Notes on the lifecycle of Melitaea arduinna (ESPER, 1783) (“Freyer’s Fritillary”) (Lepidoptera: Nymphalidae) with further records from SE Serbia

Martin Gascoigne-Pees, Rudi Verovnik, Colin Wiskin, Christopher Luckens and Milan Đurić

Abstract: Melitaea arduinna (ESPER, 1783) (“Freyer’s Fritillary”) was long considered as extremely rare and local at the western edge of its distribution in the Balkan Peninsula. It was only recently discovered in Serbia, where it is now reported from several localities. Although its life cycle has previously been described, there is no published photographic account of larval development. We provide additional records for the species in SE Serbia and present images of life cycle development from post-hibernating larva to adult. In Serbia larvae were found feeding on Centaurea phrygia, but in captivity larvae accept a wide variety of Centaurea species (Asteraceae).

Anmerkungen zum Lebenszyklus von Melitaea arduinna (ESPER, 1783) (Lepidoptera: Nymphalidae) mit neuen Nachweisen aus Südostserbien


Introduction

The lifecycle of Melitaea arduinna (ESPER, 1783) (“Freyer’s Fritillary”) was first described by Wiltshire (1952) who cites Centaurea beken L. (Asteraceae) as the larval host plant. Centaurea nemecii Náb. is mentioned as a potential host plant in Turkey (Hesselbarth et al. 1995). There is also a brief description of the lifecycle in the Collins field guide by Tolman & Lewington (2008) indicating the possible utilization of Centaurea graeca Griseb. as a host plant. Ova are laid in large batches on the undersides of the leaves of the host plant. The post-hibernating larvae resemble Euphydryas aurinia (Rottemburg, 1775) and the adult larvae bear a superficial resemblance to those of Melitaea phoebe occitanica (Staudinger, 1871) (all Nymphalidae).

The range of Melitaea arduinna is extensive, covering parts of the Balkan Peninsula, Turkey, Iran, eastern Ukraine, southern Russia and extends towards central Asia (Tshikolovets 2003, Tolman & Lewington 2008). In the Balkan Peninsula it is known from northern Greece (Pamperis 2009), several localities in the Republic of Macedonia (Schäfer & Jaščić 1989, Verovnik et al. 2010), Bulgaria (Abadjiev 2001) and Romania (Székely 2008). It was only recently discovered in the eastern part of Serbia (Jaščić & Grozdanović 2007) in proximity to the most westerly locality in Bulgaria at Vrška Čuka (Abadjiev 2001). In the last three years extensive surveys of this region were carried out and the species is now reported from twenty sites extending from Mt. Deli Jovani near Bor in the north to Mt. Suva Planina (Popović & Đurić 2010) in the south (see map, Fig. 1).

The habitat of the species in Serbia is defined as mesophphilous meadows in beech or oak woods (Jaščić & Grozdanović 2007) or as sheltered woodland clearings and humid gorges (Popović & Đurić 2010). Its habitat at Jelašnica (Đurić et al. 2010) is a thermophilous limestone gorge. Dry calcareous gullies with steppe character are also considered to be a preferable habitat of the species in Romania (Székely 2008).

During 2010 and 2011 the authors visited the region of Stara Planina on several occasions with the aim of obtaining egg batches of this poorly known species for rearing. The objective of the study is to provide an account of the species’ life cycle, a description of its habitat, and show and describe variability in adult’s wing markings. We also add new records that indicate that the western fringes of the Stara Planina Mts. are one of the strongholds for this species in Serbia and the Balkan Peninsula.

Field observations

Two authors (RV & MD) visited the Stara Planina region in early 2010. Adults of M. arduinna were found at several sites and in various habitats ranging from overgrown dry grassland to mountainous humid meadows. Adults were seen nectaring on Danewort (Sabuccus ebulus L.) on a road verge at the edge of Kalna town in a seemingly unsuitable habitat composed mainly of regularly mowed and fertilised meadows.

Three of the authors (MG-P, CW, CL) accompanied by Duncan Trew and Charles Derry visited the Stara Planina region of SE Serbia between April 30. 2010 and 7. 2011. Larval webs of M. arduinna were found in several localities. The first web was discovered on 1. 2010 in damp conditions on an un-improved but heavily grazed, NE facing hillside, approximately 1.5 km northwest of Cernova (Fig. 2). This small web was very close to the ground.
Fig. 1: Distribution of *Melitaea arduinna* in Serbia. Red dots represent new records; white squares denote published records up until 2011. — *M. arduinna* from Serbia, Stara Planina region.

