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Myrmica rubra (Hymenoptera: Formicidae): the first data on host-ant specificity of *Maculinea nausithous* (Lepidoptera: Lycaenidae) in Hungary

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Abstract

In total, 58 overwintered *Maculinea nausithous* (BERGSTRÄSSER, 1779) larvae were found in nests of *Myrmica rubra* (LINNAEUS, 1758) from three sites in West Hungary. These results confirm that *M. rubra* is, in general, the host ant of *M. nausithous*. Twenty-eight larvae of *M. nausithous* and eight larvae of *M. teleius* (BERGSTRÄSSER, 1779) were found in a single *M. rubra* nest, which is a huge density for predacious butterfly species.

Key words: *Maculinea nausithous*, *Myrmica rubra*, host-ant specificity, Hungary

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Introduction

Larvae of *Maculinea* VAN EECKE, 1915 (Lepidoptera: Lycaenidae) are obligate parasites of *Myrmica* LATREILLE, 1804 (Hymenoptera: Formicidae) colonies in Europe for most of their lives. After developing on an initial host plant, the last (fourth) instar caterpillars must be adopted by a suitable host ant colony to survive. They spend the majority of their lives within the ant nest and also pupate there (e.g., THOMAS & al. 1989). Knowledge of the host-ant species is crucial for the protection of these endangered butterflies (e.g., ELMES & al. 1998, MUNGUIRA & MARTIN 1999). Host-ant specificity may vary between regions as in the case of *Maculinea alcon* (DENIS & SCHIFFERMÜLLER, 1775) where it has been shown that different populations have evolved using different hosts in different parts of their geographical ranges (e.g., ELMES & al. 1994, 1998, ALS & al. 2002, TARTALLY 2005). Therefore data should be collected over the geographical range of a butterfly species' distribution. Data on the host-ant specificity of *Maculinea alcon*, *M. rebeli* (HIRSCHKE, 1904) and *M. teleius* (BERGSTRÄSSER, 1779) have been gathered from Hungary (TARTALLY & CSŐSZ 2004, TARTALLY 2005), but equivalent data for *M. arion* (LINNAEUS, 1758) and *M. nausithous* (BERGSTRÄSSER, 1779) are yet to be presented. The first records from Hungary on the host-ant specificity of *M. nausithous* (the Dusky Large Blue butterfly; Fig. 1) are given here.

Material and Methods

Maculinea nausithous occurs only in the western part of Hungary (BÁLINT 1996). Two sites of the Őrség region (at Kétvölgy, Fig. 2: 46° 53' N, 16° 12' E, on 26 May 2004; and at Gödörháza: 46° 45' N, 16° 21' E, on 25 May 2004) and one site of the Fertő region (at Hidegség: 47° 23' N, 16° 27 ' E, on 12 July 2005) were investigated in West Hungary (see Tab. 1, Fig. 3). Although the two sites of the Őrség region were investigated relatively early in the year (see Results and Discussion), our surveys were done a long time after the caterpillars had over-wintered. During the winter, when ant colonies are starving, non-host colonies kill caterpillars more frequently than colonies of the host species (ELMES & al. 2004, SCHÖNROGGE & al. 2004). Moreover the caterpillars were larger during these investigations than at adoption (see Figs. 4 and 5). Thus, we believe that these surveys were carried out after the most critical periods of the caterpillars' life cycle.

All three studied sites are marshy meadows with a profusion of *Sanguisorba officinalis* L., which is the initial host plant species of *M. nausithous* (e.g., THOMAS 1984, WYNHOFF 2001). *Myrmica* nests within two metres of *S. officinalis* plants were opened carefully to check the presence of *M. nausithous* larvae in the three sites. Altogether 76 nests of five *Myrmica* species (determination according to SEIFERT 1988) were investigated (Tab. 1). The determination of *Maculinea* caterpillars (according to E. Śliwińska & M. Woychechowski, pers. comm.) was confirmed by the allozyme patterns of some specimens (V. Mester, K. Pecsenye & J. Bereczki, pers. comm.). Reference samples are stored in the first author's collection and in the Hymenoptera Collection of the Hungarian Natural History Museum in Budapest.

Host specificity index (F) was calculated following THOMAS & ELMES (1998) to compare the strength of the host specificity in the studied Hungarian populations with published data for other populations of *M. nausithous* (see also ALS & al. 2002).

