

Ichneumon balteatus (Hymenoptera: Ichneumonidae) – a new parasitoid species of *Maculinea alcon* butterflies (Lepidoptera: Lycaenidae)

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Summary: During 2010 and 2012 several *Maculinea alcon* pupae were collected from colonies of *Myrmica scabrinodis* (family Formicidae) in the Natura 2000 site 'Dealurile Clujului Est' (Transilvania, Romania). Subsequently, 8 individuals of the ichneumonid species, *Ichneumon balteatus*, emerged from these pupae. Until this discovery, *Ichneumon eumerus* was the only species described as a parasitoid of *M. alcon*. Moreover, *Melitaea cinxia* and *Calliteara pudibunda* are the only known hosts of *I. balteatus*. Thus, the relationship between *Maculinea alcon* and *Ichneumon balteatus* is described here as a host-parasitoid association new to science.

Key words: *Maculinea alcon*, *Ichneumon balteatus*, *Myrmica scabrinodis*, social parasite, parasitoid, Transylvania, Romania

Introduction

All the species of genus *Maculinea* van Eecke, 1915 (recently synonymised in *Phengaris* Doherty, 1891 by FRIC *et al.* 2007, but see BALLETO *et al.* 2010) are social parasites exploiting the colonies of different species of the genus *Myrmica* Latreille, 1804 (FIEDLER 2006, WITEK *et al.* 2008). After a short period feeding on their host plant, fourth instar larvae of *Maculinea* caterpillars fall to the ground, where they are adopted by their ant hosts (THOMAS *et al.* 1998, AKINO *et al.* 1999, ELMES *et al.* 2001). The caterpillars possess a range of morphological, physiological, chemical and behavioral adaptations that enable them to enter and exploit *Myrmica* host ant colonies (THOMAS & WARDLAW 1992, AKINO *et al.* 1999, BARBERO *et al.* 2009) preying either on ant grubs ("predatory" *Maculinea*) or being fed by trophallaxis ("cuckoo" *Maculinea*) (MALICKY 1968, ELMES *et al.* 1991, THOMAS & WARDLAW 1992).

Regardless of the fact that larvae are attentively guarded inside the ant colonies by their hosts, a percentage of the *Maculinea* caterpillars are parasitised by specialist parasitoids from the Ichneumonidae family (Table 1). Following a host-parasite arms race the Ichneumonidae species develops adaptations utilizing olfactory, acoustic (vibrational) and visual cues (THOMAS & ELMES 1993, BROAD & QUICKE 2000, FISCHER *et al.* 2001) to find well hidden hosts, like *Maculinea* caterpillars.

Although all *Maculinea* species belong to one of the most intensively studied group of butterflies in Europe, their parasitoid species, with few exceptions (THOMAS & ELMES 1993, HOCHBERG *et al.* 1996, HOCHBERG *et al.* 1998, ANTON *et al.* 2007a, b), are poorly studied and information is scarce and confused (SHAW *et al.* 2009).

Two of *Maculinea* butterflies parasitoids display different ovipositional strategies. While *Neotypus melanocephalus* females oviposit on *M. nausithous* larvae feeding inside the inflorescences of host plant (ANTON *et al.* 2007a, b), *Ichneumon eumerus* females enter the subterranean ant nests and choose the largest *M. alcon* caterpillars on which to oviposit (THOMAS & ELMES 1993, HOCHBERG *et al.* 1998). *I. eumerus* parasitoids possess the ability to detect *Myrmica* ant colonies, entering only those nests infested with "cuckoo" *Maculinea* caterpillars (THOMAS & ELMES 1993). It has been reported that *Maculinea* caterpillars make specific sounds to achieve higher integration status (BARBERO *et al.* 2009) within the ant colony. It is well documented that Ichneumonidae species can find their host's location by vibrational sounding (BROAD & QUICKE 2000, FISCHER *et al.* 2001), and it would be interesting to find out whether audible sounds made by *Maculinea* caterpillars can be recognized by *Ichneumon* wasps.

The infested *Maculinea* caterpillars continue their development pupating inside the host ant nest. Only one adult parasitoid emerges from each of the

Table 1. The known parasitoid species of the European *Maculinea* butterflies.

<i>Maculinea</i> species	<i>Ichneumonidae</i> species	References
<i>M. arion</i> Linnaeus 1758	<i>Neotypus coreensis</i> Uchida 1930	SIELEZNIEW <i>et al.</i> 2010
<i>M. teleius</i> Bergsträsser 1779	<i>Neotypus melanocephalus</i> Gmelin 1790 (= <i>pusillus</i> Gregor 1940)	TARTALLY 2005
	<i>Ichneumon eumerus</i> Wesmael 1857	HINZ & HORSTMANN 2007
	<i>Ichneumon fulvicornis</i> Gravenhorst 1829	SHAW <i>et al.</i> 2009
<i>M. nausithous</i> Bergsträsser 1779	<i>Neotypus melanocephalus</i> Gmelin 1790 (= <i>pusillus</i> Gregor 1940)	STANKIEWICZ <i>et al.</i> 2004 ANTON <i>et al.</i> 2007a,b SHAW <i>et al.</i> 2009
	<i>M. alcon</i> Denis & Schiffermüller 1775	<i>Ichneumon eumerus</i> Wesmael 1857
TARTALLY 2008		
SHAW <i>et al.</i> 2009		
<i>M. rebeli</i> Hirschke 1904	<i>Ichneumon eumerus</i> Wesmael 1857	THOMAS & ELMES 1993
		HOCHBERG <i>et al.</i> 1996,1998
		HINZ & HORSTMANN 2007
		TARTALLY 2008 SHAW <i>et al.</i> 2009

Please note that the table may contain incomplete information

parasitised *Maculinea* pupa (THOMAS & ELMES 1993).