Fig. 2: Habitat 1.5 km NW Cerova, Serbia, 1. v. 2011.

Fig. 3: Larva, 9 mm in length, 9. v. 2011.

Fig. 4: Post-hibernating larvae, 3. v. 2011.

Fig. 5: Habitat 7 km S Kalna, Serbia, 7. v. 2011.

Figs. 6–7: *Centaurea phrygia*, larval host plant.

Fig. 8: Adult ♀ ovipositing on *Centaurea phrygia*, 18. vi. 2011.

Figs. 9–10: Ova batch laid on *Centaurea phrygia*, 20. vi. 2011.

Figs. 11–12: Larval webs on *Centaurea phrygia*, 3. v. 2011.

Fig. 13: Larva, 17 mm in length, 9. v. 2011.

Fig. 14: Larva, 30 mm in length, 12. v. 2011.


Fig. 17: Adult ♂ inflating its wings, 31. v. 2011.
The larvae were only just emerging from hibernation and judging by their size were in their 3rd instar. Fresh frass was observed beneath the new leaves of what appeared to be a species of *Centaurea*. The larvae were black with small grey speckles covering each segment, resembling post-hibernating larvae of *E. aurinia* (Fig. 3). Further webs were found within a 200-m radius. The larvae from several of these webs were small and massed together while those from other webs, particularly lower down the hillside, were larger. Some of the latter were found dispersed on grass stems as well as on their suspected food plant on which there was clear evidence of active feeding (Fig. 4).

On 2. v. six small larvae were found on the Stara Planina at the Golema Bridge, just above Crni Vrh, at altitude ca. 860 m. On 3. v. further webs were discovered in a damp meadow 7 km south of Kalna (Fig. 5).
vegetation here was more advanced. By the road verge several dried-up specimens of a Centaurea species, presumably the previous year’s growth, were discovered and photographed. Despite the wet conditions the larvae were very conspicuous and had a tendency to either congregate around their host plant (mostly within a silken web) or sit motionless on leaves of a Centaurea spp. They were exposed to the elements and predation, and if disturbed dropped to the ground. Some of the larvae were in an advanced instar. They had retained their black heads and bodies but they had developed a prominent lateral orange band and in appearance were similar to the larvae of M. phoebe occitania. The site was revisited on 7. v. Despite sunnier, warmer conditions larvae were far less active and many had disappeared into their webs or into the undergrowth.

MG-P accompanied by Christopher Orpin revisited the Stara Planina region in early vii. 2011. Adults of M. arduinna were seen at various altitudes in the Babin Zub area from 500–1240 m. On 4. vii. a pair was observed in copula at an altitude of 505 m near the village of Mez­dreja.

Author Md, accompanied by M. Popović and F. Franeta, visited Mt. Stol on 21. v. 2011 and found larvae in various instars, including some still in silken webs, at an altitude of 850 m. On 4. vi. they explored virtually unexplored territory in the very south of Serbia and in dry rocky terrain encountered two fresh ♂♂ of M. arduinna. This finding significantly increases the known distribution of the species within Serbia further southward.

**Rearing report**

Larvae were kept in plastic boxes and in netted pots containing various species of Centaurea. Confined to plastic boxes they readily accepted C. phrygia, C. montana L., C. scabiosa L. and C. nigra L. Larvae kept in netted pots thrived on growing plants of C. phrygia and C. montana. With additional warmth and an artificially-increased daylength they grew rapidly in size and by 12. v. the first larva had pupated. Larval feeding was mainly nocturnal. They showed very little basking behaviour. Mortality rate was very low.