Results and Discussion

During our surveys 58 overwintered *M. nausithous* larvae were found in total, all of them in *Myrmica rubra* nests (Tab. 1, Fig. 4) in the three investigated sites ($F = \infty$). These caterpillars were apparently in good general condi-

tion (see Figs. 4, 5). According to these results, we consider that *M. rubra* is likely to be the main host of *M. nausithous* in the Hungarian sites investigated here as in most of the previously investigated sites elsewhere (ELMES & al. 1998, KORB 1998, THOMAS & al. 1989, STANKIEWICZ & SIELEZNIEW 2002). However, it is important to note here that our fieldwork in the Őrség region was done in late May but the Hungarian *M. nausithous* populations start to fly in mid or late July depending on site and year (Z. Varga, pers. observ.). In spite of the relatively early sampling, the nests of the general host *M. rubra* repeatedly contained overwintered *M. nausithous* larvae at Gödörháza and Kétvölgy but other *Myrmica* species did not (Tab. 1). Similarly, although only one *M. nausithous* larva was found at the Fertő region at Hidegség, this larva was also found living in a *M. rubra* nest. No *Myrmica* species other than *M. rubra* were found there during our work (Tab. 1) and this larva was in the prepupal stage. These facts reflect the suitability of *M. rubra* as the host for *M. nausithous* at Hidegség. Thus, our results definitely support the earlier suggestions that *M. rubra* is the main host of *M. nausithous,* at least in most of this species' western range. The fact that one of the infected *M. rubra* nests contained 28 overwintered *M. nausithous* larvae (Tab. 1, Fig. 5) also confirms this statement since it is a huge number of parasitizing butterfly larvae for a predatory *Maculinea* species (THOMAS & ELMES 1998). This huge number of overwintered larvae within one nest appears to support the idea that the larvae of *M. nausithous* are possibly intermediate between the cuckoo and the predatory life forms of caterpillars (FIEDLER 1990, THOMAS & ELMES 1998, STANKIEWICZ & SIELEZNIEW 2002, THOMAS & SETTELE 2004). However, the question of the potential for cuckoo behaviour of *M. nausithous* larvae still needs thorough investigation in the laboratory. Another explanation of this result could be that these 28 *M. nausithous* caterpillars were found in a large nest of a polydomous *M. rubra* colony (A. Tartally, pers. observ.) which may have had the capacity to rear several caterpillars. Moreover, according to the relatively early sampling there is no evidence that all of these 28 *M. nausithous* larvae were able to finish their development. What we do know (see THOMAS & WARDLAW 1992, THOMAS & al. 1993) is that predacious caterpillars are subject to scramble competition (i.e., numbers get killed off and just a few big ones survive) and less likely to survive in high densities than cuckoo species which suffer from contest competition (i.e., more but smaller caterpillars survive). The *M. rubra* nest, which contained 28 *M. nausithous* larvae, was also infected by eight *M. teleius* larvae at the time of the investigation (Tab. 1, Fig. 5). Previously *M. rubra* has not been recorded as a host of *M. teleius* in Hungary (TARTALLY & CSŐSZ 2004, TARTALLY 2005) but it is mentioned as the main host of *M. teleius* in some Polish sites (STANKIEWICZ & SIELEZNIEW 2002). The most widespread host for *M. teleius* recorded in Europe is *M. scabrinodis* (THOMAS & al. 1989, ELMES & al. 1998, STANKIEWICZ & SIELEZNIEW 2002, TARTALLY & CSŐSZ 2004) and overwintered larvae of *M. teleius* were also found in nests of *M. scabrinodis* in the Őrség region (A. Tartally, unpubl. data).

Myrmica scabrinodis has also been recorded as a host of *M. nausithous* in Spain (see MUNGUIRA & MARTIN 1999). Hosts of *M. nausithous* other than *M. rubra* and

Fig. 1: A marked female of *M. nausithous* on a *Sanguisorba officinalis* flowerhead at Hidegség (photo by A. Ambrus).

Fig. 2: The site of *Maculinea nausithous* at Kétvölgy. Red lines sign the narrow zone where the nests of *M. rubra* occurred (photo by Z. Varga at the investigation).

