Muschampia cribrellum (Eversmann, 1841) — preimaginal stages and their ecology in W-Bulgaria (Lepidoptera: Hesperiidae)

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Abstract: Some 40 eggs and 15 larvae (L_1–L_2) of *Muschampia cribrellum* (Eversmann, 1841) have been found on *Fragaria viridis* (Duchesne) Weston. (Rosaceae) in steppe grasslands in W-Bulgaria (Sofia district) in early June 2018. The eggs, larvae and pupae are described and figured for the first time and some details of their ecology are revealed.

***Muschampia cribrellum* (Eversmann, 1841) — Präimaginalstadien und ihre Ökologie in W-Bulgarien (Lepidoptera: Hesperiidae)**

Zusammenfassung: Anfang Juni 2018 wurden in W-Bulgarien (Oblast Sofia) gegen 40 Eier und 15 Jungraupen (L_1–L_2) von *Muschampia cribrellum* (Eversmann, 1841) in Steppenrasen an *Fragaria viridis* (Duchesne) Weston (Rosaceae) gefunden. Die Eier, Raupen und Puppen werden beschrieben und zum ersten Mal abgebildet.

Introduction

Muschampia cribrellum (Eversmann, 1841) (Fig. 1) is a typical species of the Eurasian steppe belt with main distribution between the Ukraine and European Russia in the West and the Amur river, Mongolia and N-China in the East (Tshikolovets 2011). Further to the West (in SE-Europe) the range of this species has until recently been considered extremely disjunct, with only a few and small populations known in the Republic of North Macedonia, in E-Hungary and Romania (e.g. Tolman & Lewington 1998). Kolev (2003) reports the first records (individuals in collection) from E-Bulgaria. Since then, the species has proved to be a bit more widespread in the Balkans with numerous records in E-Serbia and Bulgaria (especially Sofia district) (Dincă et al. 2010, Hoejgaard & Beshkov 2011, Popović & Đurić 2014, Langourov 2019, Kolev, unpublished) and also Greece (Davkov & Mérit 2017).

Presently, the greatest enigma concerning this species remains its larval hostplant and the larval ecology, which have remained largely unknown up to now, though there is a very brief (only 4 lines) old note (Rothschild 1914) from the southern Urals. There, larvae had reputedly been found by Hermann Rangnow on *Potentilla* (Rosaceae) and the larva has been described merely as "indistinguishable from that of *H.* [= *Pyrgus*] *carthami*". This is the only available primary source of a hostplant. All later authors may refer to this short note or suppose *Potentilla* because of this note and/or an assessment of the habitat (e.g. Davkov & Mérit 2017). Others (e.g. Lepiforum 2019) doubt these indications and presume that the larva is more likely to occur on *Phlomis* species (Lamiaceae) as it is the case with all known congeners. According to the observations of S. A. Andreev (in [Tikhonov et al.] 2019) in the Volga region, the caterpillars reputedly develop on *Marrubium* sp. However, no illustrations of the development cycle are provided.

In 2017 Stoyan Beshkov and the first author conducted a short trip to Belasica mountains in SW-Bulgaria in search of larvae of *Hadena drenowskii* (Rebel, 1930) (Wagner & Beshkov 2018). During that trip Beshkov told the first author about records of *M. cribrellum* near Dragoman in W-Bulgaria. Thus, preliminary plans began to form for examining these populations in the following year 2018. Stoyan Beshkov could not join the trip, but in the meanwhile the first author had established contact with the second author and the main explorer of the Bulgarian sites of *M. cribrellum*. He kindly introduced some of the best habitats on 3. vi. 2018 and — lucky enough — the first author observed an oviposition within minutes. From this moment on, searching for eggs and larvae was quite easy.

Material and methods

Between 3. and 8. vi. 2018 some 40 eggs and 15 larvae in the first and second instar were found on *Fragaria viridis* in the field. One oviposition has been observed near Gubesh (1040 m), the other eggs and larvae southeast of Buchin prohod (800 m, both W-Bulgaria, Sofia district, southwestern foothills of the Balkan, also known as Stara Planina, mountain range).

Some 20 eggs and 5 L_1 larvae were reared outdoors in Germany on potted *Fragaria*. In early February 2019 one pot with 5 larvae was transferred to a sunny window indoors to accelerate development. The other pots rested outdoors.

A few larvae have been also successfully reared on potted *Potentilla neumanniana* Rchb.

