

NEW DATA ON THE PRESENCE OF THREE SIMILAR SPECIES OF THE  
GENUS *MELITAEA*: *M. ATHALIA*, *M. AURELIA* AND *M. BRITOMARTIS*  
(LEPIDOPTERA: NYMPHALIDAE) IN THE NORTH-WESTERN BALKANS

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## ABSTRACT

The recently collected distribution data about three similar *Melitaea* (Lepidoptera: Nymphalidae) species (*M. athalia*, *M. aurelia* and *M. britomartis*) that were reliably identified based on morphology of genitalia are presented. Three countries from the NW Balkans (Slovenia, Croatia, and Bosnia and Herzegovina) were included in the survey. All three species are widely distributed in Slovenia and Croatia from the lowlands to the subalpine belt, frequently occurring also in syntopy. The proportion of *M. aurelia* and *M. britomartis* that are often treated as rare is quite high, accounting for 28.5 % and 22.7 % of the total studied sample size, respectively. The known area of distribution for *M. aurelia* and *M. britomartis* has been significantly extended to the south, especially in Croatia from where only two records for the latter had previously existed. *M. britomartis* is recorded in Bosnia and Herzegovina for the first time.

**Key words:** *Melitaea athalia/aurelia/britomartis*, genitalia, distribution, Slovenia, Croatia, Bosnia and Herzegovina

NUOVE CONFERME DELLA PRESENZA DI TRE SPECIE SIMILI DEL GENERE *MELITAEA*:  
*M. ATHALIA*, *M. AURELIA* E *M. BRITOMARTIS* (LEPIDOPTERA: NYMPHALIDAE) NEI  
BALCANI NORD-OCCIDENTALI

## SINTESI

L'articolo riporta recenti dati sulla distribuzione di tre specie simili di *Melitaea* (Lepidoptera, Nymphalidae: *M. athalia*, *M. aurelia* e *M. britomartis*), che sono state determinate in base alla morfologia degli organi genitali. La ricerca ha coperto il territorio di tre stati dei Balcani nord-occidentali (Slovenia, Croazia, Bosnia ed Erzegovina). I risultati indicano che tutte le specie hanno un'ampia distribuzione in Slovenia e Croazia. *M. aurelia* e *M. britomartis*, frequentemente considerate quali specie rare, hanno rappresentato un'alta percentuale del campione studiato, ossia il 28,5 % ed il 22,7 %, rispettivamente. L'area di distribuzione conosciuta di *M. aurelia* e *M. britomartis* è stata estesa significativamente verso sud, specialmente in Croazia, dove fino ad oggi si contavano solo due segnalazioni delle specie studiate. *M. britomartis* è stata trovata in Bosnia ed Erzegovina per la prima volta.

**Parole chiave:** *Melitaea athalia/aurelia/britomartis*, genitali, distribuzione, Slovenia, Croazia, Bosnia ed Erzegovina

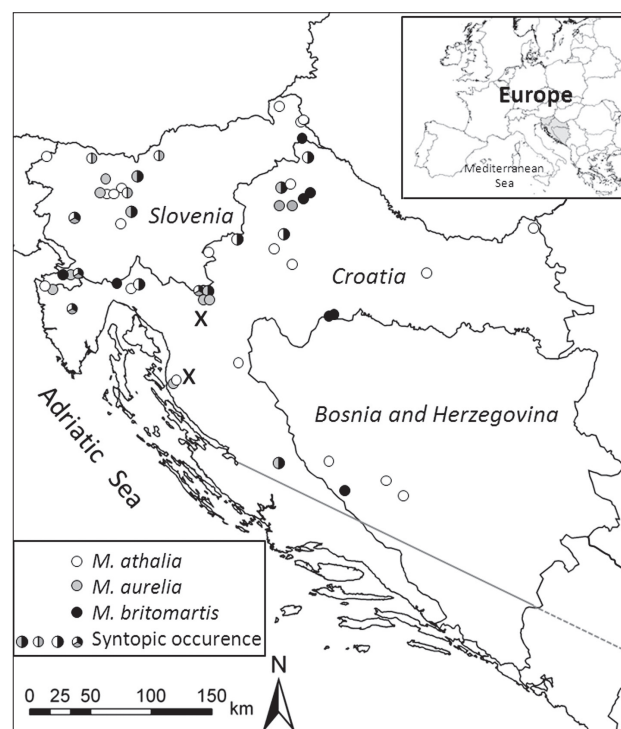
## INTRODUCTION

The genus *Melitaea* is comprised of about 65 small to medium-sized butterfly species distributed widely across the Palaearctic region (Leneveu et al., 2009). The radiation of diversity in the genus *Melitaea* is estimated to have happened in early the Miocene, somewhere in the Central Palaearctic region (Leneveu et al., 2009). In Europe, 15 species of the genus *Melitaea* are present (Van Swaay et al., 2010), of which eight are distributed in the area of the north-western part of the Balkan Peninsula. Most European representatives of this genus have clearly visible external diagnostic morphological characteristics and can be easily distinguished from similar species (Tolman & Lewington, 2008). Aside from those, this genus also includes some species which are difficult to recognize by external morphology, i.e. colour patterns on the wings. There are some species for which the morphology of the genitals must be checked for correct identification (Urbahn, 1952; Tolman & Lewington, 2008; Paulavičiūtė & Tamutis, 2009). This includes the complex of three species present in the northern Balkans: *Melitaea athalia* (Rottemburg, 1775), *Melitaea aurelia* (Nickerl, 1850) and *Melitaea britomartis* Assmann, 1847. Although some authors propose different external character keys for identification of the three species (e.g., Higgins & Riley, 1970; Lafranchis, 2004; Tolman & Lewington, 2008), i.e. combination of coloration (lunules on hind wings and band coloration, colour of hair on the palps and size), the morphological variability prevents proper identification at all times (Tolman & Lewington, 2008; Lorković, 2009).

