

***Microdon mutabilis* (Linnaeus) sensu Schönrogge et al. (2002)
in Belgium: host use, distribution and status
(Diptera: Syrphidae)**

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Summary

Over the past decade *Microdon mutabilis* sensu SCHÖNRÖGGE et al. (2002) has been claimed from several locations on dry calcareous grassland in the south of Belgium. *M. mutabilis* and its sister species *M. myrmicae* are parasites on ants and can only be distinguished by the shape of the larvae or pupae or by their host ant (genus): *Myrmica* in boggy places in *M. myrmicae* and *Formica* on dry grasslands in *M. mutabilis*. The host ant species exploited by the presumed *M. mutabilis* on the dry calcareous grasslands in Belgium was unknown; in the area where it was described (United Kingdom) all populations of *M. mutabilis* live with *Formica lemami*, but this ant species does not occur at the Belgian calcareous grasslands. The species identity of these Belgian *Microdon* populations therefore remained uncertain. On 10.VI.2015 a puparium of *M. mutabilis* was found in a nest of *Formica cunicularia* at Lavaux-Sainte-Anne. The shape of the puparium, and the fact that it lived with *Formica* ants proves that indeed this population at dry calcareous grassland is *M. mutabilis* and reveals a novel host ant used by *M. mutabilis*, outside the range of *F. lemami*. Additionally, I compared morphological measurements of the scutellum between adult *M. myrmicae* and *M. mutabilis* sensu SCHÖNRÖGGE et al. (2002), but could not find differences to discriminate between these species. Adults of this species pair remain impossible to identify.

Keywords: host-parasite relationship, Microdontinae, host ant, *Microdon*.

Samenvatting

Sinds een jaar of tien worden geregeld *Microdon mutabilis* sensu SCHÖNRÖGGE et al. (2002) geclaimd van op een aantal droge kalkgraslanden in het zuiden van België. *M. mutabilis* en zijn cryptische zustersoort *M. myrmicae* (Moerasknikspriet) zijn parasieten op mierenbroed, en kunnen enkel onderscheiden worden aan de hand van kenmerken van de larven of poppen, of aan de hand van hun gastheermier: *Myrmica* in venig grasland bij *M. myrmicae* en *Formica* in droog kalkgrasland bij *M. mutabilis*. De gastheermier van de vermoedelijke *M. mutabilis* op de Belgische kalkgraslanden is nooit gevonden, en dus was niet met zekerheid geweten om welke soort *Microdon* het hier gaat. In Engeland waar *M. mutabilis* sensu SCHÖNRÖGGE et al. (2002) ontdekt werd, leven alle populaties bij *Formica lemami*, maar deze mierensoort komt niet voor op de Belgische kalkgraslanden. Op 10.VI.2015 werd een puparium van *M. mutabilis* sensu SCHÖNRÖGGE et al. (2002) gevonden in een nest van *F. cunicularia* op het kalkgrasland "le Gros Tienne" in Lavaux-Sainte-Anne. Hiermee is bewezen dat de populaties op droge kalkgraslanden *M. mutabilis* sensu SCHÖNRÖGGE et al. (2002) zijn. Daarenboven wordt hiermee aangetoond dat *F. cunicularia* een gastheermier is, wat verklaart waarom ze voorkomt waar *F. lemami* niet voorkomt. Tenslotte vergeleek ik morfologische metingen van het scutellum tussen de twee behandelde *Microdon*-soorten, maar vond geen verschillen. De volwassen vliegen blijven derhalve niet op soort te brengen.

