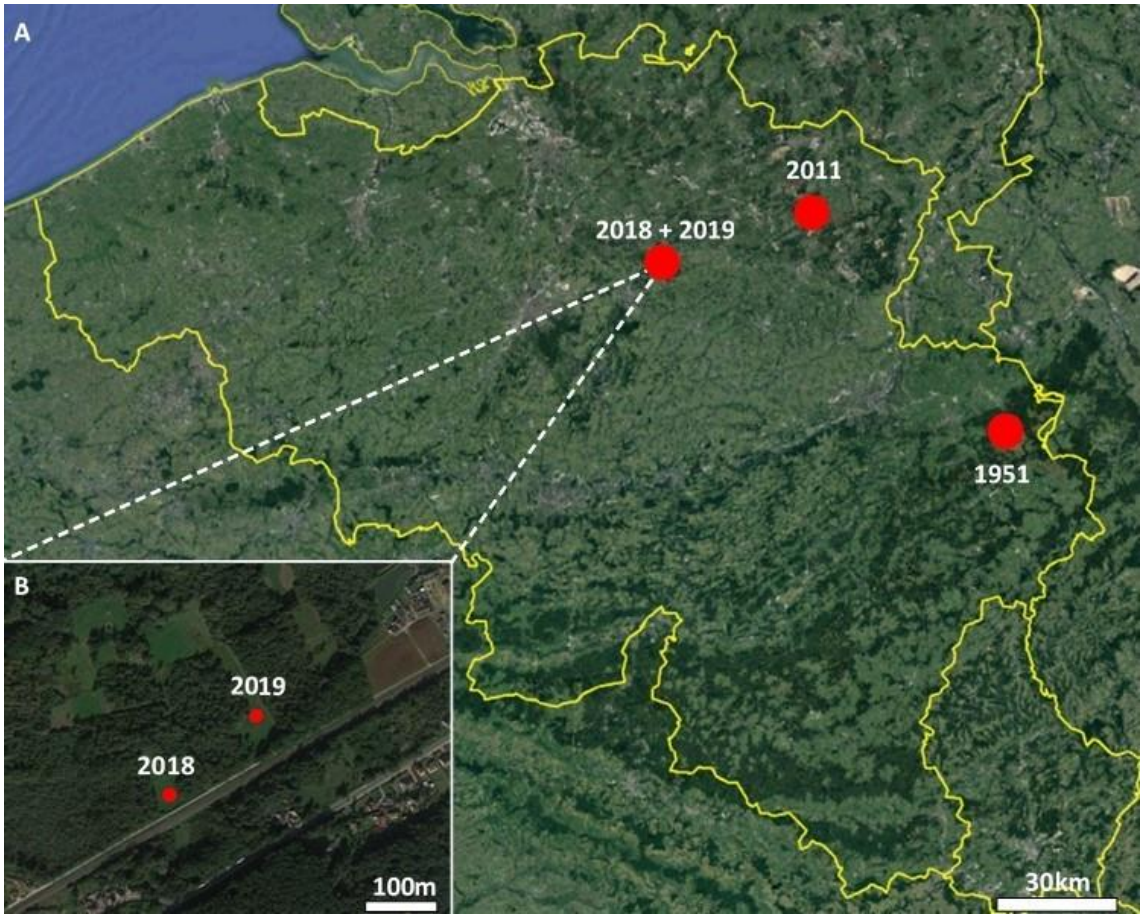

Fig. 3. Distribution map of *Myrmica karavajevi* in Belgium. A. The previous discoveries of *M. karavajevi* in the Hautes Fagnes region (1951) and in Houthalen-Helchteren (2011), as well as our recent discoveries in Aarschot are indicated in the figure. B, detailed figure of Vorsdonkbos-Turfputten (Aarschot) with indication of recent discovery sites.

The nest was located on a slightly elevated and drier part of a transition mire near an oak tree (*Quercus* sp. L.) (lat. 50.971752, lon. 4.795542, FS2648). On the site various species of *Carex* such as *Carex rostrata* Stokes 1787, *Carex nigra* (L.) Reichard, 1778, *Carex curta* L., 1753 and *Carex echinata* Murray, 1770 occur but also patches of *Sphagnum* mosses were present. In the wet patches *Menyanthes trifoliata* L., 1753, *Equisetum fluviatile* L., 1753 and *Viola palustris* L., 1753 were more abundant.