The three most north-western Balkan countries (Slovenia, Croatia and Bosnia and Herzegovina) have a long tradition of butterfly research (e.g., Mann, 1857, 1867, 1869; Hafner, 1909; Stauder, 1919–1927; Carnelutti, 1992; Lelo, 2007; Lorković, 2009; Šašić & Mihoci, 2011). Until 1991, all three countries were part of former Yugoslavia. So far only one distribution atlas for the whole area of Yugoslavia exists (Jakšić, 1988) where the presence of each species is indicated for the 10 x 10 km<sup>2</sup> UTM fields. Slovenia is the best surveyed country in the Balkans, owing to numerous recent publications, and a new Atlas of butterflies (Verovnik et al., 2012). In the last 20 years much new data regarding the butterflies of Croatia has been published (e.g., Mihoci et al., 2007; Koren & Ladavac, 2010; Koren et al., 2011; Šašić & Mihoci, 2011), but large parts of the country still remain unsurveyed. For Bosnia and Herzegovina, only a small number of papers have been published in the last 20 years (e.g., Lelo, 2000), including a book with general information on the distribution of butterflies in this country (Lelo, 2007). While *M. athalia* and *M. aurelia* have already been recorded in Bosnia and Herzegovina, this is not true for *M. britomartis* (Lelo, 2007).

The majority of the published data on the three species of *Melitaea* from the NW Balkans rely mostly on

identification based on external morphology. Since the latter is extremely difficult owing to the high rate of morphological variability in species (and/or population) (Tolman & Lewington, 2008), there is a high probability of a series of misidentifications in the older literature, most commonly in favour of *M. athalia* which is believed to be the most widespread and frequent of all three species (Jakšić, 1988; Lorković, 2009). As such, distribution data from papers in which species were identified only on the basis of external morphological characteristics needs to be treated differently from the data obtained from genitalia preparations. Without those data, however, almost no records would be left for Croatia and Bosnia and Herzegovina. With the application of identification based on the morphology of genitalia, we expect: (1) to reliably identify the specimens to the species rank, and (2) to provide exact data on their geographical, altitudinal and temporal distributions. Hence, we expect to considerably change the current knowled-



**Fig. 1: Distribution of the three *Melitaea* species (*M. athalia*, *M. aurelia*, *M. britomartis*) from the NW Balkans based on the data included in the present study. The historically defined southern limit of the distribution of *M. aurelia* is denoted by the grey line. The two historical records of *M. britomartis* in Croatia are denoted by "X".**  
**Sl. 1: Zemljevid razširjenosti treh vrst iz rodu *Melitaea* (*M. athalia*, *M. aurelia*, *M. britomartis*) na področju SZ Balkana. Zgodovinsko postavljena južna meja razširjenosti *M. aurelia* je označena s sivo črto. Dva zgodovinska podatka za *M. britomartis* na Hrvaškem sta označena z "X".**

ge on the presence of these three species in some parts of the NW Balkans.

## MATERIALS AND METHODS

Samples of three species of the genus *Melitaea* (Fig. 1, Appendix 1) were collected with a butterfly net for over last 30 years all over the NW Balkans, including the following countries: Slovenia (samples from 20 localities), Croatia (32 localities) and Bosnia and Herzegovina (4 localities). Sample size ranged from 1 to 12 for males and from 1 to 3 for females, with males prevailing (Appendix 1). On each sampling occasion, the data on sampling locality was gathered, which includes geographic position, altitude and a short habitat description (Appendix 1). Specimens were mounted and are deposited in two private collections in Pazin, Croatia (Koren T. collection) and Kranj, Slovenia (Jugovic I. collection) (see Appendix 1, under Coll.).

As a high morphological variability of the wing size, pattern and coloration has been reported by several studies (e.g., Tolman & Lewington, 2008), no specimens were attributed to a single species regarding these characteristics (see Introduction for details). Specimens were identified to the species level according to the genitalia structure that is species specific (Urbahn, 1952; Tolman & Lewington, 2008; Paulavičiūtė & Tamutis, 2009). A completely certain identification, however, is possible only in males (Urbahn, 1952). In females there are slight differences among the species, but not all specimens can be reliably attributed to the species level (Urbahn, 1952). The genitalia of each specimen were isolated using the standard procedure for genitalia isolation. The procedure includes the cutting of the abdomen and immersing it in a 10 % KOH solution overnight. Isolated genitalia were examined under a stereomicroscope (Leica MZ 12.5) and stored in 75 % ethanol afterwards. The storage vials are vouchered accordingly to specimens from the collections.

All sampling localities were geo-referenced either by using a GPS device (e-Trex Vista) or by the use of Google Earth afterwards (Appendix 1). For the distribution and statistical analyses, ArcGIS software, Excel 2010 (Microsoft) and SPSS 14.0 were used, respectively.