**Pairings**

All the eggs proved to be infertile, indicating that all pairings were unsuccessful. MG-P released several ♂♂ and ♀♀ into a large flight cage containing plants of C. phrygia and cut flowers of nectar-rich plants. The flight cage was sited in various positions ranging from sunlit to shady situations. Although pairings were not observed, many egg batches were laid on the underside leaves of C. phrygia (Fig. 8). None of the eggs from any of the batches hatched. CW reports that egg-laying posturing was seen on 7–10 occasions in low light conditions with temperatures ranging between 25–35°C, but in full sunlight butterflies were noticeably inactive. Several egg batches of between 20–200 ova were laid on leaves of C. nigra and these all proved to be infertile. CL prepared two pots were both containing nectar-rich flowers and transplanted C. phrygia plants. Two 3–4 day old ♂♂ were introduced into each pot (the first 2 ♂♂ on 17. vi., the second on 19. vi.) and were allowed at least 24 h to settle in before a single fresh ♀ was introduced into each pot. All were very active but no pairings were observed.

**Table 1: New records for Melitaea arduinna in SE Serbia.**

<table>
<thead>
<tr>
<th>Date</th>
<th>Location</th>
<th>Lat.</th>
<th>Long.</th>
<th>Stage</th>
<th>Approx. altitude</th>
<th>Observed by</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. vii. 2010</td>
<td>Stara Planina, Golema Reka</td>
<td>43°23.72′</td>
<td>22°36.29′</td>
<td>adult</td>
<td>1010 m</td>
<td>RV, MD</td>
</tr>
<tr>
<td>3. vii. 2010</td>
<td>Kalna, N edge of the town</td>
<td>43°24.70′</td>
<td>22°25.61′</td>
<td>adult</td>
<td>360 m</td>
<td>RV</td>
</tr>
<tr>
<td>4. vii. 2010</td>
<td>S of Kalna, Bigar Waterfall</td>
<td>43°21.29′</td>
<td>22°26.00′</td>
<td>adult</td>
<td>460 m</td>
<td>RV, MD</td>
</tr>
<tr>
<td>1. v. 2011</td>
<td>1.5 km NW of Cerova</td>
<td>43°19.17′</td>
<td>22°28.67′</td>
<td>larva</td>
<td>650 m</td>
<td>MG-P, CW, CL, C. Derry, D. Trew</td>
</tr>
<tr>
<td>2. v. 2011</td>
<td>Golema Bridge (above Crni Vrh), Stara Planina</td>
<td>43°24.29′</td>
<td>22°35.58′</td>
<td>larva</td>
<td>860 m</td>
<td>CL, C. Derry</td>
</tr>
<tr>
<td>3. v. 2011</td>
<td>7 km south of Kalna</td>
<td>43°21.00′</td>
<td>22°27.14′</td>
<td>larva</td>
<td>485 m</td>
<td>MG-P, CW, CL, C. Derry, D. Trew</td>
</tr>
<tr>
<td>21. v. 2011</td>
<td>Stol</td>
<td>44°10.37′</td>
<td>22°47.42′</td>
<td>larva</td>
<td>847 m</td>
<td>MD, M. Popović, F. Franeta</td>
</tr>
<tr>
<td>4. vii. 2011</td>
<td>Preševo valley, Miratovac</td>
<td>42°16.33′</td>
<td>21°39.03′</td>
<td>adult</td>
<td>550 m</td>
<td>MD, M. Popović</td>
</tr>
<tr>
<td>8. vii. 2011</td>
<td>Miljkovačka klisura</td>
<td>43°25.53′</td>
<td>21°51.94′</td>
<td>adult</td>
<td>353 m</td>
<td>M. Popović</td>
</tr>
<tr>
<td>8. vii. 2011</td>
<td>Vratarnica</td>
<td>43°39.08′</td>
<td>22°48.00′</td>
<td>adult</td>
<td>674 m</td>
<td>D. Stojanović</td>
</tr>
<tr>
<td>19. vii. 2011</td>
<td>Babušnica</td>
<td>43°48.86′</td>
<td>22°24.28′</td>
<td>adult</td>
<td>790 m</td>
<td>F. Franeta</td>
</tr>
<tr>
<td>13. vii. 2011</td>
<td>Golema Reka</td>
<td>43°24.37′</td>
<td>22°35.05′</td>
<td>adult</td>
<td>790 m</td>
<td>F. Franeta</td>
</tr>
<tr>
<td>15. vii. 2011</td>
<td>Ružičić</td>
<td>43°10.34′</td>
<td>22°46.68′</td>
<td>adult</td>
<td>673 m</td>
<td>MD, M. Popović</td>
</tr>
<tr>
<td>19. vii. 2011</td>
<td>Ravno Bučeje</td>
<td>43°26.20′</td>
<td>22°33.68′</td>
<td>adult</td>
<td>797 m</td>
<td>MD, M. Popović, F. Franeta</td>
</tr>
<tr>
<td>20. vii. 2011</td>
<td>Ružičić</td>
<td>43°23.08′</td>
<td>22°19.97′</td>
<td>adult</td>
<td>685 m</td>
<td>MD, M. Popović</td>
</tr>
<tr>
<td>25. vii. 2011</td>
<td>Kalna</td>
<td>43°23.61′</td>
<td>22°23.15′</td>
<td>adult</td>
<td>474 m</td>
<td>F. Franeta</td>
</tr>
<tr>
<td>2. vii. 2011</td>
<td>Stara Planina</td>
<td>43°23.15′</td>
<td>22°35.05′</td>
<td>adult</td>
<td>1240 m</td>
<td>MG-P, C. Orpin</td>
</tr>
<tr>
<td>3. vii. 2011</td>
<td>2.9 km west of Jalovik Izvor, 5 km NW of Kalna</td>
<td>43°23.84′</td>
<td>22°22.05′</td>
<td>adult</td>
<td>555 m</td>
<td>MG-P, C. Orpin</td>
</tr>
<tr>
<td>4. vii. 2011</td>
<td>Stara Planina, Mezдреja</td>
<td>43°24.20′</td>
<td>22°31.30′</td>
<td>adult</td>
<td>505 m</td>
<td>MG-P, C. Orpin</td>
</tr>
<tr>
<td>5. vii. 2011</td>
<td>Rtanj, Jezero</td>
<td>43°34.08′</td>
<td>21°54.17′</td>
<td>adult</td>
<td>816 m</td>
<td>M. Popović</td>
</tr>
</tbody>
</table>
All four ♂♂ died by 23. vi. and both ♀♀ had expired by 26. vi. A few ova were observed spattered on the upper surface of a *Centaurea* leaf by the first ♀ but failed either to change colour or to hatch.