M. scabrinodis have not been recorded anywhere (see ALS & al. 2004: supplementary tab. 10). During our work none of the 47 *M. scabrinodis* colonies that were searched contained larvae of *M. nausithous* in contrast to the host nests of *M. rubra* (Tab. 1). The number of *Myrmica gallienii* BONDROIT, 1920, *M. ruginodis* NYLANDER, 1846 and *M. specioides* BONDROIT, 1918 nests that were examined was too small to establish their suitability for being a host of *M. nausithous* in Hungary. However, we suppose that they cannot serve as important *M. nausithous* hosts in the study sites since their nests were found only in small numbers there. Moreover, several other *Myrmica* species were also formerly recorded from both of the regions investigated – from the Őrség region: *M. sabuleti* MEINERT, 1861, *M. salina* RUZSKY, 1905, and *M. schencki* VIERECK, 1903; from the Fertő region: *M. microrubra* SEIFERT, 1993, *M. gallienii*, *M. sabuleti*, *M. salina*, *M. schencki*, *M. scabrinodis*,

Tab. 1: The number of *Myrmica* nests examined at the Hungarian sites (see Fig. 3) and the detailed results. The host specificity index (*F*) was calculated following THOMAS & ELMES (1998). There was one nest (*) which contained 28 *M. nausithous* and eight *M. teleius* larvae in total (see Fig. 5).

Site	***Myrmica* species**	**Sample size**	**Colonies with *M. nausithous***	**Number of *M. nausithous* larvae in the infected nests**	***F***
Kétvölgy	*M. rubra*	14	4	3, 6, 6, 28* (∑ 43)	∞
	M. scabrinodis	11	0	0	
	M. specioides	1	0	0	
	M. gallienii	1	0	0	
Gödörháza	*M. rubra*	4	4	2, 2, 4, 6 (∑ 14)	∞
	M. ruginodis	1	0	0	
	M. scabrinodis	36	0	0	
Hidegség	*M. rubra*	8	1	1 (∑ 1)	(∞)

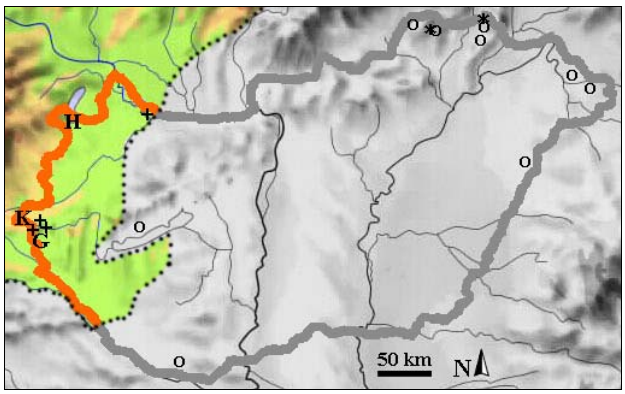

Fig. 3: The sites where *Maculinea nausithous* caterpillars were found in *Myrmica rubra* nests in Hungary (G: Gödörháza, K: Kétvölgy, H: Hidegség; see Tab. 1). Coloured area: the distribution of *M. nausithous* in Hungary and surrounds (according to BÁLINT 1996). *S. officinalis* - *M. teleius* sites (o, +, ∗) where: neither *M. rubra* nor *M. nausithous* are known (o); *M. rubra* is known but *M. nausithous* is not (∗); both *M. rubra* and *M. nausithous* are known but there are no data on the host-ant specificity of the butterfly (+) (A. Tartally, pers observ.).

Fig. 4: An overwintered *Maculinea nausithous* caterpillar in a *Myrmica rubra* nest at Gödörháza (photo by P. Kozma at the investigation).

and *M. specioides*; according to CSŐSZ & al. (2002) – but we did not find any specimens of these during the surveys. Knowledge of *Myrmica* species distribution and further investigations on these potential *Maculinea* hosts are crucial to studies in the Őrség region because four species of *Maculinea* (*M. alcon*, *M. nausithous*, *M. teleius*, and *M. arion*) co-exist within this region, and in some cases within the same locality (BÁLINT 1996, A. Ambrus pers. comm., Z. Varga pers. observ.).

These results are also of interest from a phylogenetic point of view because ALS & al. (2004) have observed two genetic forms in *M. nausithous*: they found that a specimen from Slovakia strongly diverged from the Polish and the Central-Russian specimens (see ALS & al. 2004: Fig. 2 and Supplementary Tab. 1). Potentially, these different forms of *M. nausithous* could use different host-ant species as has been found in *M. alcon* and *M. rebeli* (e.g., THOMAS & al. 1989); these two butterflies have been shown to be less different genetically than the two genetic forms of *M. nausithous* (ALS & al. 2004). As far as we know, there are no data on the host-ant specificity of *M. nausithous* from Slovakia, but there are such data from two neighbouring countries: *Myrmica rubra* was the only recorded host of *M. nausithous* both in Poland and Hungary (THOMAS & al. 1989, ELMES & al. 1998, STANKIEWICZ & SIELEZNIEW 2002; Tab. 1). ALS & al. (2004) stud-