## RESULTS

### Species and geographic occurrence

The principal result of our analysis is the confirmation of the expected presence of all three species in Slovenia, Croatia and Bosnia and Herzegovina (Fig. 1). Of 123 collected specimens, 60 (48.8 %) belong to *M. athalia* (32 localities), followed by 35 specimens (28.5 %) of *M. aurelia* (23 localities) and 28 specimens (22.7 %) of *M. britomartis* (21 localities). The distribution of all three species seems to be more or less contiguous,

and the distribution areas of the all three species greatly overlap (Fig. 1). Nevertheless, all three species were found together only at 7.1 % of all localities, and in an additional 21.4 %, two species were found in syntopy. In other cases, only one species was found in a single locality (Appendix 1).

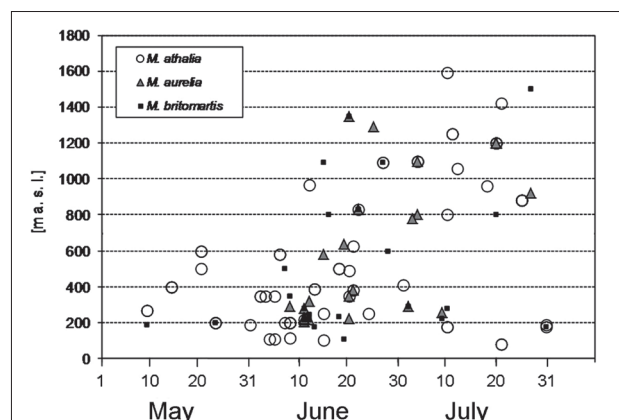
### Temporal and altitudinal distribution

The temporal and altitudinal occurrence phenology of the three studied *Melitaea* species is presented in Figure 2. The adults are active from the beginning of May until the end of July. Nevertheless, the presence of *M. aurelia* was not recorded in approximately the first third of the season (i.e., first record is from 8<sup>th</sup> of June from Šterna in Croatian Istria).

Specimens of all three studied species of *Melitaea* were found from the lowlands (< 100 m. a.s.l.) to the sub-alpine zone, as high as 1600 m a. s. l., with a shortened period of occurrence at higher elevations, especially on account of the time delay at the beginning of the season. The seasonal occurrence of each of the three species is positively correlated with altitude, meaning that the higher the altitude, the later the data on the first occurrence of *Melitaea*. For all three species pooled together, Pearson's correlation coefficient between the altitude and the date of record ( $r = 0.55$ ) is statistically significant at  $p < 0.001$ . There is no statistically significant difference (ANOVA,  $p > 0.05$ ) either between the species and dates of recordings, or between the species and altitude.

## DISCUSSION

Reliable notes on the geographic distribution of the *Melitaea* species for each of the three countries of the



**Fig. 2: Temporal and altitudinal occurrence of three *Melitaea* species (*M. athalia*, *M. aurelia*, *M. britomartis*) from the NW Balkans.**

**Sl. 2: Sezonsko in višinsko pojavljanje odraslih živali treh vrst iz rodu *Melitaea* (*M. athalia*, *M. aurelia*, *M. britomartis*) na področju SZ Balkana.**

NW Balkans are scarce due to lack of genitalia-based identification. Nevertheless, the distribution area of all three *Melitaea* species has been shown to be scattered across the whole region. Their wide distribution area was to be expected because most of the feeding plants of the *Melitaea* species (Tolman & Lewington, 2008) are common and widespread in the Balkans. Some of the primary feeding plants (Jonko, 2012) are common for all three species (e.g., *Plantago* spp. and *Veronica* spp. for all the three, with an addition of *Melampyrum nemorosum* for *M. athalia/aurelia*); secondary food plants of *M. athalia* (Jonko, 2012) are also *Valeriana officinalis*, *Polygonum bistorta* and *Centaurea* spp. *M. athalia* is therefore the least specialized of the *Melitaea* species from the NW Balkans. Nevertheless, the proportion of the other two species is somewhat higher than might be expected, and they are by no means rare or local (as suggested by some authors, e.g., Lorković, 2009). There is an indication, however, that in some localities *M. aurelia* or *M. britomartis* can be the dominant (or the only) species of the complex (Appendix 1).

Our sampling covered the whole season of the flight period of the three species. According to Tolman & Lewington (2008) the flight period for *M. athalia* and *M. aurelia* lasts during June and July, and for *M. britomartis*, from late May/Early June until end of July/early August. Our data correspond to the mentioned literature, however the flight period starts earlier in the NW Balkans for *M. athalia* and *M. britomartis*. Although two generations have been reported for *M. britomartis* in some southern localities (e.g., the Ticino Valley in NW Italy; Tolman & Lewington, 2008), no gap between the (two) generations could be seen from our data. According to data from Slovenia (Verovnik *et al.*, 2012), *M. aurelia* and *M. britomartis* fly in a single generation from mid-May until the end of July, with a distinctive peak in the second half of June for the latter. For *M. aurelia*, also a partial second generation was recorded in the Vipava Valley (Verovnik *et al.*, 2012). Adults of *M. athalia*, however, appear mostly in two partially overlapping generations from late April until September, with few fresh specimens observed in September and October that probably belong to a partial third generation (Verovnik *et al.*, 2012).