Results and discussion

Egg

The egg (Figs. 3–4) is a typical *Muschampia* egg of creamy colour with heavy relief consisting of irregular longitudinal ridges. Usually 8 of these ridges reach the apex, others convergate or end blind. These ridges show an irregular surface with ups and downs.

Between these longitudinal ridges a dense net of ± parallel transversal, more regularly elevated junctions are visible. Thus the eggs are easily separated from syntopical *Pyrgus* species.

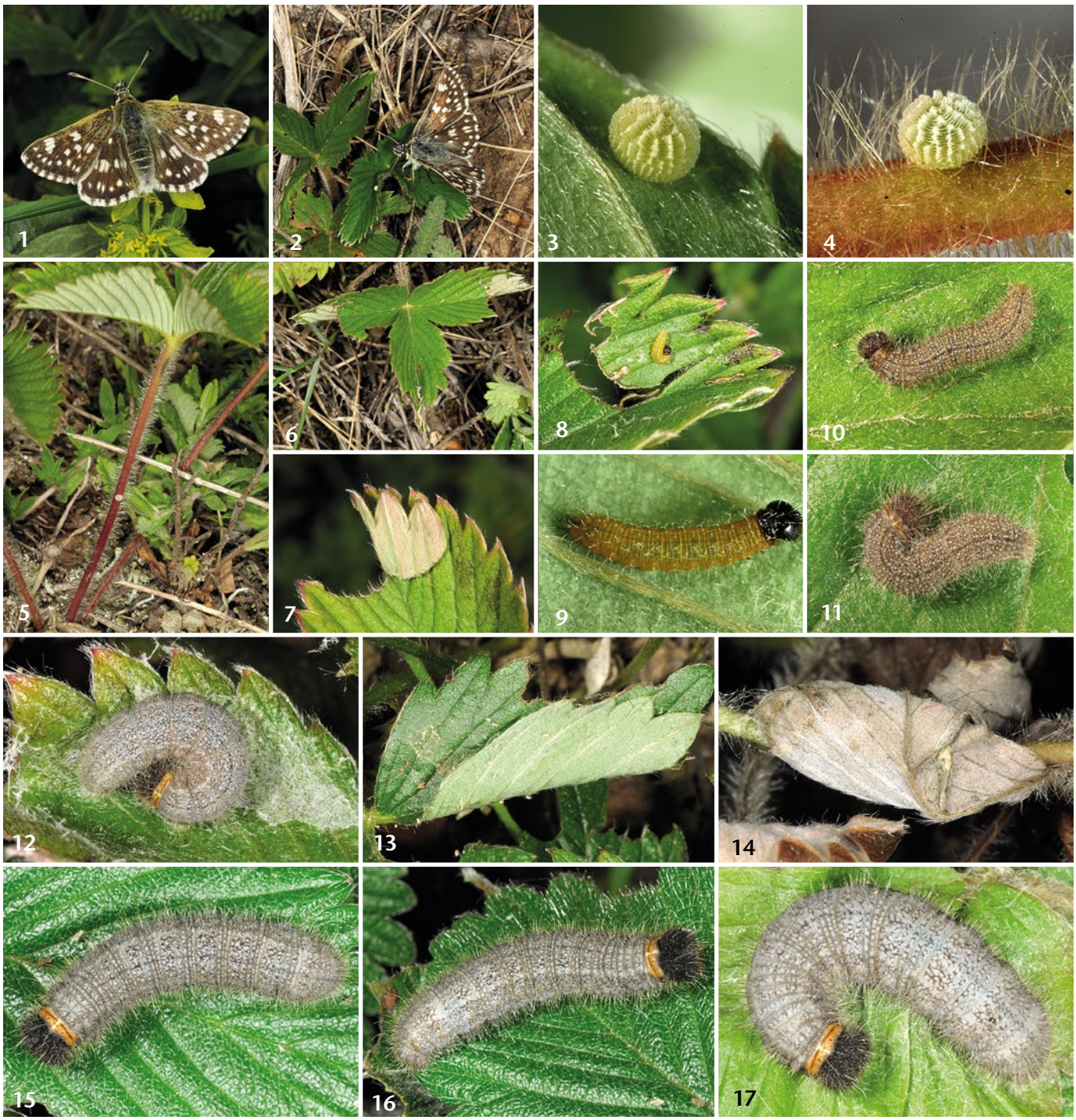

Plate 1: *Muschampia cribrellum,* biological observations. *Muschampia cribrellum* from W-Bulgaria, Sofia district, all from Buchin prohod if not indicated differently, early June 2018. **Figs. 9–23:** rearing in captivity. — **Fig. 1:** Female (Gubesh, 3. VI. 2018). **Fig. 2:** Oviposition (Gubesh, 3. VI. 2018). **Fig. 3–5:** Eggs. **Fig. 3:** On lower side of a leaflet, **Fig. 4:** on the leaf stalk, **Fig. 5:** total view of an egg on the leaf stalk. **Fig. 6:** Two shelters of L_1-larvae in the field (right and left leaflet) and a L_1-shelter of *Pyrgus malvae* (lower leaflet) on the same leaf of *Fragaria viridis*, 8. VI. 2018. **Fig. 7:** Shelter of L_1-larva, 4. VI. 2018. **Fig. 8:** Opened shelter with L_1-Larva, 8. VI. 2018. **Fig. 9:** L_1 larva details. **Fig. 10:** L_2-larva, 28. VI. 2018. **Fig. 11:** L_3-larva, 5. VII. 2018. **Fig. 12:** L_4-larva, 17. IX. 2018. **Fig. 13:** Typical shelter in L_3 and L_4. **Fig. 14:** Winter shelter of L_4 larva. **Figs. 15–21:** Larva in last instar; **Figs. 15–17:** habitus.

Larva

On hatching the L_1 larva (Figs. 8–9) is yellowish with black head capsule, black thoracal shield and an anal shield with quite narrow central, black, sclerotized stripe. The body shows whitish hairs which are bifurcate and bent backward distally. These bifurcate hairs distinguish the larva clearly from *Pyrgus* in this instar.

In the second instar (Fig. 10) the larva becomes brownish with many creamy spots and a dark dorsal line. The head capsule is black and the hairs light. Thoracical and anal shields are inconspicuous orange-brown, the spiracula brownish.

In L_3 (fig. 11) there are no larger differences compared to L_2.

In the penultimate (Fig. 12) and especially the last instar (Figs. 15–17) the larva brightens up significantly. The creamy spots increase so that the former brown ground colour and the dark dorsal line become masked and are only partially visible. Moreover, this creamy colour forms light subdorsal lines.