Résumé

Au cours de la dernière décennie, *Microdon mutabilis* sensu SCHÖNROGGE *et al.* (2002) a été observé à plusieurs endroits sur pelouses calcaires sèches dans le sud de la Belgique. *M. mutabilis* et son espèce sœur *M. myrmicae*, toutes deux parasites de fourmis, ne peuvent être distinguées que par la forme des larves ou des nymphes ou par leurs fourmis hôtes: *M. myrmicae* étant parasite de *Myrmica* dans des milieux marécageux et *M. mutabilis* parasite de *Formica* sur pelouses sèches. En Belgique, les espèces de fourmis exploitées par *M. mutabilis* ne sont pas connues, par contre dans la zone où il a été décrit (Royaume-Uni) toutes les populations vivent avec *Formica lemani*, espèce de fourmi non rencontrée sur pelouses calcaires dans notre pays. L'identité du *Microdon* de la population belge reste donc indéfini. Le 10.VI.2015, une puppe vide de *M. mutabilis* a été trouvée dans un nid de *Formica cunicularia* à Lavaux-Sainte-Anne. Cela prouve qu'il y a des populations de *M. mutabilis* sensu SCHÖNROGGE *et al.* (2002) sur pelouses calcaires sèches en Belgique et révèle une nouvelle fourmi hôte utilisée par *M. mutabilis*. En outre, la comparaison des mesures morphométriques du scutellum des adultes de *M. myrmicae* et de *M. mutabilis* sensu SCHÖNROGGE *et al.* (2002) montre qu'il est impossible de les différencier de cette manière.

Introduction

Microdon is a unique genus within the Belgian Syrphidae. It is classified within the Microdontinae, which are an ancient monophyletic group that is genetically quite different from other Syrphidae (REEMER, 2012). Ecologically they are remarkable in that they are parasites on ants (Formicidae). Host-parasite coevolution or host-shifting in such systems may lead to intimate adaptation and speciation, which has happened in *Microdon*. Of the three *Microdon* species that were known from Belgium (*M. devius*, *M. eggeri* and *M. mutabilis*; VERLINDEN, 1991), two species have since been shown to be cryptic species pairs, each species of the pair being adapted to a different host ant genus (SCHÖNROGGE *et al.* 2002, SCHMID, 2004). A detailed study of *Microdon mutabilis* in the United Kingdom has shown that some populations were confined to boggy places with *Myrmica* (mainly *M. scabrinodis*) as the host ant species, while others were found on arid, calcareous grasslands with *Formica lemani* (SCHÖNROGGE *et al.*, 2002). Adult flies of the latter populations were on average larger, but further showed no apparent differences with the former populations. However, when looking at larvae and pupae, evident differences were found in, amongst others, the respiratory horns. This prompted the authors to assign them to different species; the species living together with *Myrmica* ants was named *M. myrmicae*, the other species received the former name *M. mutabilis*. In the remainder of the text, the name *M. mutabilis* refers to *M. mutabilis* (Linnaeus) sensu SCHÖNROGGE *et al.* (2002) unless stated otherwise.

In the United Kingdom, *M. mutabilis* appears to use only one host ant species: *F. lemani* (SCHÖNROGGE *et al.*, 2002). In mainland Europe the situation seems to be different. DONISTHORPE (1927) mentions four other host ant species for *M. mutabilis*: three *Lasius* species and *Formica rufibarbis*, yet such a variety of hosts seems unlikely in the light of strong host genus specialization observed in other *Microdon* species in Europe. SCHÖNROGGE *et al.* (2002) also found a minor proportion of pupae in nests others than that of *F. lemani*. They interpret this as artifacts from nests being vacated by ant colonies (possibly due to the *Microdon* infestation, as has been similarly shown for *Maculinea* butterflies), that are later recolonized by another ant species. The records with other ant species in mainland Europe, however, seem too frequent to be explained by this. Additional information is given by ANDRIES (1912) in her description of *Microdon rhenanus*, a smaller lookalike of *M. mutabilis* described from Western Germany near Belgium (ANDRIES, 1912), that was synonymized with *M. mutabilis* (DOCZKAL & SCHMID, 1999, SCHMID, 2004). Allegedly *M. rhenanus* occurred at the same sites as *M. mutabilis* and both species were found in nests of *Formica fusca* and *Formica fusca* var. *fusco-rufibarbis* (ANDRIES, 1912), but caution is needed when dealing with old records of these ant species. The latter ant species now is known as *F. cunicularia*. It is more difficult to judge the historical report of the species *F. fusca*. *F. lemani* at that time was regarded a subspecies of *F. fusca* and both ant species are morphologically very similar. In the UK *F. fusca* is a common *Formica* species, yet *M. mutabilis* is restricted to *F. lemani* and has never been confirmed from the closely related *F. fusca*.