Our results indicate that the altitudinal distribution of the studied species in the NW Balkans is broader than mentioned from the literature (Tolman & Lewington, 2008; Verovnik *et al.*, 2012): *M. athalia*: 0–800 m a.s.l., occasionally even above 2000 m a.s.l. (Verovnik *et al.*, 2012); *M. aurelia*: 100–1500 m a.s.l. (1600 m: Verovnik *et al.*, 2012); *M. britomartis*: 300–900 m a.s.l. (1250 m: Verovnik *et al.*, 2012). While the data obtained for *M. athalia* and *M. aurelia* are within the already published range, we found *M. britomartis* from 110 up to 1500 m a.s.l. For *M. britomartis*, we can report that the highest known locality from Slovenia was at an elevation of 1350 m a.s.l. (Ambrož Pod Krvavcem, Kamniško Savinjske Alpe), and the absolute highest elevation from

Bosnia and Herzegovina was at an elevation of 1500 m a.s.l. (Troglav Mountain, The Dinarides).

### Additional notes on geographic distribution

For Bosnia and Herzegovina, Lelo (2007) reports the country-wide distribution of *M. athalia*, except for the small area in the south-eastern Mediterranean part. According to the same author, *M. aurelia* inhabits the central mountainous part of the country. No data on the presence of *M. britomartis* exists for the country (Lelo, 2000, 2007), or for the wider area of southern part of the NW Balkans (e.g., Jakšić, 1988). Hence, our record from the Bosnian part of Troglav Mountain, Vještici Gora is the first record of this species for Bosnia and Herzegovina. This specimen was collected on dry grassland at the beginning of the hiking path toward the highest peak, Troglav. Only one specimen was observed and collected. Additionally, we would expect that *M. britomartis* is also present in NW Bosnia as it was observed in Croatia in the Hrvatska Kostajnica region, only a few kilometres from the Bosnian border. Thus we predict that its range in Bosnia and Herzegovina is possibly much wider. With this addition and the recent record of *Proterebia afra* (Koren & Trkov, 2011) the butterfly fauna of Bosnia and Herzegovina now includes 192 butterfly species.

As no recent atlas about the butterflies of Croatia exists, the information on the distribution could be discerned from the atlas of the butterflies of Yugoslavia (Jakšić, 1988), and recent faunistic studies (e.g., Mihoci *et al.*, 2007; Koren *et al.*, 2011). According to Jakšić (1988), *M. athalia* is widespread in Croatia which is in line with our survey. Regarding *M. aurelia*, 42 records for Croatia exist (Bohatsch, 1892; Rebel, 1895; Koča, 1900; Abafi-Aigner, 1910; Grund, 1916; Gussich, 1917; Lorković & Mladinov, 1971; Mladinov, 1973; Cribb, 1976; Goossens-Cromphout & Goossens-Cromphout, 1982; Kranjčev, 1985; Hafner, 1994; Mihoci *et al.*, 2007; Marčec, 2008; Ábraham, 2008; Lorković, 2009; Koren & Ladavac, 2010; Koren *et al.*, 2011) but the means of identification are not clearly stated.

Regarding the presence of *M. britomartis* in Croatia, Jakšić (1988) mentions only one locality, in the area of Josipdol near Ogulin in NW Croatia. This record was originally published by Mann (1867), and was later only cited by Abafi-Aigner *et al.* (1896) and Jakšić (1988). Mihoci *et al.* (2007) report *M. britomartis* from the Velebit Mountains, Švica. In this survey *M. britomartis* was collected from 15 different localities (Appendix 1) across Croatia. This indicates a much wider distribution than was previously known. With the addition of our data, we expand the known distribution of *M. britomartis* in Croatia to different regions, including Istria, Dalmatia, Zagorje, Medimurje and Slavonija. It seems that *M. britomartis* is missing from eastern Slavonia and south-eastern Dalmatia, but as those areas were not sufficiently surveyed, the possibility exists that it will be recorded there.



## CONCLUSIONS

In the case of the three studied *Melitaea* species, for which their variability sometimes renders them almost impossible to identify using only external morphology, investigating the genitalia morphology is an irreplaceable tool. Our survey has showed that: (1) *M. athalia* is widespread in the whole researched area; (2) *M. aurelia* is more common and widespread than was previously known, especially in Croatia, and (3) *M. britomartis* is widespread in the surveyed regions of Slovenia and Croatia, and was recorded also in Bosnia and Herzegovina. All three species are widely distributed from lowlands to the mountainous belt, frequently occurring

also in sintopy. The proportion of *M. aurelia* and *M. britomartis* that are often treated as rare is quite high, accounting for 28.5 % and 22.7 % of total sample size, respectively.

## ACKNOWLEDGEMENTS

We are grateful to Ivan Jugovic (Kranj, Slovenia) for data from his collection, useful discussions with him and his help with identification. We also thank Barbara Zakšek (Voličina, Slovenia) for providing us with the literature on genitalia preparation and both referees (Rudi Verovnik, Ljubljana, and an anonymous referee) for constructive comments on the manuscript.

