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PRACTICAL CONSERVATION PAPER

Techniques for studying *Maculinea* butterflies: II. Identification guide to *Myrmica* ants found on *Maculinea* sites in Europe

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Introduction

Many published accounts of *Maculinea* pupae found in ant nests reveal difficulties in identifying the host ant to a generic level (e.g. Powell, 1917, 1920; Winterstein, 1927; Malicky, 1969). Even experienced myrmecologists make mistakes about identification! Taxonomic nomenclature changes in some instances have added to the confusion, e.g. *Myrmica laevinodis* (Nyl.), *M. ruginodis* Nyl. and *Formica rubra* (L.) are all names which have been used synonymously with *M. rubra* (L.) (Santschi, 1931; Weber, 1947; Yarrow, 1955; Bernard, 1968; Elmes, 1975; Kutter, 1977). In the field, a single *Myrmica* worker can be very difficult to identify (e.g. Elmes and Thomas, 1985) but in most cases a sample of 10 workers taken from a nest can be named using a mixture of morphological and ecological nest-site characteristic clues (Elmes, 1978a). Males and queens are more distinctive but as they are seasonal and often scarce they cannot be relied upon to confirm the identification of workers. Identification with a hand lens should be confirmed in the laboratory using a binocular microscope for finer morphometric details and measurements.

The Holarctic genus of red ants, *Myrmica* Latreille, 1804 is assigned to the tribe *Myrmicini* Smith. Its type-species: *Formica rubra* Linné, was described in 1758. About 100 *Myrmica* species have been identified worldwide (Bolton, 1995). The 60 or so Palaearctic species can be identified using comprehensive keys (e.g. Bernard, 1968, Bolton and Collingwood, 1975; Kutter, 1977; Collingwood, 1979; Seifert, 1988, 1996; Skinner and Allen, 1996). This brief guide describes the 12 species of *Myrmica* which are found most frequently on sites where European *Maculinea* are found and points out major differences between workers of apparently similar species, based on visual and morphometric characteristics. Of the 12 species of *Myrmica* featured in this guide, as many as five have been found sympatrically on a single *Maculinea* site. The major *Myrmica* host species for any *Maculinea* species is not always the most abundant and another more abundant species may occasionally succeed in rearing *Maculinea* (Elmes and Thomas, 1992).

Main diagnostic morphological features of the genus *Myrmica*

Worker ants are always reddish in colour (some may appear pale orange, others almost black). The worker caste is monomorphic. Winged males and females are found in summer. The length of workers is generally 5–10 mm. The petiole has two joints or nodes (Fig. 1a). The thorax profile is well rounded with distinct epinotal spines at the back.

Possible confusion with five other genera may occur. *Aphaenogaster* is the ant most often misidentified as *Myrmica* and may co-exist in southern Europe, south of latitude 45°N. The main distinguishing differences are a much narrower trunk and much longer petiole neck. *Maculinea arionides* M. has been found in nests of this genus in Japan (Yamaguchi, 1988). The minor workers of polymorphic *Messor* also resemble *Myrmica* but are only found in very hot southerly parts of Europe and are unlikely to co-exist. Ants of the genera *Leptothorax*

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and *Myrmecina* are easily distinguished from *Myrmica* by their much smaller size, usually less than 2 mm in length. *Manica* only occurs in mountainous regions of Europe and their workers are approximately double the size of *Myrmica* workers.

Identification to species in *Myrmica*

The main features used to characterize a *Myrmica* ant species are head characters including the shape of the antennal scapes and the frons : headwidth measurements ratio (Figs 1b, 2 and 3), and the shapes of the petiole, post-petiole and epinotal spines (Figs 1a, 4).

The four main taxonomic groups

Lobicornis group: M. lobicornis *Nylander and* M. schencki *Emery*

Characterized by tooth or plate on the right-angled bend of the scape projecting vertically. Ecologically these two species live in very different habitats.