Other ants in Vorsdonkbos-Turfputten

In the pitfall traps installed in 2018, *Lasius platythorax* Seifert, 1991, dealate *Lasius umbratus* (Nylander, 1846) gynes, a dealate gyne of *Myrmecina graminicola* (Latreille, 1802) and workers, gynes and one male of *Myrmica scabrinodis* were found. During the sampling in 2019 a nest of *Formica fusca* Linnaeus, 1758 and a nest of *Lasius platythorax* were found near the edge of the grassland and beginning of the forest.

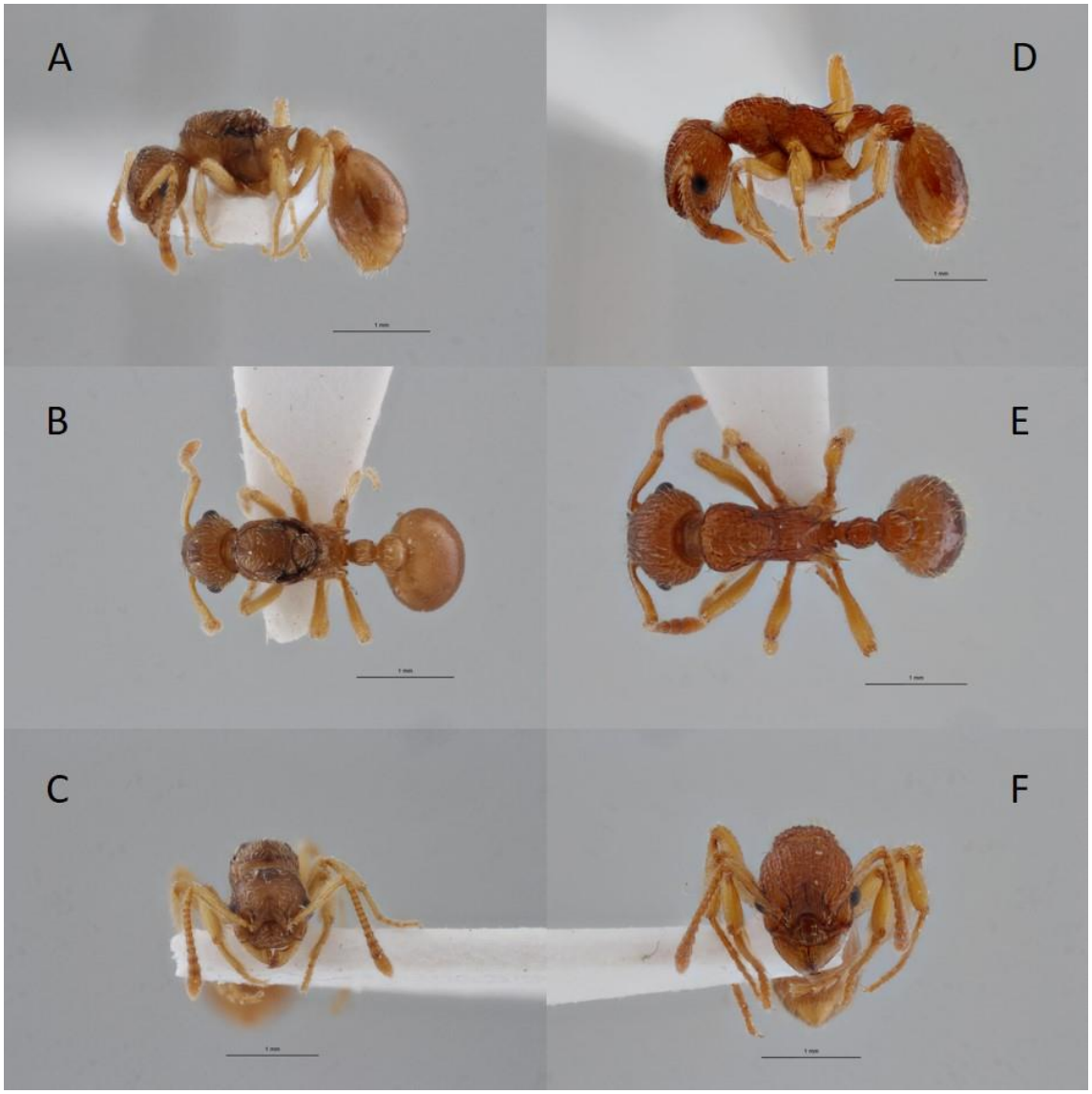

Fig. 4. Left: dealate gyne of *Myrmica karavajevi* that was collected at Aarschot, Belgium in 2019. A, lateral view; B, dorsal view; C, frontal view. Right: hostworker of *Myrmica scabrinodis* collected at the same locality. D, lateral view; E, dorsal view; F, frontal view. Scale bar indicates 1mm. © Julien Lalanne.