Fig. 5: These 28 *Maculinea nausithous* and eight *M. teleius* caterpillars were found together in one *Myrmica rubra* nest (see Tab. 1). There is also a *M. rubra* worker on this photo to enable estimation of the size of the caterpillars (photo by P. Kozma at the investigation).

ied some *M. nausithous* specimens from Slovakia and Poland but they did not examine any from Hungary. Accordingly, it would be worth studying the host-ant specificity of *M. nausithous* in Slovakia and comparing *M. nausithous* specimens from Hungary genetically with Slovakian and Polish ones. It would be desirable to do similar experiments on the European southern fringe populations of *M. nausithous* in Slovenia (see WYNHOFF 1998), Bulgaria (KOLEV 2002) and especially the isolated and acutely endangered populations in Transylvania (Romania; BÁLINT 1996, RÁKOSY & LÁSZLÓFFY 1997, T. Cs. Vizauer pers. comm., A. Tartally, pers. observ.).

It would also be desirable to collect more data about the host specificity of *M. nausithous* in Hungary, because our unpublished results suggest that *M. rubra* frequently occurs in *S. officinalis* sites in West Hungary but not in East Hungary (see Fig. 3). It also appears that in East Hungary this ant species occurs in the adjacent marshy forests of the *S. officinalis* sites rather than on the meadows. An explanation for the absence of *M. nausithous* from East Hungary (see Fig. 3) could be that its host ant is usually not living in the *S. officinalis* sites there. However, to answer these questions a better knowledge of the host specificity of *M. nausithous* and a thorough knowledge of the distribution of the host ant species are necessary.

We suggest that – to be successful – management of *S. officinalis* meadows for Hungarian *M. nausithous* should include leaving a mosaic of scrub fragments and natural forest edges according to the ecological requirements of *M. rubra* (see ELMES & al. 1998; Fig. 2).

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Zusammenfassung

Insgesamt 58 überwinterte Raupen von *Maculinea nausithous* (BERGSTRÄSSER, 1779) wurden in Nestern von *Myrmica rubra* (LINNAEUS, 1758) an drei Stellen in Westungarn gefunden. Unsere Ergebnisse bestätigen, dass *M. rubra,* im allgemeinen, als Wirtsameise von *M. nausithous* fungiert. In einem *M. rubra* Nest fanden wir 28 Larven von *M. nausithous* und acht Larven von *M. teleius* (BERGSTRÄSSER, 1779) – eine für räuberische Schmetterlinge enorme Zahl von Larven.

References

ALS, T.D., NASH, D.R. & BOOMSMA, J.J. 2002: Geographical variation in host-ant specificity of the parasitic butterfly *Maculinea alcon* in Denmark. – Ecological Entomology 27: 403-414.

ALS, T.D., VILA, R., KANDUL, N.P., NASH, D.R., YEN, S.-H., HSU, Y.-F., MIGNAULT, A.A., BOOMSMA, J.J. & PIERCE, N.E. 2004: The evolution of alternative parasitic life histories in Large Blue butterflies. – Nature 432: 386-390.

BÁLINT, ZS. 1996: A Kárpát-medence nappali lepkéi 1. rész. [Butterflies of the Carpathian Basin vol. 1]. – Magyar Madártani és Természetvédelmi Egyesület, Budapest, 183 pp.

CSŐSZ, S., MARKÓ, B., KISS, K., TARTALLY, A. & GALLÉ, L. 2002: The ant fauna of the Fertő-Hanság National Park (Hymenoptera: Formicoidea). In: MAHUNKA, S. (Ed.): The fauna of the Fertő-Hanság National Park. – Hungarian Natural History Museum, Budapest, pp. 617-629.

ELMES, G.W., THOMAS, J.A., HAMMARSTEDT, O., MUNGUIRA, M.L., MARTIN, J. & VAN DER MADE, J. 1994: Differences in host-ant specificity between Spanish, Dutch and Swedish populations of the endangered butterfly, *Maculinea alcon* (DENIS et SCHIFF.) (Lepidoptera). – Memorabilia Zoologica 48: 55-68.

ELMES, G.W., THOMAS, J.A., WARDLAW, J.C., HOCHBERG, M., CLARKE, R.T. & SIMCOX, D.J. 1998: The ecology of *Myrmica* ants in relation to the conservation of *Maculinea* butterflies. – Journal of Insect Conservation 2: 67-78.