M. lobicornis. Workers of this widespread dark coloured ant (often almost bicoloured with blackish head and gaster and dark red thorax) may be confused with *M. schencki* but they are unlikely to co-exist as this species prefers colder, wetter habitats. In the British Isles this

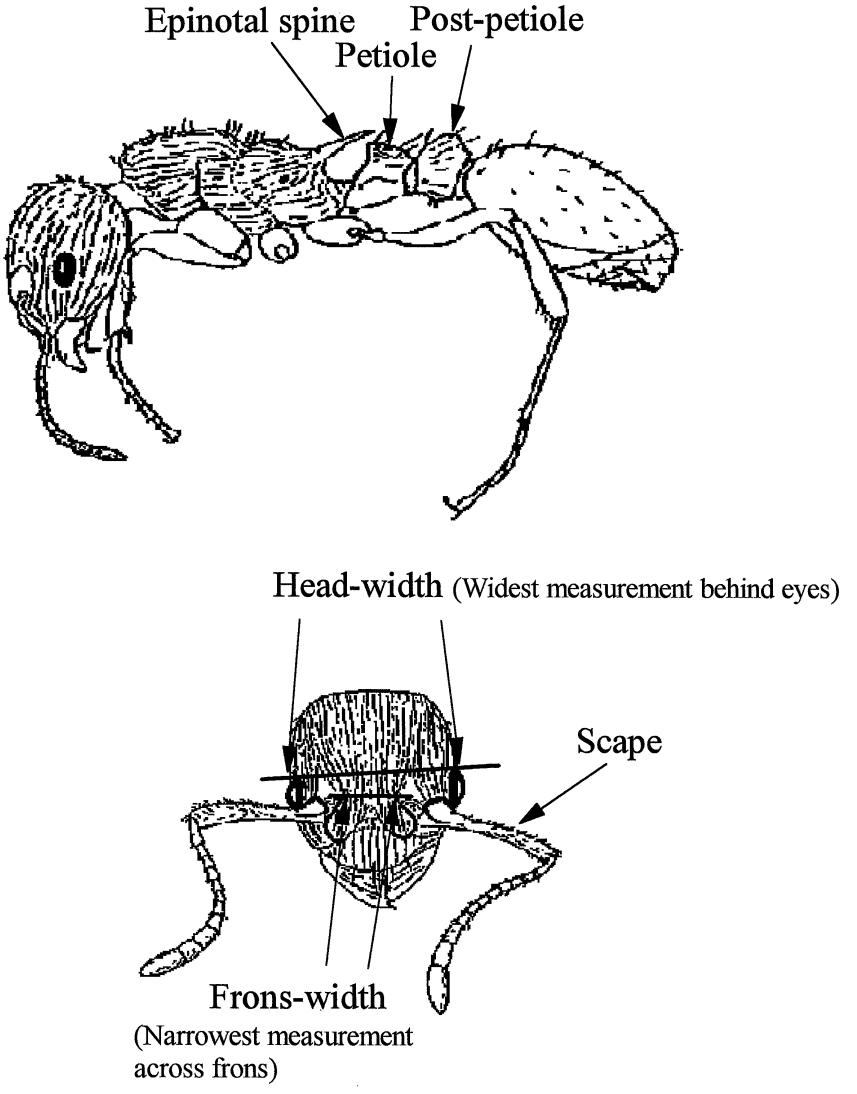

Figure 1. (a) Lateral view of the body of a *Myrmica* ant; (b) *Myrmica* head.

species is typically found on upland acid moorland and cool pastures (e.g. Elmes, 1978b). Colonies may co-exist with *M. sabuleti*, *M. scabrinodis* and *M. ruginodis* and are found in short turf in full sun; sometimes building solaria (heaps of earth and shredded dead vegetation which conceal temporary nest chambers amongst the