Discussion

Taxonomical clarification of Myrmica karavajevi versus Symbiomyrma karavajevi

Throughout the years *M. karavajevi* underwent several taxonomic revisions and consequently name changes. The inquiline *M. karavajevi* was first designated to a new genus, *Symbiomyrma,* by Arnoldi in 1930 after finding this social parasite in a nest of *M. scabrinodis* (Smiev, East Ukraine, 1926). With a new observation of a dealate gyne of this inquiline in Janov, Czech Republic another genus *Sifolinia* was created for the description of *Sifolinia pechi* (SAMŠIŇÁK, 1956). Later, in 1964 Samšiňák postulated that the genera *Sifolinia* and *Symbiomyrma* are identical (SAMŠIŇÁK, 1964) and Radchenko and Elmes synonymized these names with *Myrmica karavajevi* (Arnoldi, 1930) (RADCHENKO & ELMES, 2003, 2010) as the species was moved to the genus *Myrmica*. The individual that was found in the Hautes Fagnes region and named *Myrmica faniensis* by VAN BOVEN (1970) was later synonymized with *Symbiomyrma karavajevi* by Seifert. At the same time he also designated *Sifolinia winterae* Kutter, 1973 as a junior synonym of *S. karavajevi* considering *Symbiomyrma* as a valid taxonomic genus (SEIFERT, 1994). After a transition phase in 2007 when Seifert presented *Symbiomyrma* as a subgenus of *Myrmica* he later revived *Symbiomyrma* from this subgeneric status and considers now *Symbiomyrma karavajevi* Arnoldi, 1930 as a valid species name (SEIFERT, 2007, 2018). Together with 3 other West-Palearctic parasitic species Seifert assembles *S. karavajevi* into what he calls 'a biologically distinct cluster' (SEIFERT, 2018). On the other hand, in a molecular phylogenetic study *M. karavajevi* is allocated to the *scabrinodis*-group (JANSEN *et al*., 2010). Since there is no taxonomic consensus and the taxonomy of this species is not the subject of this study, we prefer to use the name *M. karavajevi.*

Host and habitat preferences of Myrmica karavajevi

Based on the known observations of *Myrmica karavajevi* it appears that this species prefers humid habitats, as is also the case for the observations reported here. However, some records indicate that this species can also be present in dryer environments. For instance, on August 23, 1961 Pisarski found 13 dealate gynes and 1 winged male of *Sifolinia pechi* Samšiňák, 1957 (junior synonym of *M. karavajevi*) in a *M. rugulosa* nest situated on a dry, sunny south-facing slope. Furthermore, KUTTER (1973) reports 13 winged females and 1 male of *Sifilonia winterae* (junior synonym of *M. karavajevi*) collected by Buschinger from a nest of *M. ruginodis*. Radchenko & Elmes, on the other hand, refute the identification of the host as determined by both Pisarski (*M. rugulosa*) and Buschinger & Kutter (*M. ruginodis*), perhaps from the conviction that *M. karavajevi* prefers a host which is located in a rather humid habitat. After re-evaluation of the collected specimens, in both cases Radchenko & Elmes designate *M. gallienii* as the host, a species that is strongly associated with a wet environment. The notification of PER DOUWES (1995) from Sweden remains undiscussed however and there are more and more reports indicating *M. rugulosa* as a host (SEIFERT, 1994; CZECHOWSKI *et al*., 2002). Following the publication of the monograph of CZECHOWSKI *et al*. (2012) on the genus *Myrmica* and in a paper dedicated to this parasitic species, the determination of *M. rugulosa* as a host by Pisarski is being restored (WITEK *et al*., 2013).

