

The species of *Maculinea* van Eecke, 1915 in Bulgaria: distribution, state of knowledge and conservation status (Lycaenidae)

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Summary. This paper presents the currently available information on the three species of *Maculinea* occurring in Bulgaria. Their distributions are shown on maps produced on the basis of literature records as well as unpublished data. Own observations on habitat preferences and aspects of the biology of these species, the first of their kind in the country, are presented. At least three populations of the species referred to in Bulgarian literature mostly as '*Maculinea alcon*' occur on relatively dry habitat, a preference otherwise known from *M. rebeli*, and should be referred to by the latter name. Larval host plants are reported for *M. rebeli* (eggs and egg-laying of one population on *Gentiana asclepiadea*) and *M. nausithous* (*Sanguisorba officinalis*, by association of adult butterflies with that plant). The unusual host plant affiliation of one *M. rebeli* population again emphasizes the need for a re-appraisal of the taxonomy of the *alcon* complex in south-eastern Europe. The conservation status of all species is assessed. Only *M. nausithous* is of immediate conservation concern; measures are proposed for research on, and conservation of, its populations in the country.

Zusammenfassung. Auf der Grundlage von Literaturdaten und neuen Feldbeobachtungen wird die bekannte Verbreitung der drei in Bulgarien heimischen *Maculinea*-Arten in Karten dokumentiert. Ergänzend werden eigene Beobachtungen zur Habitatbindung und zu Aspekten der Lebensweise vorgestellt; dies sind die ersten derartigen Daten aus Bulgarien. Zumindest drei Populationen der in der Literatur als „*Maculinea alcon*“ bezeichneten Art besiedeln ein trockenes Habitat, was andernorts nur von *M. rebeli* bekannt sind. Daraus wird geschlossen, daß diese bulgarischen Populationen dem Taxon *M. rebeli* zuzuordnen sind. Der taxonomische Status des *alcon/rebali*-Komplexes bedarf nach diesen Erkenntnissen einer umfassenden Überarbeitung. Wirtspflanzen wurden für *M. rebeli* (Eiablagebeobachtungen auf *Gentiana asclepiadea*) und *M. nausithous* (enge Assoziation der Falter mit *Sanguisorba officinalis*) beobachtet. Der Status der drei *Maculinea*-Arten im Hinblick auf den Naturschutz wird aufgrund der verfügbaren Information beurteilt. Nur *M. nausithous*, die bisher nur von einem Reliktareal in unmittelbarer Umgebung der Hauptstadt Sofia bekannt ist, ist unmittelbar gefährdet. Maßnahmen zur weiteren Erforschung und zum Schutz der bulgarischen *Maculinea*-Populationen werden vorgeschlagen.

Резюме. Настоящата публикация обобщава наличната информация за трите вида от род *Maculinea*, срещащи се в България. Разпространението им е картирано на основата както на литературни, така и на непубликувани данни. Доказва се, че видът, известен досега в България като «*Maculinea alcon*», всъщност отговаря по екологичните си характеристики на близкия вид *M. rebeli*. Представени са резултатите от проучванията на автора, първите по рода си в страната, върху някои страни от биологията на тези видове. Съобщават се хранителни растения за *rebali* (*Gentiana asclepiadea*) и *nausithous* (*Sanguisorba officinalis*). Въпреки че и трите вида са редки и локални, само *nausithous* е застрашен. Предлагат се мерки за по-нататъшното му изучаване и опазването на забележителните му реликтни популации, единствените по рода си на Балканския полуостров.

Key words: Lycaenidae, *Maculinea*, taxonomy, habitat, biology, IUCN Red List Categories, conservation, Bulgaria

Introduction

The genus *Maculinea* comprises some of the most fascinating and vulnerable butterflies in Europe, a distinction that is due on both counts to their complex larval development which is unique among European butterflies. The larvae of *Maculinea* possess sophisticated adaptations for a parasitic lifestyle in the final larval instar which they

spend inside nests of ants of the genus *Myrmica* (see Elmes *et al.* 2001 and references therein). Larvae of each *Maculinea* species are narrowly specialised to develop with only one or very few *Myrmica* host species (Thomas *et al.* 1989). Once adopted into the ant nest, the larvae of the more primitive species prey on ant brood, while those of the more advanced species have carried their mimicry of ant larvae even further and are fed directly by the ants in a cuckoo-like manner (Elmes *et al.* 1991; Elmes *et al.* 1994). As a result of their specific resource requirements, all *Maculinea* species can only exploit very narrow ecological niches defined by the presence of both the host plant and, especially important, the host ant in sufficiently high densities to support a viable population of the butterfly (Thomas *et al.* 1998). The drastic decline and numerous local extinctions experienced by most *Maculinea* species in central and northern Europe during the 20th century are attributable to the alteration or destruction of suitable habitats caused by cessation of traditional methods of land-use (on which most *Maculinea* habitats in central and northern Europe depend) as well as different industrial and agricultural activities (for a detailed review see Munguira & Martín 1999).