Plate 12, Figs. 18–21: Larva in last instar, details. **Fig. 18:** Detail dorsal with pinacula. **Fig. 19:** Detail lateral with pinacula and spiracles. **Fig. 20:** Feces expulsor. **Fig. 21:** Head with mandibles in defense position. **Figs. 22–23:** Pupa. — **Figs. 24–27:** Larval habitat with *Fragaria viridis*. **Fig. 24:** In a low-growing steppe grassland with *Festuca* sp. (Poaceae) and *Teucrium chamaedrys* L. (Lamiaceae). **Fig. 25:** On a shallow rock in steppe grassland. **Figs. 26–27:** Total view of larval habitats, **27:** Gubesh, 3. VI. 2018, the other Figs. 4. VI. 2018, Buchin prohod. — All photos by the first author.

The thoracical shield is bright orange with white interruption where the dorsal line runs and only a very narrow blackish transversal line and a few dark spots. The spiracula are as well orange (Fig. 19).

Additionally to the creamy spots (insertion of light setae) there are also small gray or brown, stronger sclerotized pinacula (Figs. 18–19): on an abdominal segment two dorsal ones (at each side one) and usually 4 lateral ones (2 at each side: one above and one below the spiracle).

The mandibles are conspicuous red-brown with black margins and teeth (Fig. 21).

By the orange thoracical shield (and other, more subtle characters) the larvae are easily separated from those of *Pyrgus carthami* (Hübner, 1813) (black thoracical shield).

The expulsor (to shoot away droppings, Fig. 20) is distally rounded with about 9 strong distal teeth and additionally a few basal teeth.

Pupa

The pupa (Figs. 22–23) is a typical Pyrginae pupa with very dense pruinose surface which masks the dark ground colour of the pupa. Dark elements are especially visible bordering the wing sheaths, as a dorso-median line on the thorax, around the spiracles, in the head region, intersegmental and on the cremaster. The cremaster hooks are orange-brown.

Especially on the dorsal side there are additionally many but small darkish dots.

The pupa rests within a shelter between leaves which is constructed with strong, partly reticular filaments.

Hostplants and larval habitat

All eggs and larvae have been observed on *Fragaria viridis* in open, sunny and moderately intense grazed, steppe-like and large-scale grasslands (Figs. 24–27). The highest concentrations were recorded on sparsely vegetated ground, e.g. on the border to shallow rocks. These grasslands trace back to transhumance and are depending on future grazing and ongoing roll back of shrubs and trees.