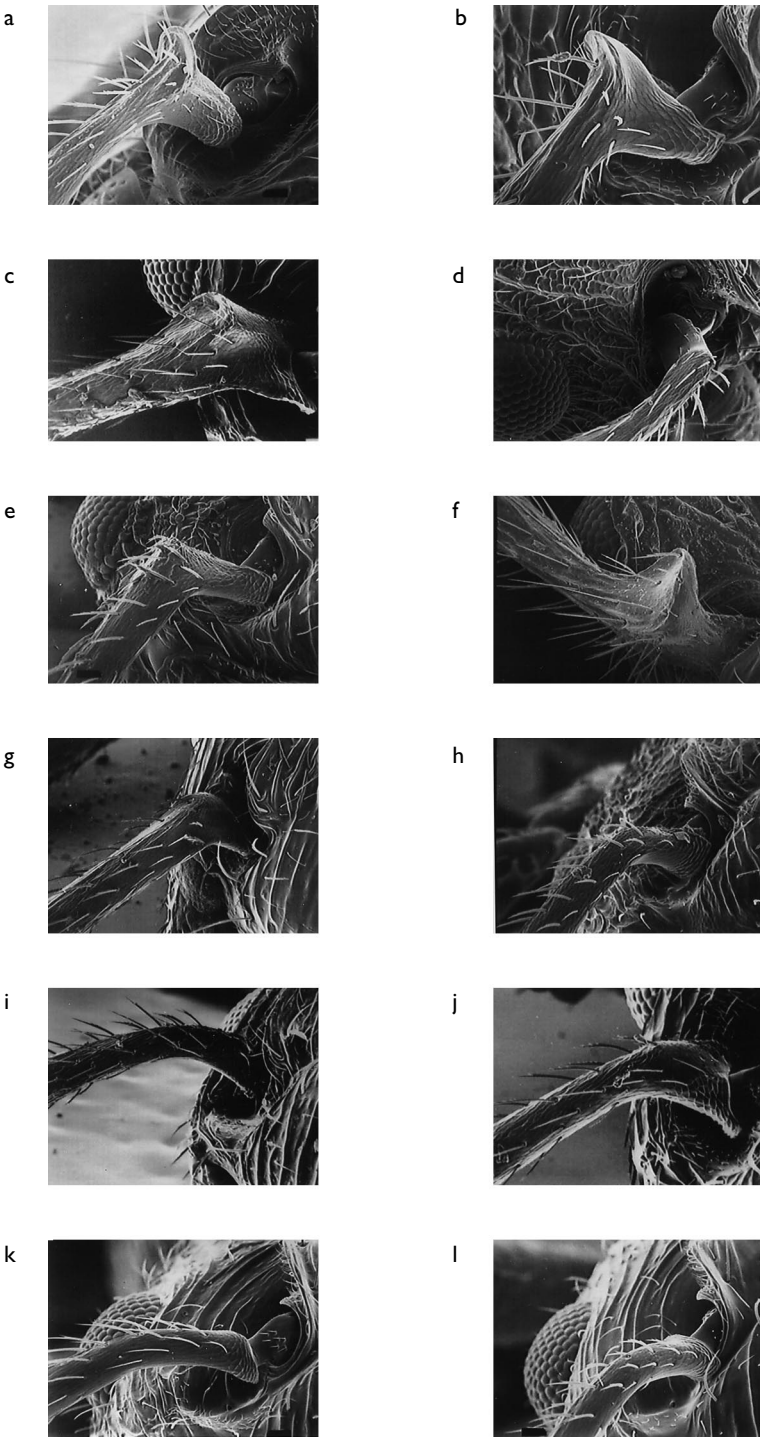

Figure 2. Scanning elecron micrograph (× 200 approx) of the base of an antennal scape in *Myrmica* species (a) *M. lobicornis*, (b) *M. schencki*, (c) *M. sabuleti*, (d) *M. scabrinodis*, (e) *M. specioides*, (f) *M. lonae*, (g) *M. vandeli*, (h) *M. rugulosa*, (i) *M. gallienii*, (j) *M. sulcinodis*, (k) *M. rubra*, (l) *M. ruginodis*.

base of growing vegetation) and sometimes nesting beneath stones. As far as it is known, this species is not a host to any European *Maculinea* species. The antennal scape has a right-angled bend with a low transverse ridge which is slightly smaller than *M. schencki*'s (Fig. 2a). Frons-width to head-width ratio ranges between