Published information so far available on *Maculinea* in Bulgaria consists of little more than distribution records. The overwhelming majority of these carry virtually no information other than locality data and, in very few cases, vague habitat descriptions of little practical use. Even until only very recently, the old catalogue of Bulgarian butterflies and larger moths (Buresch & Tuleschcow 1930) remained the most comprehensive source of such records. It listed 13 localities of '*Lycaenaalcon* F.[sic]' (= *Maculinea rebeli* (Hirschke, 1904) under the definition used here, see below), 21 of '*Lycaena arion* L.' (*Maculinea arion* (Linnaeus, 1758)) and a single, doubtful record of '*Lycaena arcas* Rott.' (*Maculinea nausithous* (Bergsträsser, 1779)). Since the publication of this catalogue, numerous records of *Maculinea* were reported in scattered faunal publications, the majority in Bulgarian language. Of these, most interesting are the reports by Gogov (1963) and Vihodcevisky & Gogov (1963), who established beyond doubt the occurrence of *M. nausithous* in the country. However, the paucity of basic information about Bulgarian *Maculinea* has been aggravated by the fact that these sporadic records are virtually inaccessible to non-Bulgarian researchers. This was emphatically shown by a recent assessment of *Maculinea* distributions in Europe (Wynhoff 1998) which lacked any specific records from Bulgaria.

The latest publication concerning Bulgarian *Maculinea* is a distributional atlas which summarised most of the currently known records of butterflies in the country (Abadjiev 2001). Although providing only distribution data, this atlas, written entirely in English, combines UTM maps (10×10 km grid) with a list of all mapped localities for each species and is thus the single most important source of locality data for Bulgarian *Maculinea* to date. It lists 63 localities for *M. arion* falling into 51 UTM squares, 33 localities for *M. rebeli* falling into 22 UTM squares, and two localities for *M. nausithous* falling into a single UTM square. It has to be noted that this atlas omits a few published records of *Maculinea*, notably of *M. arion* from the eastern part of Mt. Alibotush (Drenowski 1930) as well as *M. arion* from Mt. Stara Planina (Shipka) and Mt. Rhodopi (Batak dam; Naretschenski Bani) and '*Maculinea sebastos*' (= *M. rebeli* under the defi-

inition used here, see below) from Mt. Stara Planina (Shipka) and Mt. Rhodopi (Narechenski Bani) reported by Bálint ([1995]).

The first information on the present-day conservation status and priorities for research and conservation of Bulgarian *Maculinea* was compiled by the present author and eventually appeared in the ‘Action plan for *Maculinea* butterflies in Europe’ (Munguira & Martín 1999). My research since 1997, when these data were gathered, showed that, due to the occasional use of unverified second-hand sources, my original contribution contained several errors mostly pertaining to details of the distribution of *M. rebeli* and *M. nausithous*. Corrections were duly suggested to the editors but these errors nevertheless found their way into the final version of the Action Plan. Likewise, the information concerning threats to and conservation status of *M. nausithous* presented in that publication has to be augmented in the light of new information that became available in 1999.

The purpose of this paper is to provide a concise and updated review of the distribution, ecology and conservation status of the *Maculinea* species occurring in Bulgaria. This is particularly important in view of the advances that are presently being made, under the auspices of the Council of Europe, towards creating a co-ordinated strategy for the study and conservation of European *Maculinea* (Munguira & Martín 1999). The following aspects of each species are discussed here:

Taxonomy. This is dwelt upon briefly in the case of *M. arion* and *M. nausithous*, which present no special problems in this respect. The closely related taxa *alcon* ([Denis & Schiffermüller], 1775) and *rebeli* (Hirschke, 1904) present a complicated case that remains so far unresolved.

Distribution. This is outlined in appropriate detail in the text. Due to the large number of localities involved in the case of *rebeli* and especially *arion*, only previously unpublished data are listed. The accompanying maps show all records that could be traced to a specific locality as well as unpublished data from several collections, which include my own materials and field records amassed since 1986. Localities of numerous *M. arion* and *M. rebeli* specimens collected by A. Slivov and presently preserved in the collection of the Institute of Zoology, Sofia (hereafter abbreviated as IZS) are included here, with the following cautionary note. The materials of A. Slivov in that collection contain a considerable number of clear, in some cases grave, cases of mislabelling (Kolev 2002). Thus, even though all locality data of the *Maculinea* specimens are, in my opinion, entirely plausible (which is why they are included here) an eventual confirmation of these records should be attempted. The records by Drenowski (1930) and Bálint ([1995]) omitted by Abadjiev (2001) are also included in the maps; these localities are listed above.

Habitat and biology. Based on my own observations, the habitats of each species are described and larval host plants are reported for *rebeli* and *nausithous*. No host ant species have yet been identified for any of the Bulgarian *Maculinea*. Brief comments on flight period and population size are included; the latter are however based on casual observations and counts and should not be taken as estimates of population size. **Conservation status.** This is assessed using the latest revised IUCN Red List Categories (IUCN 2001).