## NOVI PODATKI O RAZŠIRJENOSTI TREH PODOBNIH VRST IZ RODU *MELITAEA*, *M. ATHALIA*, *M. AURELIA* IN *M. BRITOMARTIS* (LEPIDOPTERA: NYMPHALIDAE), NA PODROČJU SEVEROZAHODNEGA BALKANA

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## POVZETEK

V prispevku so zbrani podatki o razširjenosti treh podobnih vrst iz rodu *Melitaea* (Lepidoptera: Nymphalidae) na področju SZ Balkana. V raziskavo smo vključili podatke iz treh držav: Slovenije, Hrvaške ter Bosne in Hercegovine. V preteklih 30 letih je bilo zbranih 123 osebkov metuljev treh podobnih vrst, navadnega pisančka (*M. athalia*), jetičnikovega pisančka (*M. aurelia*) in temnega pisančka (*M. britomartis*). Čeprav za pomoč pri razlikovanju med temi vrstami obstajajo opisi njihove zunanje morfologije in določevalni ključi, smo ugotovili, da visoka morfološka (znotraj- in medvrstna) raznolikost ne omogoča zanesljive določitve. Genitalne preparate smo pripravili za vse živali, vključene v analizo, in jih zanesljivo določili do vrste. Ugotovili smo, da so vse tri vrste razmeroma pogoste, čeprav navadni pisanček s skoraj polovico (48,8 %) vseh analiziranih živali prevladuje. Preostali vrsti sta približno enako zastopani z 28,5 % (*M. aurelia*) in 22,7 % (*M. britomartis*). Vse tri vrste se pogosto pojavljajo sintopo, najdemo pa lahko tudi lokalitete, kjer smo zabeležili vse tri skupaj. Razširili smo znano vertikalno razširjenost za temnega pisančka v Sloveniji do višine 1350 m (Ambrož pod Krvavcem, Kamniško-Savinjske Alpe), sicer pa do višine 1500 m (Troglav, Bosna in Hercegovina). Podatek s Troglava je obenem tudi najjužnejši podatek za to vrsto na območju SZ Balkana in prva najdba za Bosno in Hercegovino. Tudi na Hrvaškem smo znano območje razširjenosti te vrste močno razširili, saj je bila do sedaj (določena na podlagi zunanje morfologije) na Hrvaškem znana le z dveh lokalitet.

**Ključne besede:** *Melitaea athalia/aurelia/britomartis*, genitalije, razširjenost, Slovenija, Hrvaška, Bosna in Hercegovina

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**Appendix 1: Data on sampling localities of three *Melitaea* species (*M. athalia*, *M. aurelia*, *M. britomartis*) from the NW Balkans. Legend: SN = sample number, BIH = Bosnia and Herzegovina, CRO = Croatia, SLO = Slovenia), X, Y = GPS coordinates, M = number of males, F = number of females, Coll. = collection (TK = Toni Koren, Jul = Ivan Jugovic): data for leg. and det. the same, except for cases denoted with asterisk (\*), where leg. J. Premrl.**

**Priloga 1: Podatki o vzorčnih lokalitetah za tri vrste iz rodu *Melitaea* (*M. athalia*, *M. aurelia*, *M. britomartis*) s področja SZ Balkana. Legenda: SN = številka vzorca, BIH = Bosna in Hercegovina, CRO = Hrvaška, SLO = Slovenija, X, Y = GPS koordinata, M = število samcev, F = število samic, Coll. = zbirka (TK = Toni Koren, Jul = Ivan Jugovic): podatki za leg. in det. enaki, razen v primerih, označenih z zvezdico (\*), kjer je leg. J. Premrl.**