After the first confirmed records of extant populations of *M. myrmicae* (pupae) in Belgium in boggy areas (VAN DE MEUTTER *et al.*, 2009), also *M. mutabilis*-type flies (on average larger than *M. myrmicae*) were found on some xerothermic calcareous grasslands at Torgny, Musson and at several locations in the surroundings of Rochefort. Whereas *M. myrmicae* pupae were fairly easily found by investigating ant nests near perches or under the patrolling areas of male *M. myrmicae* (VAN DE MEUTTER *et al.*, 2009), this proved unsuccessful in the presumed *M. mutabilis*. Even more, no visible signs of *Formica* nests were found although small numbers of *Formica* workers were often browsing the ground. This paradox may point to an ant species that makes underground nests, an idea shared by M. SPEIGHT (pers. comm.) that has instigated a new search that led to the discovery reported here.

In addition to this, I evaluate the use of morphological body ratios in discerning adult *M. myrmicae* and *M. mutabilis*, that are regarded cryptic and indiscernible. SCHÖNRÖGGE *et al.* (2002) reported that amongst others the ratio of scutellum length on scutellum width, and the ratio of the distance between the microdents on the scutellum and the scutellum width, were successful in 95% of cases in assigning individuals correctly, although there remains some overlap. Although later authors (e.g. BARTSCH, 2009, SPEIGHT & SARTHOU, 2013) have echoed the proposition that *M. myrmicae* and *M. mutabilis* cannot be told apart as adults, it may be possible to identify the non-overlapping ranges for some of the proposed ratios, where identification is certain. First, we need to validate the use of some of the proposed measurements for Belgian *M. mutabilis* and *M. myrmicae*.

Material and methods

On 10 June 2015, the author visited “le Gros Tienne” a dry south-faced calcareous grassland famous for its orchid diversity at Lavaux-Sainte-Anne. In 2011 a population of presumed *M. mutabilis* was discovered here and observed each year since. In all years, male *M. mutabilis* were observed mainly in a small area in the eastern part of the grassland. There are no stones lying on the ground and previous inspections of visible ant nests (different genera) in the hope to find pupae or puparia were in vain. Because *Formica* is the expected host ant genus in the case of *M. mutabilis*, I followed workers of a red-and-black *Formica* species to find colonies. Because pupae and puparia of *Microdon* are to be found in the top of ant nests, it is possible to open ants’ nests without damaging the nest too much.

To validate the use of morphological body ratios to discern adult *M. mutabilis* and *M. myrmicae*, I photographed the scutellum of 7 presumed *M. mutabilis* (Lavaux-St-Anne and Torgny) and 8 *M. myrmicae* (4 different populations) from Belgian populations. Relative measurements on the scutellum were performed on a PC screen with a measuring stick. Measures taken were distance between the microdents on the scutellum, maximal scutellum width and scutellum length at the median distance between the microdents. From these measurements we calculated three ratios: distance between microdents/scutellum width, distance between microdents/scutellum length, scutellum length/scutellum width.

Results

Eventually the search for *Microdon* immature stages at Lavaux-Sainte-Anne led to the discovery of a large subterranean *Formica* nest, hidden in a grass tussock, only discernible from the surrounding by some more open ground and some indications of worker trails yet no visible worker ants. I carefully opened the top of the nest and immediately found one puparium. Five worker ants were collected to allow identification of the species. All five ants belonged to *Formica cunicularia* (determination was confirmed by E. Lommelen). Besides host ant, the puparium of *M. mutabilis* can be used to distinguish between *M. mutabilis* and *M. myrmicae*, especially the difference in shape of the respiratory horns. Yet, in enclosed pupae, these horns are mostly lacking. The larger size (Fig. 1), and the more prominent reticulation at the base of the dome-shaped puparium (Fig. 2) compared to *M. myrmicae* allow to confirm it as *M. mutabilis* (see SCHÖNRÖGGE *et al.*, 2002).