Threats. I have attempted to estimate if and what potential threats exist for each species. Much of this evidence available is speculative as no previous information on this issue exists in Bulgaria.

Priority actions. I give a personal opinion, based on where the most significant data deficiencies lie, as to what aspects of each species should be studied next. This is especially important in the case of the relict populations of *M. nausithous*, the only *Maculinea* species in the country that is in need of active protection in view of its endangered status.

Results

Maculinea arion (Linnaeus, 1758)

Taxonomy. Bulgarian specimens correspond well to nominotypical *M. arion*. There is considerable individual variation in size, ground colour and extent of wing markings, apparently in response to local environmental factors and thus, in my opinion, without taxonomic significance.

Distribution. This is the most widespread *Maculinea* species in Bulgaria. It occurs in hilly lowland terrain and mountains, at altitudes between 150 and 1800 m (Fig. 1). The higher concentration of records in the central-western and south-western parts of the country is at least partly due to the relatively better state of lepidopterological exploration of these regions (cf. Abadjiev 2001: 10). The butterfly faunas of large areas (e.g. north-eastern Bulgaria, the foothills of Stara Planina, eastern Rhodopi, the lower mountains along the western border, etc.) are very poorly known. In view of this, there is little doubt that the known localities of *arion* represent but a fraction of the real distribution of the species in the country.

Previously unpublished localities. Dobroged village north-west of Varna, 250 m (Z. Kolev & N. Shtinkov leg. & coll.). – Dobrudzha: ‘Palamara’ game reserve [200–250 m] (A. Slivov leg., in coll. IZS). – Dobrudzha: Alfatar town [170–200 m] (A. Slivov leg., in coll. IZS). – Mt. Stara Planina: the path from Cherni Osŭm village to ‘Ambaritsa’ chalet, 800–1200 m (N. Shtinkov in litt.). – [Karnobat town, 200–250 m] (in coll. Karnobat Zoo). – Mt. Rila: the path from Rilski Manastir to Cherni rid, below ‘Ravna’ locality, 1300–1400 m (Z. Kolev leg. & coll.). – Mt. Pirin: ‘Popina Lŭka’ locality, 1200–1300 m (A. Slivov leg., in coll. IZS). – Mt. Pirin: Dobrinishka river 2 km south of the ‘Kozarevi Ribarnitsi’ historical site, 1100–1200 m (Z. Kolev leg. & coll.). – Mt. Pirin: ‘Yavorov’ chalet [1750 m] (A. Slivov leg., in coll. IZS). – Mt. Rhodopi: the ridge between ‘Kleptuza’ mineral springs and the valley of Lepenitsa river, 900–1000 m (Z. Kolev leg. & coll.). – Mt. Rhodopi: Velingrad town, [900–950 m] (N. Shtinkov in litt.). – Mt. Rhodopi: Lukovitsa river valley, 300–350 m (Z. Kolev leg. & coll.). – Mt. Rhodopi: Khvoyna village, 750–900 m (Z. Kolev leg. & coll.).

Habitat and biology. *M. arion* inhabits a wide range of habitats in Bulgaria: flowery meadows, pastures, forest glades and clearings, dry rocky gullies and slopes covered with sparse pine woodland, roadsides etc. The species occurs in mesic as well as xeric conditions, avoiding truly xerothermic or excessively wet habitats. The adults fly in a single generation from mid-June to late July, at higher altitudes till mid-August.

As far as can be judged, most of the known *arion* habitats in Bulgaria do not depend on sustained human activities. So far only a single case is known where grazing by live-

stock has created an unnatural habitat with extremely favourable conditions for *arion*. In 1992 N. Shtinkov and I discovered an unusually large population in western Rhodopi Mts. located at an altitude of 900–1000 m on a west-facing slope of a ridge between the valley of Lepenitsa river and the ‘Kleptuza’ mineral springs on the outskirts of Velingrad. The habitat is a dry, heavily overgrazed pasture in sparse pine forest with large-scale erosion of the sandy topsoil. Very few butterfly species were observed in this highly degraded habitat, *arion* being relatively the most abundant (precise counts could not be made). This is a dramatic reversal of the normal condition of this species’ relative rarity: Bulgarian populations of *arion* are typically very localised and small, usually with less than four specimens seen at a time.

The larval host plant of *arion* has not been identified positively in the country as yet. Elsewhere in Europe these are species of the group of *Thymus serpyllum* L., as well as *Origanum vulgare* L. (e.g. Elmes & Thomas 1992; Munguira & Martín 1999), and *Myrmica sabuleti* and *My. scabrinodis* serve as most important ant hosts (Thomas *et al.* 1989).