In the habitats also several *Potentilla* species, especially *Potentilla cinerea* Vill., but also occasionally e.g. *P. recta* L. and *P. argentea* L., occurred. These *Potentilla* had been searched in vain for about 3 hours. This search produced many eggs and larvae of *Pyrgus malvae* (Linnaeus, 1758) as well as eggs of *P. carthami*, a quite common species in these sites – but not a single *Muschampia* egg. Thus it is very probable that *Fragaria viridis* is at least the main hostplant of the population of the western Balkan mountains. *Potentilla neumanniana* has been accepted in rearing. Thus (and due to the close relationship between *Potentilla* and *Fragaria*) it is probable that *Potentilla* may be a hostplant in other sites (e.g. on Mount Olympus in Greece, as hypothesized by Davkov & Mérit 2017).

Fragaria viridis is a species that has its main occurrence in steppe-like grasslands and dry edges from Central Europe mainly across the steppe belt in S-Russia and adjacent regions to Mongolia, and thus shows a large overlap with the distribution of *M. cribrellum*. The range of the insect in as usual smaller than that of the plant.

But there should be more field examinations also in other parts of the range in order to verify *F. viridis* as the main hostplant of the species there, too.

As far as the hostplant is concerned, the note of Rotschild (2014) could be true and refer to *M. cribrellum*. But the characterization of the larva still raises the question whether it has been confused with that of *P. carthami*. As clearly demonstrated above, the larvae of both species can be separated quite easily.

The reputed record on *Marrubium* ([Tikhonov et al.] 2019) most probably refers to another Pyrginae species, e.g. *Carcharodus* sp.

Life cycle

In W-Bulgaria the imagines occur between mid-May and June in about 700–1100 m. In 2018 (with a hot month of May) the flight time was already largely finished by early June. Most of the about 10 recorded adults were quite worn, except for two females. At higher altitudes (Mount Olympus at 2300 m, Davkov & Mérit 2017) the flight time is, as should be expected, much later – i.e. mainly in July.

Oviposition takes place in two different ways: Either the female rests on the margin of the upper side of a leaf and bends the abdomen to oviposit on the lower side of the leaf (Fig. 2) – very rarely also on the upper side – or the egg is deposited on the leaf stalk (petiole). The latter case was more common (about two thirds of all recorded field eggs or egg shells) and the egg usually situated in about one to two thirds of the length of the petiole (Fig. 5). Because in this case no direct oviposition has been observed, it is assumed that the female lands on the upper side of the leaf and then crawls down the stalk to oviposit.

The hatched larva crawls to the upper side of a leaflet and from there to the tip region. It creates a typical *Muschampia* shelter by cutting half of the leaflet width circularly and folding this part to the other side (Figs. 6–7). This very regular form of shelter is easily separated from those of *Pyrgus* species (without incision). After the second moult the larva constructs larger shelters (Fig. 13) between leaves which are then similar to *Pyrgus* shelters.

After this second moult development is retarded during the hot summer months (July and August, only sparse feeding) and accelerated again from late August or September when the larvae reach the next, penultimate instar. This penultimate instar is also the hibernation stage. Feeding stops during October or early November. The hibernation shelter (Fig. 14) is very dense and created (in rearing on potted plants) with older leaves that die in winter.

In spring the larvae are active with the first milder days with sunshine in late February or early March. In rearing under field conditions, the first fresh feeding scars have been recorded around 23. II. 2019 after a few sunny days with about 12–14° Centigrade.

The last moult takes place between the second half of March and early April. Pupation is expected in the field especially between mid- or late April and mid-May.

The attempt to avoid hibernation (rearing a few larvae indoors with cut fresh leaves) did not succeed. The species seems to be obligatory univoltine, at least in the W-Bulgarian sites, but presumably also in the whole range.

The life cycle is similar to many other steppe species, e.g. *Arctia festiva* (Hufnagel, 1766) (Erebidae), with spring or early summer adults, a delayed development (or even dormancy as in *A. festiva*) in the hot and dry summer time and a quicker development in autumn and especially spring.

Decisive for the early start in spring is the fact that in *Fragaria* (as is also the case with *Potentilla*) the younger leaves usually hibernate and can be used by the larva in the first warm days. Additionally, the plant quickly sprouts new leaves in spring.

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