The confirmation that *M. karavajevi* is also associated with *M. rugulosa* is an indication for an extensive habitat choice. Most observations show us a connection between *M. karavajevi* and species that prefer a humid biotope and as a consequence they are often related to its primary host *M. scabrinodis*. However, the general view remains that the choice of host always falls within the *scabrinodis*-group, being the species *M. scabrinodis, M. gallienii, M. rugulosa, M. lonae* and *M. sabuleti*. However, we have to consider a possible exception: the presence of this inquiline in a nest of *M. ruginodis* (KUTTER, 1973). Although Radchenko & Elmes also

question this determination (RADCHENKO & ELMES, 2003, 2010) and correct it to *M. gallienii*, we want to reconsider the correctness of the identification since both Kutter and Buschinger are renowned myrmecologists. If the identification of *M. ruginodis* would be correct, then this would suggest that *M. karavajevi* can also choose a host outside the *scabrinodis*-group, but still a host associated with a humid habitat. Additionally, it is also not inconceivable that this social parasitic species might have two ecotypes with each a different biotope preference (WITEK *et al*., 2013).

The species of the genus *Myrmica*, belonging to the *scabrinodis*-group and which are known to be a potential host are very common in Flanders (DEKONINCK *et al*., 2012) with the exception of *M. gallienii* (VANKERKHOVEN *et al*., 2008). As for most social parasites, a fertilized female must use a special strategy to be accepted into a hostile nest. A possible strategy is that the social parasite mimics or receives the cuticular hydrocarbon profile of the host and we assume that this species uses this approach as well. Until now, we are only aware of a single experiment in the laboratory conducted by Elmes trying to introduce inquiline gynes in a nest of *M. scabrinodis* resulting in the death of the parasitic queens instead of a welcoming acceptance (WITEK *et al*., 2013). The rareness of *M. karavajevi* can therefore potentially be attributed to a very critical introduction phase in the life of this remarkable social parasite. But once established in a chosen area the amount of *M. karavajevi* individuals possibly increases, leading to higher densities of this species and a higher number of parasitized host nests. It is not imaginary that the successful colonisation of a first individual can thus be the stepping stone for further dispersion. In the situation of Vorsdonkbos-Turfputten, this can be an explication for finding the species in two sites separated by forest located almost 200 meters apart. This also suggests the presence of an established population in this nature reserve. Little is known about the prevalence of *M. karavajevi* on the locations where it occurs. In Poland it concerned in two cases at least 3 infested *M. scabrinodis* colonies out of a total of 11 investigated and 1 out of 30 respectively (WITEK *et al*., 2013).

The four locations where *M. karavajevi* was found in Belgium all consisted of nutrient-poor humid to wet grasslands and mires. The occurrence of extensive open wet vegetations possibly results in a high abundance of the main host species *M. scabrinodis*. The combination of large quantities of host nests and in some cases the presence of multiple host species (*M. gallienii* and *M. lonae*) in such habitats might be of great importance for a large and vital population of *M. karavajevi*. Therefore, directed searches in similar habitat types with presence of host species in the Campine region or the Ardennes might result in additional findings of this social parasite. It would also be very interesting to investigate the distribution and prevalence of *M. karavajevi* in nests of *M. scabrinodis* and other potential host species in Vorsdonkbos-Turfputten. Nature management consisting of traditional mowing (twice a year), as carried out in the wet grasslands and mires in Vorsdonkbos-Turfputten, might turn out to be beneficial for *M. karavajevi* thanks to its effects on the density of its main host *M. scabrinodis*. In two (moderately) moist long-term experimental grassland sites in Germany, with *M. scabrinodis* as most abundant species, *M. scabrinodis* worker and nest density as well as food resource occupancy was higher in traditional (twice per year) and -to a lesser extent- intensively (4–5 times per year, including fertilization) mowed plots than in abandoned or mulched (once per year) plots (PÉREZ-SANCHEZ *et al.*, 2018). Similar results were obtained in another study, despite rather large variation between sites (GRILL *et al.*, 2008). This might be due to the warmer microclimate in the treatments with mowing, since *M. scabrinodis* tends to be associated with less disturbed but warm and wet habitats, but may also be caused by a decrease of litter- and grass-cover associated *Lasius* species in mowed grasslands (GRILL *et al.*, 2008).

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