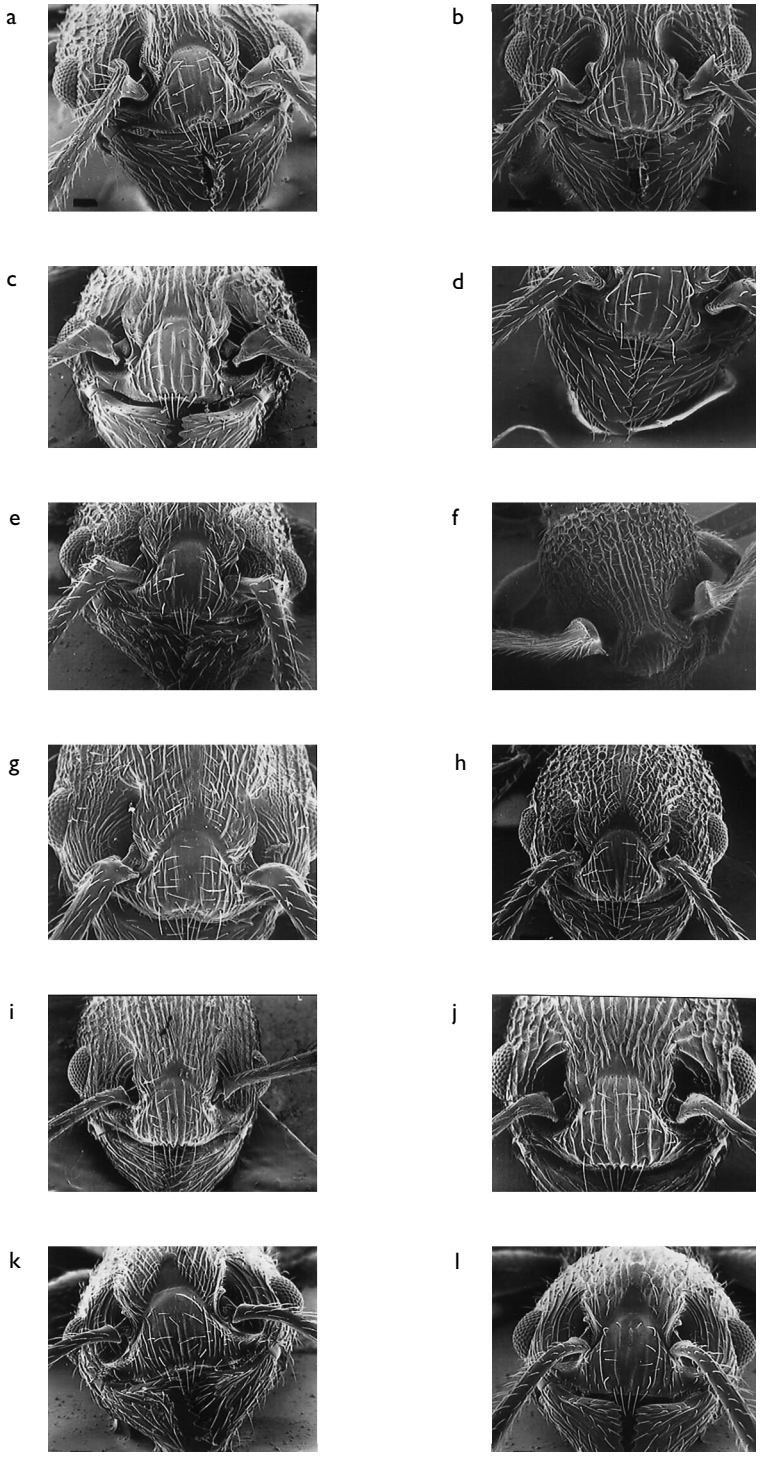

Figure 3. Scanning elecron micrograph (× 75 approx) of the antero-dorsal view of a head in *Myrmica* species (a) *M. lobicornis*, (b) *M. schencki*, (c) *M. sabuleti*, (d) *M. scabrinodis*, (e) *M. specioides*, (f) *M. lonae*, (g) *M. vandeli*, (h) *M. rugulosa*, (i) *M. gallienii*, (j) *M. sulcinodis*, (k) *M. rubra*, (l) *M. ruginodis*.

0.28 and 0.32 (Fig. 3a). The post-petiole is relatively high and narrow in profile (more than 1.4 times higher than long) (Fig. 4a). The length of a male scape, excluding the basal constriction, is greater than the head-width (measured in front of the eyes) and notably longer than the male scape in *M. schencki* (ca 1 mm).