| SN                             | Country | Locality                         | X       | Y       | Date      | Altitude (m) | Habitat            | Syntopic occurrence                       | Gender | Coll. |
|--------------------------------|---------|----------------------------------|---------|---------|-----------|--------------|--------------------|-------------------------------------------|--------|-------|
| <b><i>Melitaea athalia</i></b> |         |                                  |         |         |           |              |                    |                                           |        |       |
| 1                              | BIH     | Kupres, Demirovac                | 5683172 | 4876659 | 11.7.1988 | 1250         | mountain grassland |                                           | 1M, 1F | Jul   |
| 2                              | BIH     | Makljen, mountain pass           | 5709025 | 4861175 | 12.7.1988 | 1060         | mountain grassland |                                           | 1M, 0F | Jul   |
| 3                              | BIH     | Šator, Medugorje                 | 5632681 | 4890062 | 21.7.2011 | 1420         | mountain grassland |                                           | 0M, 1F | TK    |
| 4                              | CRO     | Grdanjci, Samobor                | 5549483 | 5076453 | 10.7.2010 | 175          | wet grassland      | <i>M. britomartis</i>                     | 2M, 0F | TK    |
| 5                              | CRO     | Ivanščica, hiking path           | 5586114 | 5118082 | 12.6.2011 | 967          | dry grassland      |                                           | 1M, 0F | TK    |
| 6                              | CRO     | Obruč, hiking path »Pod planinu« | 5458566 | 5029635 | 13.6.2010 | 390          | dry grassland      |                                           | 1M, 1F | TK    |
| 7                              | CRO     | Papuk, toward Klinovac           | 5709760 | 5041569 | 21.6.2011 | 624          | woodland edge      |                                           | 1M, 0F | TK    |
| 8                              | CRO     | Peščenica, Velika Gorica         | 5591311 | 5051891 | 15.6.2009 | 105          | woodland edge      |                                           | 1M, 0F | TK    |
| 9                              | CRO     | Platak, Planinarski dom          | 5466155 | 5031809 | 27.6.2001 | 1090         | alpine grassland   | <i>M. britomartis</i>                     | 2M, 0F | TK    |
| 10                             | CRO     | Plitvice                         | 5547652 | 4967041 | 10.7.1988 | -            | wet grassland      |                                           | 1M, 0F | Jul   |
| 11                             | CRO     | Plovanija, Istra                 | 5393198 | 5035042 | 5.6.2011  | 111          | dry grassland      |                                           | 1M, 0F | TK    |
| 11                             | CRO     | Plovanija, Istra                 | 5393198 | 5035042 | 4.6.2011  | 111          | dry grassland      |                                           | 1M, 0F | TK    |
| 12                             | CRO     | Skoblić Brdo, Bosiljevo          | 5523865 | 5030113 | 11.6.2011 | 215          | dry grassland      | <i>M. aurelia</i> , <i>M. britomartis</i> | 1M, 0F | TK    |
| 13                             | CRO     | Šenkovec, Čakovec                | 5609093 | 5142392 | 30.7.2011 | 175          | wet grassland      | <i>M. britomartis</i>                     | 0M, 1F | TK    |
| 14                             | CRO     | Vela Traba, Pazin                | 5411485 | 5012008 | 2.6.2008  | 350          | dry grassland      | <i>M. aurelia</i> , <i>M. britomartis</i> | 2M, 0F | TK    |
| 14                             | CRO     | Vela Traba, Pazin                | 5411485 | 5012008 | 3.6.2008  | 350          | dry grassland      | <i>M. aurelia</i> , <i>M. britomartis</i> | 0M, 1F | TK    |
| 14                             | CRO     | Vela Traba, Pazin                | 5411485 | 5012008 | 5.6.2008  | 350          | dry grassland      | <i>M. aurelia</i> , <i>M. britomartis</i> | 0M, 1F | TK    |
| 14                             | CRO     | Vela Traba, Pazin                | 5411485 | 5012008 | 20.6.2009 | 350          | dry grassland      | <i>M. aurelia</i> , <i>M. britomartis</i> | 1M, 0F | TK    |
| 15                             | CRO     | Velebit, Zavižan                 | 5498251 | 4961973 | 10.7.2002 | 1594         | alpine grassland   |                                           | 0M, 1F | TK    |
| 16                             | CRO     | Vugrovec, Zagreb                 | 5586762 | 5081473 | 8.6.2008  | 200          | dry grassland      | <i>M. britomartis</i>                     | 1M, 0F | TK    |
| 16                             | CRO     | Vugrovec, Zagreb                 | 5586762 | 5081473 | 24.5.2009 | 200          | dry grassland      | <i>M. britomartis</i>                     | 3M, 0F | TK    |
| 16                             | CRO     | Vugrovec, Zagreb                 | 5586762 | 5081473 | 7.6.2010  | 200          | dry grassland      | <i>M. britomartis</i>                     | 1M, 0F | TK    |
| 16                             | CRO     | Vugrovec, Zagreb                 | 5586762 | 5081473 | 8.6.2010  | 200          | dry grassland      | <i>M. britomartis</i>                     | 1M, 1F | TK    |
| 17                             | CRO     | Zagreb, Savski nasip             | 5573958 | 5071307 | 8.6.2001  | 112          | wet grassland      |                                           | 1M, 0F | TK    |
| 18                             | CRO     | Zmajevac, Baranja                | 5797019 | 5081041 | 21.7.2011 | 80           | dry grassland      |                                           | 0M, 2F | TK    |