Threats. The total population of *M. arion* in Bulgaria is apparently out of danger. The species occurs in numerous localities over a large part of the country. Its habitats, for the most part, do not appear to be critically affected by adverse human activities. Finally, its actual distribution is certainly much wider than presently known. Small isolated populations may be vulnerable to activities with the potential to destroy the whole or most of their habitat.

Conservation status. Lower risk, least concern.

Priority actions. Research on the plant and ant hosts of *M. arion*, preferably encompassing a wider range of habitats with varying humidity, is desirable. Conservation measures are not needed.

***Maculinea rebeli* (Hirschke, 1904)**

Taxonomy. The closely related, externally very similar taxa *alcon* [Denis & Schiffermüller], 1775 and *rebeli* Hirschke, 1904, form a problematic pair whose taxonomic relationship to each other and, consequently, the taxonomic status of the latter, are still fraught with controversy. The high-altitude ‘form’ *rebeli* of *M. alcon* was first separated from *alcon* on species level by Berger (1946) on account of the two taxa living in different habitat types, respectively dry and damp. More recent research on the ecology (Thomas *et al.* 1989) and larval morphology (Munguira 1989) of *alcon* and *rebeli* revealed differences that lend what has been accepted as decisive support to the existence of two species. However, other authors (e.g. Kaaber 1964; Kudrna 1996; Tolman & Lewington 1997) have repeatedly raised the argument that the purported differences between the two taxa in morphological and ecological characters are in fact connected by intermediate states and that therefore the species status of *rebeli* is questionable. Only a rigorous and extensive genetic study can resolve this issue, which cannot be further discussed here. For the present report I follow the currently most widely accepted treatment of *rebeli* and *alcon* as two species defined on ecological grounds as follows (after Munguira & Martín 1999).

Maculineaalcon is hygrophilous and occurs in wet or marshy, mainly lowland meadows on acidic soils; its larval host plants are *Gentiana pneumonanthe* L. and *Gentiana asclepiadea* L. and its host ants are *Myrmica scabrinodis* Nyl., *My. ruginodis* Nyl. and *My. rubra* L. *Maculinea rebeli* is xerophilous and occurs in more or less dry meadows in lowlands and mountains, always on calcareous soils; its larval host plants are *Gentiana cruciata* L. and *Gentianella germanica* (Willd.) Börner and its principal host ant is *Myrmica schencki* Emery (also recorded are *My. sulcinodis* Nyl., *My. sabuleti* Meinert and *My. scabrinodis*). An interesting confirmation of the applicability of this approach also outside western Europe is the recent separation of the 'alcon' populations of European Russia into *alcon* and *rebeli* based on habitat type and host plant (Dantchenko *et al.* 1996).

However, within *alcon* (and probably also within *rebeli*) there is geographic variation in the use of host plants and ants (e.g. Elmes *et al.* 1994, Gadeberg & Boomsma 1997). Moreover, here it must be noted that populations with *rebeli*-type habitat preferences may also thrive on *Gentiana asclepiadea* (Tolman & Lewington 1997; see below). This should again serve as a reminder that the differences in ecological requirements between *alcon* and *rebeli* (in this case with regard to the habitat and species identity of their host plants) may not always be as clear-cut as it may appear from the above definition.

On species level, the populations of the *alcon* type in Bulgaria were until recently referred to as 'alcon', with the curious exception of Bálint ([1995]) who used, without further explanation, the name '*Maculinea sevastos*' in connection with Bulgarian populations. Based on my observations on the habitats of two newly discovered populations (Mt. Rhodopi: the town of Smolyan, 1000m; Mt. Alibotush: Hambar Dere gorge, 1300–1400 m) and inferences regarding the geological habitat substrate of the majority of known populations in the country (see below), I recently associated *rebeli* with the Bulgarian fauna and accordingly excluded *alcon* from it (cf. Munguira & Martín 1999). On this basis Abadjiev (2001) too assigned all Bulgarian populations to '*Glaucopsyche rebeli*'. The more detailed observations on the habitat and oviposition preferences of another newly discovered Bulgarian population (see below) support this conclusion. This agrees with the opinion expressed by some authors that all records of '*Maculineaalcon*' from the mountains of the Balkans and Greece should be referred to *rebeli* (van der Poorten 1982; Tolman & Lewington 1997). Pamperis (1997) figured eggs on *G. cruciata* observed at an unspecified north-western Greek locality in the Epirus province at 1300 m altitude, which again points to an affiliation of at least some Balkan mountain populations with *rebeli* rather than *alcon*.

Morphologically, the Bulgarian material at my disposal does not differ from material of the *alcon* group from different regions of Europe (in the collection of the Zoological Museum, University of Helsinki). However, it should be noted that Bulgarian females resemble true *alcon* more than typical *rebeli* in that the blue suffusion on the upperside is much less extensive: it is either absent or, if present, does not reach the postdiscal area. However I consider it premature at this point to discuss the issue of whether there are sufficient grounds to recognise the taxon *sevastos* (Rebel & Zerny,

1931), described from Montenegro (Zljeb) and Albania (Pashtrik), as a separate Balkan and Bulgarian subspecies of *rebeli*.