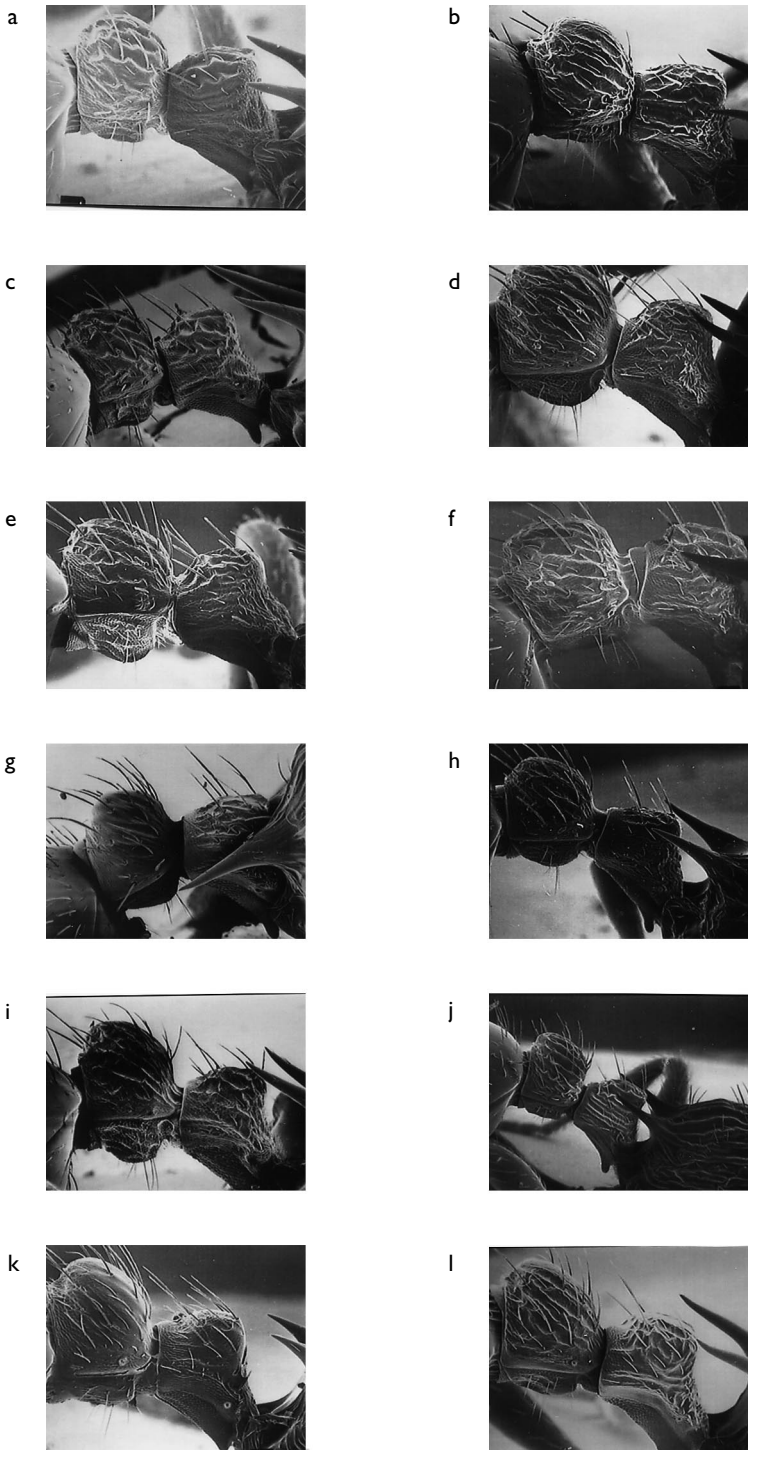

Figure 4. Scanning elecron micrograph (× 100 approx) of the alitrunk profile of *Myrmica* species (a) *M. lobicornis*, (b) *M. schencki*, (c) *M. sabuleti*, (d) *M. scabrinodis*, (e) *M. specioides*, (f) *M. lonae*, (g) *M. vandeli*, (h) *M. rugulosa*, (i) *M. gallienii*, (j) *M. sulcinodis*, (k) *M. rubra*, (l) *M. ruginodis*.