ELMES, G.W., WARDLAW, J.C., SCHÖNROGGE, K. & THOMAS, J.A. 2004: Food stress causes differential survival of socially parasitic larvae of *Maculinea rebeli* (Lepidoptera, Lycaenidae) integrated in colonies of host and non-host *Myrmica* species (Hymenoptera, Formicidae). – Entomologia Experimentalis et Applicata 110: 53-63.

FIEDLER, K. 1990: New information on the biology of *Maculinea nausithous* and *M. teleius* (Lepidoptera: Lycaenidae). – Nota lepidopterologica 12: 246-256.

KOLEV, Z. 2002: The species of *Maculinea* VAN EECKE, 1915 in Bulgaria: distribution, state of knowledge and conservation status (Lycaenidae). – Nota lepidopterologica 25: 177-190.

KORB, S.K. 1998: To the study of the associations Formicidae (Hymenoptera) and Lycaenidae (Lepidoptera) in the middle part of European Russia. – Biuletin Moskovskovo Obshestva Ispytat'elej Prirody 103: 45-47 [in Russian].

MUNGUIRA, M.L. & MARTIN, J. (Eds.) 1999: Action Plan for the *Maculinea* butterflies in Europe. – Nature and Environment, No. 97. Council of Europe Publishing, Strasbourg, 64 pp.

RÁKOSY, L. & LÁSZLÓFFY, ZS. 1997: Fauna de macrolepidoptere de la Fânatele Clujului (Lepidoptera) (Cluj, România). – Buletin de Informare Societatea Lepidopterologică Română 8: 165-186.

SCHÖNROGGE, K., WARDLAW, J.C, PETERS, A.J., EVERETT, S., THOMAS, J.A. & ELMES, G.W. 2004: Changes in chemical signature and host specificity from larval retrieval to full social integration in the myrmecophilous butterfly *Maculinea rebeli*. – Journal of Chemical Ecology 30: 91-107.

SEIFERT, B. 1988: A taxonomic revision of the *Myrmica* species of Europe, Asia Minor and Caucasia (Hymenoptera, Formicidae). – Abhandlungen und Berichte des Naturkundemuseums Görlitz 62: 1-75.

STANKIEWICZ, A. & SIELEZNIEW, M. 2002: Host specificity of *Maculinea teleius* BGSTR. and *M. nausithous* BGSTR. (Lepidoptera: Lycaenidae) the new insight. – Annales Zoologici 52: 403-408.

TARTALLY, A. 2005: *Myrmica salina* (Hymenoptera: Formicidae) as a host of *Maculinea alcon* (Lepidoptera: Lycaenidae). – Sociobiology 46: 39-43.

TARTALLY, A. & CSŐSZ, S. 2004: Adatok a *Maculinea* boglárkalepkék (Lepidoptera: Lycaenidae) kárpát-medencei hangyagazdáiról. [Data on the ant hosts of the *Maculinea* butterflies (Lepidoptera: Lycaenidae) of Hungary.] – Természetvédelmi Közlemények 11: 309-317.

THOMAS, J. A. 1984: The behaviour and habitat requirements of *Maculinea nausithous* (the dusky large blue butterfly) and *M. teleius* (the scarce large blue) in France. – Biological Conservation 28: 325-347.

THOMAS, J.A. & ELMES, G.W. 1998: Higher productivity at the cost of increased host-specificity when *Maculinea* butterfly larvae exploit ant colonies through trophallaxis rather than by predation. – Ecological Entomology 23: 457-464.

THOMAS, J.A., ELMES, G.W. & WARDLAW, J.C. 1993: Contest competition among *Maculinea rebeli* butterfly larvae in ants nests. – Ecological Entomology 18: 73-76.

THOMAS, J.A., ELMES, G.W., WARDLAW, J.C. & WOYCIECHOWSKI, M. 1989: Host specificity among *Maculinea* butterflies in *Myrmica* ant nests. – Oecologia 79: 452-457.

THOMAS, J.A. & SETTELE, J. 2004: Butterfly mimics of ants. – Nature 432: 283-284.

THOMAS, J.A. & WARDLAW, J.C. 1992: The capacity of a *Myrmica* ant nest to support a predacious species of *Maculinea* butterfly. – Oecologia 91: 101-109.

WYNHOFF, I. 1998: The recent distribution of the European *Maculinea* species. – Journal of Insect Conservation 2: 15-27.

WYNHOFF I. 2001: At home on foreign meadows: the reintroduction of two *Maculinea* butterfly species. – Published PhD thesis, Wageningen Agricultural University, Wageningen, 236 pp.