|                                |     |                                |         |         |           |      |                      |                                           |        |      |
|--------------------------------|-----|--------------------------------|---------|---------|-----------|------|----------------------|-------------------------------------------|--------|------|
| 19                             | CRO | Žumberak, Pilatovci            | 5523549 | 5062242 | 20.6.2009 | 490  | woodland edge        |                                           | 1M, 0F | TK   |
| 20                             | SLO | Bobovek, Kranj                 | 5450705 | 5125738 | 15.5.1988 | 400  | grassland            |                                           | 0M, 3F | Jul  |
| 21                             | SLO | Šenčur, near airport Ljubljana | 5456256 | 5121139 | 21.6.1992 | 380  | grassland & shrubs   | <i>M. aurelia</i>                         | 1M, 0F | Jul  |
| 22                             | SLO | Bukovnica, Bukovniško jezero   | 5602357 | 5171252 | 31.5.1991 | 190  | cultivated grassland |                                           | 1M, 0F | Jul  |
| 23                             | SLO | Čaven                          | 5409270 | 5088045 | 4.7.1992  | 1100 | dry grassland        | <i>M. aurelia</i> , <i>M. britomartis</i> | 2M, 1F | Jul  |
| 24                             | SLO | Črna na Koroškem               | 5487586 | 5146958 | 6.6.2002  | 580  | woodland edge        | <i>M. aurelia</i>                         | 1M, 1F | TK   |
| 25                             | SLO | Grad, Goričko                  | 5582925 | 5184520 | 10.5.1992 | 270  | -                    |                                           | 2M, 0F | Jul  |
| 26                             | SLO | Strmec, Mangart, Julijske Alpe | 5393091 | 5142528 | 18.7.1992 | 960  | mountain grassland   |                                           | 0M, 1F | Jul  |
| 27                             | SLO | Kobilje, Murska Sobota         | 5605131 | 5172643 | 30.7.1993 | 190  | wet grassland        |                                           | 0M, 1F | Jul  |
| 28                             | SLO | Pševo, Kranj                   | 5447330 | 5122012 | 21.5.1972 | 500  | cultivated grassland |                                           | 0M, 1F | Jul  |
| 28                             | SLO | Pševo, Kranj                   | 5447330 | 5122012 | 18.6.1984 | 500  | cultivated grassland |                                           | 1M, 1F | Jul  |
| 29                             | SLO | Slavnik                        | 5419065 | 5045274 | 22.6.1991 | 830  | dry grassland        | <i>M. aurelia</i> , <i>M. britomartis</i> | 0M, 1F | Jul  |
| 30                             | SLO | Smrekovec                      | 5455326 | 5084255 | 15.6.2002 | 248  | -                    |                                           | 2M, 0F | TK   |
| 31                             | SLO | Stražiče, Kranj                | 5447596 | 5120616 | 1.7.1984  | 410  | -                    |                                           | 0M, 1F | Jul  |
| 32                             | SLO | Završnica                      | 5435616 | 5142011 | 20.7.1984 | 1200 | mountain grassland   | <i>M. aurelia</i>                         | 3M, 1F | Jul  |
| <b><i>Melitaea aurelia</i></b> |     |                                |         |         |           |      |                      |                                           |        |      |
| 33                             | CRO | Grabrk, Bosiljevo              | 5522898 | 5024839 | 11.6.2011 | 230  | wet grassland        |                                           | 1M, 0F | TK   |
| 34                             | CRO | Klimen, Konščina               | 5590333 | 5106635 | 11.6.2010 | 220  | wet grassland        | <i>M. britomartis</i>                     | 1M, 0F | TK   |
| 34                             | CRO | Klimen, Konščina               | 5590333 | 5106635 | 20.6.2009 | 220  | wet grassland        | <i>M. britomartis</i>                     | 1M, 0F | TK   |
| 35                             | CRO | Lomska Duliba, Velebit         | 5501560 | 4959268 | 25.6.2009 | 1292 | alpine grassland     |                                           | 1M, 0F | TK   |
| 36                             | CRO | Mali Komor, Zagorje            | 5579587 | 5106815 | 9.7.2011  | 255  | dry grassland        |                                           | 0M, 1F | TK   |
| 37                             | CRO | Novi Golubovec, Zagorje        | 5576317 | 5114684 | 12.6.2011 | 320  | dry grassland        |                                           | 1M, 1F | TK   |
| 38                             | CRO | Orišje, Bosiljevo              | 5522896 | 5029172 | 12.6.2011 | 215  | dry grassland        | <i>M. britomartis</i>                     | 1M, 0F | TK   |
| 12                             | CRO | Skoblič Brdo, Bosiljevo        | 5523865 | 5030113 | 11.6.2011 | 215  | dry grassland        | <i>M. athalia</i> , <i>M. britomartis</i> | 1M, 0F | TK   |
| 39                             | CRO | Šterna, Istra                  | 5404566 | 5030623 | 8.6.2011  | 293  | dry grassland        |                                           | 1M, 0F | TK   |
| 40                             | CRO | Varoš, Bosiljevo               | 5522522 | 5029364 | 11.6.2011 | 206  | dry grassland        |                                           | 1M, 0F | TK   |
| 14                             | CRO | Vela Traba, Pazin              | 5411485 | 5012008 | 20.6.2009 | 350  | woodland edge        | <i>M. athalia</i> , <i>M. britomartis</i> | 1M, 0F | TK   |
| 41                             | CRO | Zrmanja Vrelo, Gračac          | 5513001 | 4895146 | 2.7.2010  | 290  | -                    | <i>M. britomartis</i>                     | 0M, 1F | TK   |
| 21                             | SLO | Šenčur, near airport Ljubljana | 5456256 | 5121139 | 21.6.1992 | 380  | grassland & shrubs   | <i>M. athalia</i>                         | 0M, 1F | Jul  |
| 23                             | SLO | Čaven                          | 5409270 | 5088045 | 4.7.1992  | 1100 | dry grassland        | <i>M. athalia</i> , <i>M. britomartis</i> | 1M, 0F | Jul  |
| 24                             | SLO | Črna na Koroškem               | 5487586 | 5146958 | 15.6.2002 | 580  | dry grassland        | <i>M. athalia</i>                         | 1M, 0F | TK   |
| 42                             | SLO | Črni kal                       | 5412693 | 5045611 | 26.5.1975 | -    | dry grassland        |                                           | 1M, 0F | Jul* |
| 43                             | SLO | Dom v Dragi, Draga, Begunje    | 5439927 | 5138585 | 4.7.1993  | 800  | grassland            |                                           | 0M, 1F | Jul  |