M. schencki. This species may be confused with *M. lobicornis* even with a hand lens, but is unlikely to co-exist as it prefers warmer, drier habitats such as hot mountainsides and sand dunes. It is scarce in the British Isles (Collingwood, 1958) and only found on shales or sandy soils. The workers are normally larger and lighter in colour. Colonies may co-exist with *M. sabuleti* and average 350 workers. Nests are found in soil and in summer it is usually possible to find solaria and 'chimneys' of dried vegetation and sandy granules above the nest. It is the major host of *Maculinea rebeli*. (Thomas *et al*., 1989, Elmes *et al*., 1998 this issue). The antennal scape has a right-angled bend with a massively developed transverse ridge (Fig. 2b). Frons-width to head-width ratio ranges between 0.18 and 0.24 (Fig. 3b). The post-petiole is relatively low and thick in profile (less than 1.4 times higher than long) (Fig. 4b). The length of a male scape, excluding the basal constriction, is less than the head-width (measured in front of the eyes) and notably shorter than the male scape in *M. lobicornis* (< 0.5 mm).

Scabrinodis group: M. sabuleti *Meinert*, M. scabrinodis *Nylander*, M. specioides *Bondroit*, M. lonae *Finzi and* M. vandeli *Bondroit*

Taxonomically an extremely difficult group: characterized by a lateral plate, projection or thickening on the right-angled bend of the scape. These five species overlap in their ecological requirements and several species may co-exist on a single site: the nest-site microhabitat determines the species distribution. Intraspecific variation is apparent among some 'species', and it is possible that further cryptic species which have yet to be described exist in this group.

M. sabuleti. This widespread species lives in warm biotopes and never nests in wet soils. It is typically found on well-grazed, grassy south facing slopes in northern Europe and the Alps (Elmes and Wardlaw, 1982). Nests are found under stones and in pasture. Colony size averages ca 500 workers. Sympatric species include *M. scabrinodis*, *M. specioides*, *M. schencki*, *M. lobicornis* and *M. rubra*. This is the main host species for *Maculinea arion* throughout Europe (Thomas, 1994). Occasional pupae of *M. rebeli* and *M. teleius* have also been found in *M. sabuleti* nests (Thomas *et al*., 1989; Elmes *et al*., 1998 this issue). The antennal scape has a well-developed scooped dish-shaped extension at the right-angled bend (Figs. 2c, 3c). Frons-width : head-width ratio is usually in the range 0.32–0.34 (Fig. 3c). The profile of the petiole is flattened on top and stepped towards the post-petiole (Fig. 4c). Epinotal spines are longer than those of *M. scabrinodis*. Male scape length is usually longer than that for *M. scabrinodis*, >0.5 mm.

M. scabrinodis. Workers are often pale ginger in colour but on moorland sites can be almost black or bi-coloured red and black. This is the most widely distributed and abundant *Myrmica* species. It tolerates a wide variety of habitats and overlaps the ranges of most other *Myrmica* species (Elmes and Wardlaw, 1982). Nests are found either in soil in bogs or long grass, or under stones. Colony size varies with nest density and averages ca 500 workers. There may be at least three ecological forms which are indistinguishable taxonomically. It is the major host species for *Maculinea teleius* (Thomas *et al*., 1989). It has been recorded as a host for *M. alcon* in Spain, northern France and southern Netherlands (Elmes *et al*., 1994, Scheper *et al*., 1995). It is also a minor host for *M. arion* and *M. rebeli* (Thomas *et al*., 1989). Typically the antennal scape has a grooved right-angled bend without a projection, although in one form the scape is much like a reduced version of that of *Myrmica sabuleti* (Fig. 2d). The frons-width : head-width ratio is usually in the range 0.36–0.38 (Fig. 3d). The shape of the petiole profile is similar to *M. sabuleti* but differs from that of *M. specioides*: the dorsal surface is flattened and steps down towards the post-petiole (Fig. 4d). Male scape length is usually short by comparison with *M. sabuleti*, <0.35 mm.

M. specioides. Workers are yellow-red to reddish-brown in colour and resemble those of *M. scabrinodis* morphologically, but differ in their ecological requirements. Although it has a northern distribution, it lives in even hotter and drier grasslands with thin soils compared to *M. sabuleti*. Nests are hard to find as it does not build solaria. It may be found on some *M. arion* sites (D.J. Simcox, P.S. Nielsen pers. comm.) but has never been recorded as a host. Workers are more aggressive than *M. scabrinodis* and sting freely. The antennal scape is similar to *M. scabrinodis* for workers (Fig. 2e) but the frons-width : head-width ratio is greater 0.38–0.40 (Fig. 3e). The petiole, whose dorsal surface curves smoothly towards the post-petiole in profile, is narrower than in *M. scabrinodis* (Fig. 4e). The scapes of males are indistinguishable from those in *M. scabrinodis* (<0.35 mm).