The results of the morphological measurements on adult *Microdon* are presented in table 1. We found no significant differences between the two species. Compared to SCHÖNRÖGGE *et al.* (2002), there was much less difference between the species in the measured ratios.



Fig. 1. Photograph of the *M. mutabilis* puparium (Lavaux-Sainte-Anne) in comparison with puparia of *M. myrmicae* (Maasmechelen, Olloy-sur-Viroin).



Fig. 2. Photograph of the *M. mutabilis* puparium showing the fine reticulation pattern.

Table 1. Ratios of measurements (averages, standard errors) of the scutellum for Belgian *Microdon mutabilis* (N=7) and *M. myrmicae* (N=8) (microd/width=distance between the microdents/scutellum width; microd/length= distance between the microdents/scutellum length; Width/length=scutellum width/scutellum length).

	microd/width	SE	microd/length	SE	Width/Length	SE
<i>Microdon mutabilis</i>	2,95	0,066	0,72	0,038	2,06	0,061
<i>Microdon myrmicae</i>	3,08	0,10	0,71	0,029	2,04	0,029

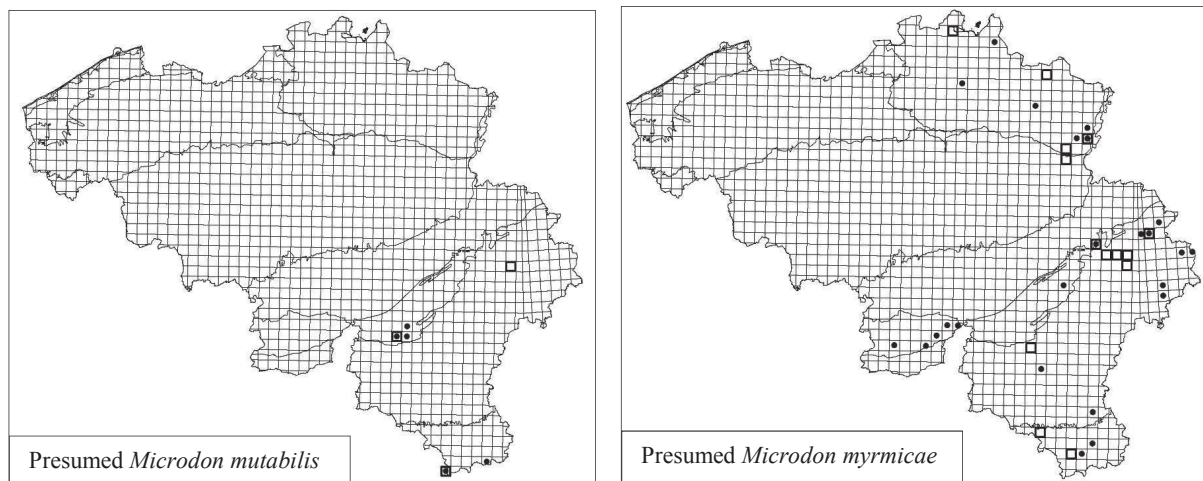


Fig. 3. Distribution map of presumed *M. mutabilis* and presumed *M. myrmicae*, provisionally identified based on habitat information. Observations before 1988 are indicated by hollow squares, observations after this date are indicated with black dots.

Discussion

The discovery of a *M. mutabilis* puparium in a nest of *F. cunicularia* is in line with the expectations. It is one of the host ants used by *M. mutabilis* mentioned by ANDRIES (1912), however, it has not been reported as a host since. *F. cunicularia* belongs to the subgenus *Serviformica* which often builds underground nests, and therefore may go unnoticed easily. This would explain why it was so difficult to find the host ant. *F. cunicularia* is a fairly common and widespread ant in Belgium (DEKONINCK *et al.*, 2012). *M. mutabilis* however has been found only on a handful of the most exquisite calcareous grasslands in Belgium, suggesting some extra needs (microclimate?) for this species. In literature some further host ants for *M. mutabilis* in mainland Europe are listed. *F. fusca* was mentioned by ANDRIES (1912). This ant species makes fairly conspicuous mounds in short-turfed grassland and was present at several of the sites where *M. mutabilis* flies in Belgium, however, I never found pupae in