**Ovum**

Most of the ova were laid in large batches containing several hundred eggs but some batches were smaller and strung out and a few eggs were laid individually (Fig. 9). The ovum is yellow/green in colour, barrel-shaped, with vertical keels and a typical nymphalid depression at the apex (Fig. 10). After 5 weeks, and despite few eggs collapsing, it became apparent that all the ova were infertile.

**Larva**

In appearance post-hibernating larvae bear a close resemblance to *E. aurinia* larvae at the same stage of their development. Their web structuring and larval behaviour is also similar (Figs. 11–12). They have black heads and each body segment is covered in an irregular pattern of grey speckles (Figs. 3–4, 13). On average adult larvae grow to 30 mm in length prior to pupation. Their heads and bodies are black. Each segment is speckled grey and contains a white-ringed spiracle. The thoracic legs, prolegs, tubercles and spines are black. In advanced instars the most obvious development is the wide lateral orange band. On and below this band the tubercles are pale orange in colour (Fig. 14). Final instar larvae are similar to those of *Melitaea phoebe occitanica* and *Melitaea aetherie* (Hübner, 1826). In comparison to *M. arduinna*, larvae of *M. phoebe occitanica* usually have a narrower orange band and paler (often white) tubercles.

**Pupa**

A majority of the pupae were suspended by silken pads from the netting at the top of the cage. Compared to other European *Melitaea* species, the pupae of *M. arduinna* bear the closest resemblance to those of *Melitaea cinxia* (Linnaeus, 1758) (Figs. 15–16). By contrast, *M. cinxia* pupae are generally paler, the evolving wing pattern is clearly visible through the pupal casing (not evident in *M. arduinna*), and the dark spots on each segment contrast with their paler ground colour (all markings muted in *M. arduinna*). On average pupae took 10–14 days to hatch but some took as long as 17 days.

**Adults**

There was surprisingly very little mortality. As most of the larvae we collected were found exposed to all the elements, it was assumed that there would be a high rate of parasitism. However, none of the larvae that pupated produced a parasite. The first ♂♂ emerged on 28. vi. (Fig. 17; see also Figs. 18–19), the first ♀♀ on 6. vi. (Figs. 20–21). Male forewing measurements (basis to apex) range from 20 mm to 24 mm with an average of 22.45 mm ± 0.83 mm s.d., female forewing measurements vary from 22 mm to 27 mm with an average of 25.01 mm ± 1.10 mm. There is variation in colour and markings in both sexes (Figs. 22–25). Females are extremely variable, with larger darker forms hatching at the end of the brood (Fig. 25).