M. lonae. This species is considered by Collingwood (1979) to be a variety of *M. sabuleti*, which it resembles, but is a 'good' species based on ecology (Seifert, 1994). Although difficult to separate morphologically from

extreme forms of *M. sabuleti*, it usually lives in much wetter habitats, e.g. damp heathland in the Netherlands where *Maculinea alcon* live (Elmes *et al*., 1994). There have been no records of this species acting as host to any *Maculinea* species. We consider its stronghold to be the Balkan region. The antennal scape has a much more developed extension at the right-angled bend than *M. sabuleti* (Fig. 2f). The frons-width : head-width ratio is the same as in *M. sabuleti*, 0.32–0.34 (Fig. 3f). Petiole and post-petiole shape are similar to *M. sabuleti* (Fig. 4f).

M. vandeli. It is almost impossible to separate workers of *M. vandeli* from those of sympatric *M. scabrinodis* in the field (Elmes and Thomas, 1985). On measurement it is evident that their workers are generally larger and more hirsute than *M. scabrinodis*; their queens are noticeably larger and darker and the males have longer scapes, more like *M. sabuleti*. This species has a more restricted distribution but tolerates warmer and wetter conditions. Nests are found in tussocks of grass and sedge where prominent solaria may be built. Nest size is moderate and similar to *M. scabrinodis*. It is common in the French Alps in bogs and marshes where *Maculinea nausithous* and *M. teleius* live and it has been recorded as a minor host for *M. teleius* (Elmes *et al*., 1998 this issue). The antennal scape is similar in shape to *M. scabrinodis* (Fig. 2g): the head-width is greater (Fig. 3g). The petiole has more hairs than *M. scabrinodis* and the post-petiole is wider (Fig. 4g).

Rugulosa group: M. rugulosa *Nylander*, M. gallienii *Bondroit and* M. sulcinodis *Nylander*

Characterized by scapes curved almost at right angles with no projections or teeth but sometimes with a slight oblique thickening visible. These three species are unlikely to be confused as they have differing habitat requirements.

M. rugulosa. This ant is widespread but locally distributed in dry, warm, open pastures and on northern European hills or lowland sandy heath (Collingwood, 1979). It is most probably found on some *Maculinea arion* sites, but is not recorded as an alternative host. Large colonies up to many thousands of pale reddish-yellow, small 3.0–4.5 mm workers tunnel deep into the ground. Queens are very small, 4.6–5.2 mm. Antennal scapes bend sharply but evenly near the base without any projection (Figs 2h, 3h). The petiole appears narrowly rectangular from above and simply angled in side view with a very short truncate dorsal area (Fig. 4h). Male scapes are very short (< 0.35 mm).

M. gallienii. This ant may be confused with *M. rubra*, with which it often co-exists, but has a more restricted distribution. It lives in damp meadows and on the sandy margins of lakes in localized parts of northern Europe (Collingwood, 1979). Large colonies, averaging ca 800 workers, build mounds among vegetation. There are no records of it acting as host to any *Maculinea*, but it may be found where *M. teleius, M. nausithous* and *M. alcon* live, e.g. in Poland. Other *Myrmica* which may be found on the same site include *M. sabuleti, M. scabrinodis* and *M. rubra*. The antennal scape is slender, obliquely curved near its base (Fig. 2i). The shape of the head is more square than *M. rubra* (Fig. 3i). The dorsal area of the petiole is truncated and the height of the post-petiole is comparatively greater than its width (Fig. 4i). Male scapes are much shorter than for *M. rubra* (< 0.35 mm).

M. sulcinodis. A bicoloured ant with reddish thorax, and blackish head and gaster. This species is localized, nesting in damp areas, often under stones on mountains and moorlands (Elmes, 1987). It is distinctly associated with coarse sandy soil. In high montane regions and in extreme northern Europe it can form dense populations but is otherwise patchy. Colonies are small, on average ca 150 workers. It may live where alpine *Maculinea arion obscura* breeds. There is a single record of an *M. rebeli* being found in a nest of this species in Switzerland (David Jutzler, pers. comm.). Antennae curve sharply (Fig. 2j). The frontal triangle of the head is grooved (Fig. 3j). The dorsal surface of the thorax is also grooved. The high petiole has an elongate anterior face and a rounded dorsal face which slopes steeply (Fig. 4j). The male scape is long, comparable to *M. lobicornis* and *M. ruginodis* ca 1 mm.