these nests. In the UK, no extant populations of *M. mutabilis* occur with *F. fusca*, and older records with *F. fusca* are believed to be *F. lemani* (SCHÖNRÖGGE *et al.*, 2002). This assumption may also hold for the mainland until proof is provided that *F. fusca* may host *M. mutabilis*. Also, it is worth mentioning that some colonies of *F. cunicularia* may be nearly black which makes them prone to misidentification as *F. fusca*. DONISTHORPE (1927) also lists *F. rufibarbis* as a host. Whether this species is also used as a host in Belgium is unclear so far, but this species also is liable to be confused with *F. cunicularia* and further evidence is needed before this ant species can be regarded a host of *M. mutabilis*. Besides the reports in ANDRIES (1912) and DONISTHORPE (1927) there are no published reports on *Formica* host ant use on mainland Europe that I know of. On the French website (http://www.galerie-insecte.org/galerie/Microdon_mutabilis.html) a photo gallery shows several photographs of typical pupae of *M. mutabilis* from central and southern (Pyrenees) France, all found in ant nests underneath stones, without further information on the ant species. One photograph taken near Langres shows a larva surrounded by red-brown ants that by all signs look like *F. cunicularia*, but cannot be conclusively identified by photographs alone. *F. cunicularia* has an extensive repartition in Europe and it therefore may act as a host over much of the European range of *M. mutabilis*.

As *Microdon* are poor fliers (ELMES *et al.*, 1999), and the habitats where the main host ants are found are very different (boggy places for *M. myrmicae*, chalky pavements for *M. mutabilis*), the habitat where a fly is found can probably be used as an indicator of species identity (combined with e.g. average size of the flies). Based on this I produced maps of the distribution of presumed *M. mutabilis* and presumed *M. myrmicae* in Belgium, provisionally showing that *M. myrmicae* is a relatively widespread species in the east and south of Belgium, whereas *M. mutabilis* is restricted to two regions (Fig. 3). One historical record, however comes from the high Ardennes in the east of Belgium with *Formica lemani*. We have no recent records of *M. mutabilis* with this ant species, but if so, this could complicate assigning individuals to species based on habitat information.

By far most of the records of *M. mutabilis* or *M. myrmicae* are from adults caught by sweep net, but these animals cannot be certainly identified. Searching larvae or pupae is time-consuming and to some extent disturbing the *Microdon* and its host. We therefore evaluated the use of three body morphology ratios that proved rather distinctive in UK populations of *M. mutabilis* and *M. myrmicae*. Unfortunately the measured proportions were not distinctive among these species in Belgium, performing even worse than in SCHÖNRÖGGE *et al.* (2002). Apart from differences in size, which show some overlap and may vary by nutritional conditions, adult flies thus far remain indistinguishable.

The status of *M. mutabilis* in Belgium is difficult to assess. Because we cannot know the species identity of ancient records of *M. mutabilis* without collected pupae, trends cannot simply be calculated. For some populations, we know that they are present for more than 60 years (e.g. at Torgny). If the data in Figure 3 are correct, several new populations have been discovered recently, but this is likely due to increased attention for Syrphidae in general. Fact is that all extant populations occur in a selection of the best preserved historically permanent calcareous grasslands, and that populations are localized and few. *Microdon* are thought to be bad dispersers (ELMES *et al.*, 1999), and the habitat is highly fragmented in Belgium. Hopeful is that over the last decade more than 200 hectares of calcareous grasslands that were encroached by shrubs have been restored (LIFE project *Restoration and sustainable management of upper Meuse dry Grasslands*). It will take some time however before they will evolve into equally suitable habitats with high ants densities, and it remains unknown whether *M. mutabilis* may be able to colonize. The conclusion at present is that *M. mutabilis* is a highly threatened species in Belgium, restricted to some scattered patches of dry calcareous grasslands in southern Belgium. Current management is in favour of *M. mutabilis*, yet whether this poor disperser will be able to exploit new habitat in the near future remains to be seen.

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