Distribution. In Bulgaria, *M. rebeli* is rare and very local. It occurs mainly in the country's medium-high and high mountains or their foothills: Stara Planina, Vitosha, western Rhodopi, Rila, Pirin, Alibotush, the karstic Zemen gorge between the massifs Konyavska Planina and Zemenska Planina, and the foothills of Osogovska Planina near the town of Kyustendil. The occurrence of this taxon on Mt. Belasitsa in the extreme south-west of the country (Munguira & Martín 1999) is so far unconfirmed. The records from the mountains span an altitudinal range of 500–2100 m, with most known populations occurring at altitudes between 800 and 1700 m. Two lowland localities (at about 200–250 m) are also known from the limestone region Dobrudzha in north-eastern Bulgaria (Fig. 2). The lepidopteran fauna of Dobrudzha is very poorly known and further localities of *rebeli* may be expected to exist there. This applies even to the relatively best-known mountainous strongholds of this species such as Rila and Rhodopi.

The apparent disparity between *rebeli* occurring in lowlands in northern Bulgaria, but at much higher altitudes in the southern half of the country is explained by the major climatic difference between these two areas. Due to the climatic barrier of Stara Planina range, the climate is continental to the north of this mountain chain but much warmer, with pronounced Mediterranean influence, to the south of it, with the exception of the higher mountains. Thus, species not adapted to survive under more Mediterranean climatic conditions occur only at higher altitudes in southern Bulgaria. Very similar 'dichotomous' distributions in the country are exhibited by other central European butterflies, e.g. *Lasiommata petropolitana* (Fabricius, 1787) and *Coenonympha glycerion* (Borkhausen, 1788).

Previously unpublished localities. Dobrudzha: 'Palamara' game reserve [200–250 m] (A. Slivov leg., in coll. IZS). – Mt. Stara Planina: nature park 'Karandila', 950–1000 m (Z. Kolev leg. & coll.). – Mt. Rila: 'Bayuvi Dupki' biosphere reserve [precise altitude unknown: the reserve encompasses altitudes from 1200 to 2820 m] (A. Slivov leg., in coll. IZS). – Mt. Rhodopi: Smolyan town, 1000 m (Z. Kolev leg. & coll.). – Mt. Rhodopi: 'Perelik' chalet [1900 m] (A. Slivov leg., in coll. IZS). – Mt. Rhodopi: Trigrad village, 1200 m (A. Slivov leg., in coll. IZS).

Habitat and biology. *M. rebeli* in Bulgaria inhabits flowery meadows, dry mountain grassland as well as rocky, grassy glades and margins of deciduous, mixed or coniferous forests. Truly xerothermic conditions are avoided. The habitats with which I have personal experience or for which sufficiently precise geological data could be found (after Gerasimov & Gulubov 1966) – e.g. all localities in Dobrudzha, Zemen gorge, Mt. Alibotush: Hambar Dere gorge, Mt. Rhodopi, Mt. Pirin, Stara Planina Mts: 'Karandila' – lie invariably on calcareous rock (in most cases dry karst). However, the substrate for some habitats (e.g. in Mt. Rila, the foothills of Osogovska Planina, Sofia: Lozenets suburb) remains to be determined with certainty. The adults fly in one generation from the second half of June till the beginning of August. Populations are typically very small: usually less than four or five specimens are seen at a time. An exception is the newly discovered population in the nature park 'Karandila', in which about 40 individuals were counted on a single day

(19.vii.1999): this appears to be the highest count so far for any Bulgarian population of *rebeli*. The habitat and butterfly fauna of this remarkable locality are described in more detail elsewhere (Kolev 2002).

Because of its size the last-mentioned population proved particularly well suited for observations on oviposition preferences, which I carried out in July 1999. In all 96 *Gentiana* plants were found in the habitat which measured about 800 m²; 71 of these carried a total of 672 eggs. In addition oviposition was directly observed once. The larval host plant, initially presumed by me to be *G. cruciata*, was identified in all cases as *Gentiana asclepiadea* L. by Michaela Yordanova (Faculty of Botany, University of Sofia) using the latest identification guide to Bulgarian plants (Andreev *et al.* 1992); particular care was taken to ascertain that the plant samples were indeed not *G. cruciata*. In the said habitat this plant grows in dry, stony places as well as in more shaded conditions at the forest edge and in higher, denser grass. However, robust plants either in flower or with well-developed flower buds, growing in small groups on exposed, dry rocky ground amid sparse and low (0–30 cm) vegetation, were preferred for oviposition. The eggs were laid on the flowers and flower buds and at the base of the uppermost leaves. Interestingly, according to Andreev *et al.* (1992) *G. asclepiadea* is found in ‘grassy, bushy and forested places’ in all high mountains of Bulgaria, but only above 1000 m. In the studied habitat this plant is therefore near the lower limit of its distribution. The present discovery may therefore not apply to populations of *rebeli* at lower altitudes. The host plant most commonly associated with *rebeli* in Europe, *Gentiana cruciata*, occurs in Bulgaria in ‘stony, grassy, bushy and forested places’ at altitudes above 200 m in Dobrudzha and in the hilly and mountainous regions of central and southern Bulgaria (Andreev *et al.* 1992). It is thus a very likely host of at least the lowland populations of Bulgarian *rebeli*, too.