We found that specimens of *M. arduinna* from Serbia are on average smaller than those from northern Greece. Specimens measured from Florina have male wing measurements ranging from 22–25 mm with an average of 23.38 mm ± 0.82 mm while females vary from 24.5–27 mm with an average of 26.08 mm ± 0.90 mm.

**Food plant**

The premature growth of the host plant discovered in Serbia resembled *Centaurea nigra* but as it grew in size it was evident that it was a different species (Figs. 6–7). Close-up photos of the leaf, stem and flower were sent to Božo Frajman (botanist and assistant professor at the Institute of Botany, University of Innsbruck, Austria) to be identified. He in turn passed on these images to his Serbian colleague Marjan Niketić (botanist and senior curator at Natural History Museum, Belgrade) who identified the species as *Centaurea phrygia*.

**Conclusions**

*Melitaea arduinna* was only recently discovered in Serbia and was considered extremely rare (Jakšić & Grozdanović 2007). Recent faunistic studies in eastern Serbia have provided many additional records and the species appears to be much more widespread than previously thought. This is certainly the case for the wider surroundings of Stara Planina where *M. arduinna* was found at almost all surveyed sites. The record from the Preševo valley indicates an even wider distribution of the species in Serbia. Although nothing is specifically known about their dispersal, when it comes to habitat requirements *M. arduinna* appears to be far less selective than previously thought (Jakšić & Grozdanović 2007, Székely 2008, Popović & Đurić 2010). Their presence in areas dominated by ‘improved’ meadows is particularly significant.

Larval webs were found to be widespread and in several areas in the Stara Planina area numerous. Larvae were discovered concurrently in various stages of development. They appeared inactive by day feeding mainly at night. Post-hibernating larvae massed together in large larval webs dispersing from their webs as they reached maturity. In the wild, larvae were only discovered on *C. phrygia* but in captivity accepted other species of *Centaurea*.

**Acknowledgements**

To Duncan Trew (Buckinghamshire, U.K.) and Charles Derry (Shropshire, U.K) for their assistance with field observations. To Božo Frajman and Marjan Niketić for helping to identify the host plant *Centaurea phrygia*. To Filip Franeta, Miloš Popović and Dejan Stojanović for providing additional unpublished field observations.
References


In 2008 the senior author reported Ochus subvittatus (Moore, 1878) (Hesperiidae) as new for Peninsular Thailand, where he found a big population of the “Tiger Hopper” near the village Khiriwong (Aste

Fig. 1: Ochus subvittatus (Moore, 1878) auf Wedelia biflora (Asteraceae); 21. vii. 2011, Ton Pring Valley, Ban Lam Kaen, Amphoe Thai Muang, Phang Nga Province, S-Thailand.


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A further note on Ochus subvittatus (MOORE, 1878) from South Thailand (Lepidoptera: Hesperidae)

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In 2008 the senior author reported Ochus subvittatus (Moore, 1878) (Hesperiidae) as new for Peninsular Thailand, where he found a big population of the “Tiger Hopper” near the village of Khiriwong in the southern part of the Khao Luang Mountain Range (Nakhon Si Thammarat Province).

In 2011 the authors observed this small butterfly at several opportunities near Ban Lam Kaen in the lower Ton Pring Valley (Khao Lak, Phang Nga Province, Amphoe Thai Muang) from the west coast of the Thai Peninsula at an elevation of about 25–30 m (8° 36′50″–31″ N, 98° 14′42″,54″ E).

Between 11. vii. and 21. vii. 2011 the skippers could be seen on the wing in open country around secondary growth, visiting flowers (mainly Asteraceae) or settling on leaves of grasses and low growing herbs. Usually they occurred at about 10:30 h and were on the wing until 13:00–13:30 h, when the butterflies slowly disappeared.

The population of Ochus subvittatus (Moore, 1878) is by far not so plentiful in Khao Lak as in Khiriwong and we presume that, while still spreading, small populations are going to be established at suitable places on the way southwards.

We hope to get more information about the butterfly during this year.

References