|                                    |     |                                |         |         |           |      |                      |                                           |        |      |
|------------------------------------|-----|--------------------------------|---------|---------|-----------|------|----------------------|-------------------------------------------|--------|------|
| 44                                 | SLO | Javornik, Kranj                | 5445746 | 5121595 | 19.6.1994 | 640  | cultivated grassland |                                           | 1M, 0F | Jul  |
| 45                                 | SLO | Ambrož, Krvavec, Kamniške Alpe | 5463371 | 5126537 | 20.6.1992 | 1350 | grassland & shrubs   | <i>M. britomartis</i>                     | 1M, 0F | Jul  |
| 46                                 | SLO | Sv. Jošt, Kranj                | 5446049 | 5122185 | 3.7.1995  | 780  | grassland            |                                           | 1M, 0F | Jul  |
| 29                                 | SLO | Slavnik                        | 5419065 | 5045274 | 22.6.1991 | 830  | dry grassland        | <i>M. athalia</i> , <i>M. britomartis</i> | 2M, 0F | Jul  |
| 47                                 | SLO | Vremščica                      | 5426322 | 5060845 | 27.7.1995 | 920  | dry grassland        |                                           | 1M, 0F | Jul  |
| 48                                 | SLO | Zadvor, Ljubljana              | 5468719 | 5099919 | 11.6.2011 | 280  | woodland edge        | <i>M. britomartis</i>                     | 1M, 0F | TK   |
| 32                                 | SLO | Završnica                      | 5435616 | 5142011 | 20.7.1984 | 1200 | alpine grassland     | <i>M. athalia</i>                         | 9M, 1F | Jul  |
| <b><i>Melitaea britomartis</i></b> |     |                                |         |         |           |      |                      |                                           |        |      |
| 49                                 | BIH | Troglav, Vješić Gora           | 5629438 | 4865960 | 27.7.2011 | 1500 | alpine grassland     |                                           | 1M, 0F | TK   |
| 4                                  | CRO | Grdanjci, Samobor              | 5549483 | 5076453 | 13.6.2011 | 175  | wet grassland        | <i>M. athalia</i>                         | 1M, 0F | TK   |
| 50                                 | CRO | Hrvatska Kostajnica            | 5618449 | 5009397 | 19.6.2011 | 110  | dry grassland        |                                           | 1M, 0F | TK   |
| 51                                 | CRO | Jovac, Hrvatska Kostajnica     | 5616039 | 5004984 | 18.6.2011 | 235  | wet grassland        |                                           | 1M, 0F | TK   |
| 34                                 | CRO | Klimen, Konščina               | 5590333 | 5106635 | 11.6.2011 | 220  | wet grassland        | <i>M. aurelia</i>                         | 1M, 0F | TK   |
| 38                                 | CRO | Orišje, Bosiljevo              | 5522896 | 5029172 | 12.6.2011 | 215  | dry grassland        | <i>M. aurelia</i>                         | 1M, 0F | TK   |
| 52                                 | CRO | Pažurovec, Zagorje             | 5591436 | 5110791 | 9.7.2011  | 220  | dry grassland        |                                           | 0M, 1F | TK   |
| 9                                  | CRO | Platak, Planinarski dom        | 5466155 | 5031809 | 15.6.2002 | 1090 | mountain grassland   | <i>M. athalia</i>                         | 1M, 0F | TK   |
| 9                                  | CRO | Platak, Planinarski dom        | 5466155 | 5031809 | 27.6.2002 | 1090 | mountain grassland   | <i>M. athalia</i>                         | 1M, 0F | TK   |
| 53                                 | CRO | Podrute, Novi Marof            | 5596886 | 5113393 | 10.7.2011 | 280  | woodland edge        |                                           | 1M, 0F | TK   |
| 54                                 | CRO | Radoboj, Malogorski            | 5571673 | 5114812 | 12.6.2011 | 245  | dry grassland        |                                           | 1M, 0F | TK   |
| 55                                 | CRO | Rupa, Rijeka                   | 5443502 | 5038328 | 7.6.1982  | 500  | dry grassland        |                                           | 1M, 0F | Jul* |
| 12                                 | CRO | Skoblić Brdo, Bosiljevo        | 5523865 | 5030113 | 11.6.2011 | 215  | dry grassland        | <i>M. athalia</i> , <i>M. aurelia</i>     | 2M, 0F | TK   |
| 13                                 | CRO | Šenkovec, Čakovec              | 5609093 | 5142392 | 30.7.2011 | 175  | wet grassland        | <i>M. athalia</i>                         | 1M, 0F | TK   |
| 14                                 | CRO | Vela Traba, Pazin              | 5411485 | 5012008 | 8.6.2008  | 350  | dry grassland        | <i>M. athalia</i> , <i>M. aurelia</i>     | 1M, 0F | TK   |
| 16                                 | CRO | Vugrovec, Zagreb               | 5586762 | 5081473 | 24.5.2010 | 200  | dry grassland        | <i>M. athalia</i>                         | 1M, 0F | TK   |
| 41                                 | CRO | Zrmanja Vrelo, Gračac          | 5585027 | 4895475 | 2.7.2010  | 290  | wet grassland        | <i>M. aurelia</i>                         | 1M, 0F | TK   |
| 23                                 | SLO | Čaven                          | 5409270 | 5088045 | 19.6.1978 | 800  | dry grassland        | <i>M. athalia</i> , <i>M. aurelia</i>     | 1M, 0F | Jul* |
| 23                                 | SLO | Čaven                          | 5409270 | 5088045 | 28.6.1982 | 600  | dry grassland        | <i>M. athalia</i> , <i>M. aurelia</i>     | 0M, 1F | Jul* |
| 45                                 | SLO | Ambrož, Krvavec, Kamniške Alpe | 5463371 | 5126537 | 20.6.1992 | 1350 | grassland & shrubs   | <i>M. aurelia</i>                         | 0M, 1F | Jul  |
| 29                                 | SLO | Slavnik                        | 5419065 | 5045274 | 22.6.1991 | 830  | dry grassland        | <i>M. athalia</i> , <i>M. aurelia</i>     | 3M, 1F | Jul  |
| 29                                 | SLO | Slavnik                        | 5419065 | 5045274 | 16.6.1969 | 800  | dry grassland        | <i>M. athalia</i> , <i>M. aurelia</i>     | 1M, 0F | Jul* |
| 56                                 | SLO | Veščica, Ormož                 | 5597409 | 5153326 | 10.5.1992 | 190  | wet grassland        |                                           | 1M, 0F | Jul  |
| 48                                 | SLO | Zadvor, Ljubljana              | 5468719 | 5099919 | 11.6.2011 | 280  | woodland edge        | <i>M. aurelia</i>                         | 1M, 0F | TK   |