Threats. No direct threats exist at present to the total population of *M. rebeli* in Bulgaria. As in the case of *arion*, smaller populations may be vulnerable to extinction caused by physical destruction of most or the entire habitat. No documented cases of such extinctions are known, but it is necessary to establish whether e.g. the population that existed more than 70 years ago in Lozenets (Buresch & Tuleschkow 1930), presently a heavily urbanised suburb of Sofia, still survives there. The small number of known populations and the relatively restricted area of potentially suitable calcareous habitats make *rebeli* a species of higher conservation concern relative to *arion*.

Conservation status. Lower risk, near threatened.

Priority actions. Further research on the taxonomy, distribution and biology of Bulgarian *M. rebeli* is needed. The possible effects of vegetation succession on populations that may be affected by it, such as those at higher altitudes in Mt. Rhodopi, should be studied. Conservation measures are presently not needed.

Maculinea nausithous (Bergsträsser, 1779)

Taxonomy. Bulgarian specimens correspond well to *nausithous* from the main European range of the species. There is little variation, mainly in size as well as in the extent and brightness of the blue upperside suffusion of males.

Distribution. The populations of *M. nausithous* in this country are widely separated from the main European range: the nearest localities, in Slovenia and northern Croatia (Jakšić 1988) and western Ukraine (Wynhoff 1998), are about 600 km away. In Bulgaria this species is found in an extremely limited area on the southern outskirts of Sofia, namely the foothills and lower slopes of the adjacent mountains Lyulin and Vitosha (Fig. 3). Most records are from the slopes of Lyulin above the suburb of Gorna Banya. A single specimen was first collected there in 1904 (Drenowski 1907) but this record remained doubtful until 1957, when a population was discovered and specimens were collected during four consecutive years (Gogov 1963). Subsequent records from Mt. Lyulin are lacking until 1999, when I discovered a small population at 750–800 m. It is unfortunately not known whether all these records concern the same population.

The other known localities of this species are very poorly documented. In 1955 a single specimen was found in the suburb of Boyana on the lower slope of Vitosha (Vihodcevsy & Gogov 1963); in the collection of the museum of Natural History in Burgas there are additional specimens from this locality with labels “Boyana, 5.7.[19]55” collected by the late Sevar Zagorchinov. More recently, *nausithous* has been established in two further localities (see below). All records come from an altitude of about 650–850 m. The information in Munguira & Martín (1999) regarding the occurrence of *nausithous* near the town of Kostinbrod, just north of Sofia, is erroneous. It is interesting that, despite the presence of extensive meadows with abundant growth of *Sanguisorba officinalis* L. (pers. observ.), this butterfly has not yet been discovered on Lozenska Planina, a small massif immediately to the east of Vitosha (S. Abadzhiev, pers. comm.).

Previously unpublished localities. Sofia: Vladaya suburb at the junction of Mt. Lyulin and Mt. Vitosha [750–800 m] (S. Beshkov, pers. comm.). – Sofia: Sukhodol suburb north of Mt. Lyulin [650–700 m] (I. Stoychev leg. & coll.). – Mt. Lyulin: south-west of Gorna Banya suburb, 750–800 m (Z. Kolev leg. & coll.).

Habitat and biology. Precise habitat descriptions are lacking for most Bulgarian localities of *M. nausithous*. In the newly discovered locality on Mt. Lyulin this species was found only in a small part of a tall-grass meadow, in which *Sanguisorba officinalis* L. was present. Unlike in central Europe, where *nausithous* is found in damp, marshy habitats with some preference for their relatively drier edges (e.g. Tolman & Lewington 1997; Munguira & Martín 1999), the newly discovered habitat as well as that in Sukhodol (I. Stoychev, pers. comm.) are situated on slopes with well-drained sandy soils and are much drier than what is generally considered acceptable to this species. *M. nausithous* has a single generation flying approximately from early July (judging by the somewhat worn condition of the specimens observed by me on 10.vii.1999) till the second half of August. The populations are small. Thus, Gogov (1963) reported the number of specimens collected by him in a single locality on Mt. Lyulin as follows: ‘21.vii.1957: 1 male; 1.viii.1958: 4 males, 1 female; 3.viii.1959: 2 males, 1 female; 18.viii.1960: 12 very worn specimens’. In the Sukhodol locality less than ten specimens were seen during several hours of intensive search (I. Stoychev, pers. comm.). My observations yielded the highest count so far for a Bulgarian population of *nausithous*: about 20 individuals during a two-hour census.