Rubra group: M. rubra *(L.) and* M. ruginodis *Nylander*

Scapes smoothly curved with no projections on bend. These species seldom co-exist in western Europe but frequently occur together in woodland in eastern Europe.

M. rubra. This species is easily confused with *M. ruginodis*. It lives in damp meadows, woodland edges, river banks and cool grasslands. Nests are found in rotting logs, under stones and in soil. On cooler sites it constructs solaria. An average colony has more than 1000 workers. Colonies are highly polygynous and aggress-

ive when disturbed. The most common *Myrmica* species found sympatrically is *M. scabrinodis*. It is the major host for *Maculinea nausithous* but is also recorded as a host to *M. alcon* in Sweden and as a minor host to *M. teleius* (Thomas *et al*., 1989). The antennal scape is smoothly curved without a right-angled bend (Figs 2k, 3k). Short epinotal spines and petiole shape distinguish workers from those of *M. ruginodis*: the dorsal surface of the petiole slopes backwards in a smooth curve which tapers towards the post-petiole (Fig. 4k). The male scape is shorter than that of *M. ruginodis* ca 0.6 mm.

M. ruginodis. This woodland species also lives in cool damp bogs, marshes and N-facing slopes. Nests are found in rotting tree stumps and in tussocks of grass and sedge where it builds solaria. Nests may have two forms of queens, either *macrogyne* (large) or *microgyne* (small) (Brian and Brian, 1955). Both forms may coexist in the same nest and on the same site (Elmes and Clarke, 1981). Colonies average ca 500 workers. It is the major host species for *Maculinea alcon* in Denmark and the northern Netherlands (Elmes *et al*., 1994, Gadeberg and Boomsma, 1997). Antennae curve smoothly without a right-angled bend (Figs 2l, 3l). The epinotal spines are longer than those found on *Myrmica rubra* and the petiole profile is flatter on top with the posterior section adjacent to the post-petiole resembling a right-angled step (Fig. 4l) . The male scape is long, ca 1 mm.

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Appendix: A simple guide to identifying *Myrmica* workers for field lepidopterists using a hand lens (not dichotomous)

1. **Examine antennal scape:** Is it (2) smoothly curved *or* (3) sharply curved *or* (4) right angled near the base?
2. **Smoothly curved antennal scape:** Are the epinotal spines long and is the petiole flat on top? (*Myrmica ruginodis*) *or* are the epinotal spines short and the petiole rounded on top? (*M. rubra*)
3. **Antennal scape sharply curved and without any projecting extension on the curve:** Are the frontal triangle on the head and upper parts of the petiole and post-petiole coarsely grooved, the petiole domed and the epinotal spines blunt? (*M. sulcinodis*) *or* is the lower part of the frontal triangle smooth, the head longer than broad with wide frons, the petiole simply angled and post-petiole cubical? (*M. rugulosa*) *or* is the head broader than long, frons narrower, petiole striated and post-petiole higher than long in profile? (*M. gallienii*)
4. **Antennal scape right-angled:** does it have (5) a vertical projection at the right-angle? *or* (6) a lateral projection? *or* (7) is it simply-angled with no projection?
5. **Vertical projection on antennal scape:** Is it large, with the post-petiole only slightly higher than long, the petiole rounded and is the ant from a warm, dry site with skeletal soil, shale or sand? (*M. schencki*) *or* is it small, with the post-petiole distinctly higher than long, the petiole angled and the ant from a cool, wet site? (*M. lobicornis*)
6. **Lateral projection on antennal scape:** Is it well developed and the ant from a warm dry site? (*M. sabuleti*) *or* is it massively developed and the ant from a wet or damp site? (*M. lonae*)
7. **Simple right-angled antennal scape without obvious projection:** Most usually *M. scabrinodis* which inhabits a wide range of sites and tolerates a broad range of conditions but if the ant comes from a very hot, dry site and its post-petiole is higher than its length but of equal length and width, consider *M. specioides or* if it comes from a wet area and has a wide post-petiole, a very hairy petiole and wider head width than usual consider *M. vandeli*.