In Romania there is limited available data relating to *Maculinea* parasitoids species. Pupae belonging to the two *Maculinea alcon* ecotypes parasitised by *Ichneumon eumerus* were found at Şardu and Răscruci (TARTALLY 2008).

Materials and methods

Our research was carried out in the Natura 2000 site “Dealurile Clujului Est” (East Hills of Cluj), in a meso-higrophilous meadow of ca 40 ha. named Fânaţul Domnesc (located between the villages of Răscruci and Luna de Jos 46.92N, 23.73E, 410-460m a.s.l., Cluj county, Transylvania, Romania).

In Fânaţul Domnesc three *Maculinea* species cohabit syntopically: *M. alcon* (with two ecotypes), *M. teleius* and *M. nausithous ssp kijevensis* Sheljuzhko 1928 (VODĂ *et al.* 2010, RÁKOSY *et al.* 2010, TIMUŞ *et al.* 2011, HOLLÓS *et al.* 2012). The females of one of the *M. alcon* ecotypes oviposit on *Gentiana cruciata*, the other on *Gentiana pneumonanthe* (Fig.1). Since the taxonomy of *Maculinea* butterflies that oviposit on *G. cruciata* is not clear (STEINER *et al.* 2006, HABELER 2008), we prefer to call the two ecotypes according to their host plants, thus: the form using *G. cruciata* is referred to as *M. a. “cruciata”*, while the form utilising *G. pneumonanthe* as *M. a. “pneumonathe”*. Besides their different specific host plant, the ecotypes have clearly separate flight periods and their distributions do not overlap (CZEKES *et al.* 2013, TIMUŞ *et al.* 2013)

The presence of the four syntopical forms of *Maculinea* is unique in Europe. This was the reason

why in 2009 a series of biological and ecological studies, such as mark-release-recapture studies, *Myrmica* nests investigation, laboratory experiments etc., was initiated.

Results and Discussion

As a result of investigations carried out on *Myrmica* nests in 2010 and 2012, *M. alcon* pupae were found in three *Myrmica scabrinodis* colonies. In total 13 infested pupae (Fig. 2) were collected and kept under laboratory conditions, from which 3 males and 5 females *Ichneumon balteatus* Wesmael 1845 emerged after 1-2 weeks (Fig. 3). Among the infested pupae we also found caterpillars and unparasitised pupae from which *M. alcon* butterflies emerged. *Maculinea alcon* pupae and caterpillars were identified based

Figure 1. Female of *M. alcon* „*pneumonathe*” ecotype oviposit on *Gentiana pneumonanthe*.



Figure 2. Pupa belonging to the *M. alcon* „*pneumonanthe*” ecotype parasitised by *Ichneumon balteatus*.



on the keys of ŚLIWIŃSKA *et al.* (2006). Taking into consideration the fact that the parasitised pupae were found in a humid depression where only *G. pneumonanthe* was present in abundance, we can certify the pupae belong to *M. alcon* “*pneumonanthe*” ecotype.

Ichneumon balteatus is a Palearctic species very common in Romania although sparsely distributed. It has been recorded, frequently in meadows, in nine Romanian counties - Bacău, Constanța, Tulcea, Caraș - Severin, Hunedoara, Alba și Bistrița – Năsăud. Adult individuals frequent the inflorescence of Apiaceae (*Daucus carota* L., *Peucedanum oreaselinum* (L.) Moench, *Heracleum sphondylium* L.) and *Euphorbia virgata* W. K. (Euphorbiaceae). It is a typical trait for adult females to hibernate under moss on the wood trees. Prior to our recent discovery, *Ichneumon balteatus* was only known to utilise two host species: *Melitaea cinxia* (L., 1758) (Nymphalidae) and *Calliteara pudibunda* L. (Lymantriidae) (CONSTANTINEANU 1959, ALIYEV 1999, PAUL & HANSKI 2004), and *Ichneumon eumerus* was the only recorded parasitoid of *M. alcon* butterflies (THOMAS & ELMES 1993, HOCHBERG *et al.* 1998, HINZ & HORSTMANN 2007, TARTALLY 2008, SHAW *et al.* 2009). Therefore the association *Maculinea alcon* and *Ichneumon balteatus* is new to science.

The parasitoids are of immense importance in practically all terrestrial ecosystems because of their impact on the population levels of their hosts (SHAW *et al.* 2009). *Maculinea* species are rare and globally endangered (VAN SWAAY *et al.* 2012, IUCN 2013) and have already experienced extinctions at regional and national levels (THOMAS 1980, WYNHOFF 1998). Owing to their sparseness as opposed to the host

Figure 3. *Ichneumon balteatus* ♂.



species, *Maculinea* parasitoids are inclined to be even more at risk (HOCHBERG *et al.* 1998, ANTON *et al.* 2007a,b, SHAW *et al.* 2009). The presence of a particular parasitoid species can work as a useful indicator of the intact and functional host butterflies metapopulation, recent studies have shown. Therefore, it is crucial for the projects aimed to preserve the flagship species like *Maculinea* to also focus on natural parasitoids (ANTON *et al.* 2007a).

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