All butterflies observed by me were found on or in immediate proximity to *Sanguisorba officinalis* plants, on whose flowerheads the adults perched and drank nectar. Although oviposition was not observed, nor were any eggs found, the close association of all observed butterflies with *Sanguisorba officinalis* leaves no doubt that this plant is the host for young larvae of *nausithous* in this Bulgarian locality, as elsewhere in Europe (e.g. Malicky 1969) and western Asia (Hesselbarth *et al.* 1995; Korshunov & Gorbunov 1995).

Threats. The known populations of *M. nausithous* are situated in immediate proximity to the most densely populated region in Bulgaria. Prior to the present study the status of *nausithous* in Bulgaria had not been critically examined, although it was listed as 'vulnerable' in the Red List of Bulgarian Butterflies and Moths (Ganev 1985). On the basis of this source and in the absence of more definite data, I provisionally retained this status (cf. Munguira & Martín 1999). Potential or actual threats have yet to be identified for any of the Bulgarian populations. Urban development may prove to be of concern in the more urbanised foothills of Vitosha and in the suburb of Sukhodol (Munguira & Martín 1999). Mowing of the extensive meadows on Lyulin, which was observed also in the meadow inhabited by *nausithous*, may affect the populations of the butterfly on that mountain. The newly found *nausithous* population as well as the only *S. officinalis* plants in the extensive meadow were located, significantly, at the very fringe of the meadow where mowing has been much less thorough due to the steeper, more uneven terrain.

Conservation status. In Bulgaria, presently available data suggest that *M. nausithous* meets the criteria for category 'Endangered' (IUCN 2001). It is thus the only member of its genus in the country of immediate conservation concern.

Priority actions. The ecological requirements of *M. nausithous* and its hosts must be studied in detail. Extensive search for new populations of the butterfly in the southern environs of Sofia as well as neighbouring regions is necessary, as is a regular monitoring scheme for at least some localities. The potential or existing threats to all populations should be identified. In view of the proximity to the capital and the restricted size of the area involved, most if not all of the research could be carried out efficiently and relatively inexpensively in the form of field exercises or individual research projects for students of biology at the University of Sofia. Since mowing may prove to be an important factor for preventing afforestation of *nausithous* habitats, a total ban on mowing there should perhaps not be pursued. Instead, it is recommended that conservation actions in mown habitats should focus on restrictions of mowing during the flight period of the butterflies and the time needed for their larvae to complete their feeding on the host plant (see Garbe 1993). Providing a legal basis for the protection of this species and its habitats in Bulgaria is most desirable.

Concluding remarks

The present contribution reports 13 new localities of *Maculinea arion*, 6 of *M. rebeli* and 3 of *M. nausithous*, which is a significant increase in the known distribution of all these species in Bulgaria. This once again underscores the fact that there is yet much

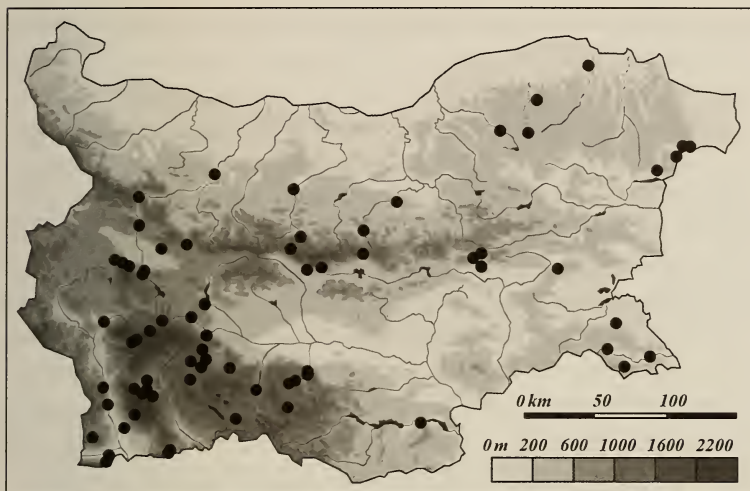


Fig. 1. Known records of *Maculinea arion* in Bulgaria.

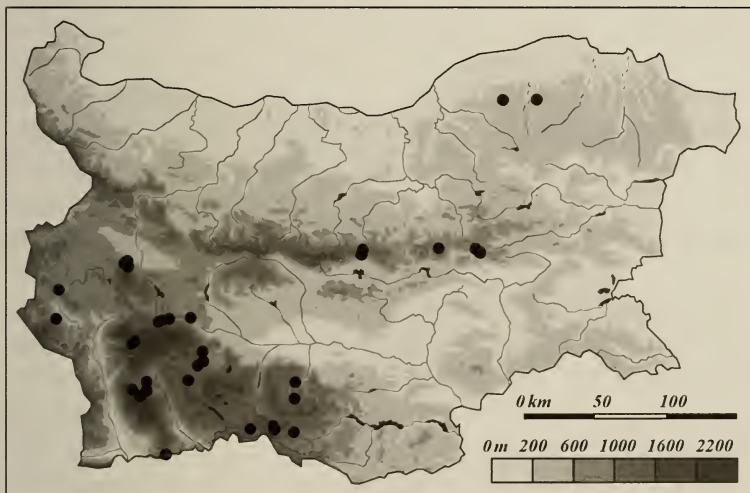


Fig. 2. Known records of *Maculinea rebeli* in Bulgaria.

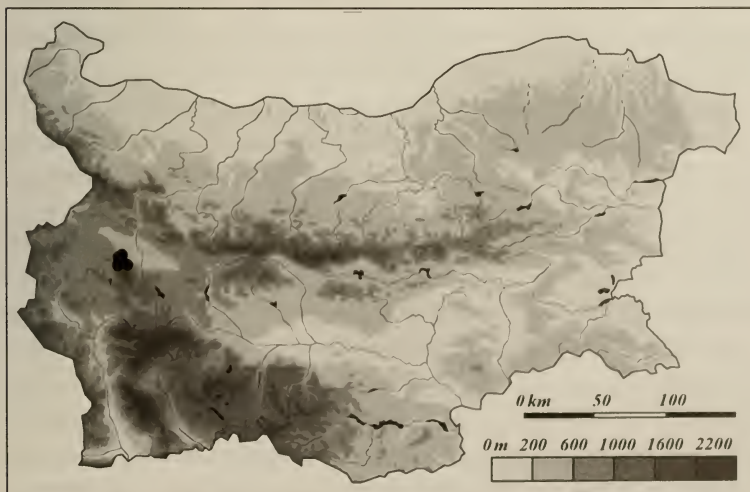


Fig. 3. Known records of *Maculinea nausithous* in Bulgaria.

basic research to be done on eastern-European *Maculinea* in general (see also Wynhoff 1998 and Munguira & Martín 1999).

My studies on *M. rebeli* in Bulgaria revealed the first case of utilization of *Gentiana asclepiadea*, a host plant so far only linked with *M.alcon*, by a 'dry-habitat' population. This shows the urgent need for more research on the taxonomy of the *alcon* complex as a whole and especially on the eastern European populations, which until now have remained virtually unstudied. The population reported here combines *alcon*-like morphology and host plant with clearly *rebeli*-like habitat preferences. This is perhaps the best demonstration of the frailty of the conventional, western-European view on the specific differences between *alcon* and *rebeli*. Though based on extensive and detailed research this view may be biased since these studies concentrated on populations on the extreme distributional margin of both taxa. Cases like this, should they prove to be more widespread, can seriously challenge the validity of present species delimitations with respect to the populations in the Balkans and perhaps further east.

M. arion and *M. rebeli* are found to be of no immediate, and perhaps long-term, conservation concern in Bulgaria. These two species thrive in hilly and mountainous terrain that is mostly of little value to potentially harmful agricultural or industrial development. It can even be said that both have locally benefited from disruptions in the forest cover created by animal husbandry and other human activities in formerly densely forested regions such as Mt. Rhodopi and Mt. Stara Planina. This situation is in stark contrast to that at the western and northern extremes of the ranges of these species, where both are considered endangered and many populations have already become extinct.

Bulgarian *M. nausithous* is an altogether different case. The present main range of the species, from France across central Europe to western Siberia, appears to be a relic of a once wider distribution as evidenced by widely separated 'islands' at great distances from the main present-day range. Such still survive in e.g. Spain, Bulgaria and north-eastern Turkey. These 'islands' have as a whole a greater risk of extinction than populations in the main range of the species. In addition such peripheral populations may differ from 'mainland' *nausithous* in certain aspects of their biology. Such is the case with some Spanish populations which have a different ant host: *My. scabrinodis* instead of *My. rubra* (Munguira & Martín 1999). In conservation terms such an exceptional adaptation to local conditions means that, should such a population become extinct, an eventual re-introduction with stock from the main range would most likely be a costly and complete failure. Similar 'abnormalities' might be expected for Bulgarian *nausithous*. Moreover, the distribution and habitat preferences of *My. rubra* in the country apparently do not fit those of the butterfly at all: this ant is widespread in Bulgarian mountains above 1500 m, but at lower altitude occurs only in 'stream banks in strongly shaded woodland' (Atanasov & Dlussky, 1992). It is interesting to note that a species closely related to *My. scabrinodis*, *My. bessarabica* Nasonov, is found in Bulgaria only in the western part, 'especially on Mt. Lyulin', which is a distribution pattern unique among Bulgarian *Myrmica* (Atanasov & Dlussky, 1992). Studies of the biology of the Bulgarian populations of *nausithous* are therefore of utmost importance both locally, as these are essential for the creation of an efficient conservation

scheme, as well as on European scale, as they are likely to contribute new data to the biology of the species as a whole.

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