The lifecycle and ecology of *Pseudochazara amymone* (Brown, 1976) (Lepidoptera: Nymphalidae, Satyrinae)

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Abstract: Until recently very little was known about the biology and ecology of Brown's Grayling (*Pseudochazara amymone* (Brown, 1976)). In order to shed more light on this elusive species we present a manuscript on the habitat requirements of *P. amymone* along with a detailed description of its preimaginal stages, and also provide helpful information regarding the conservation of this species. The larvae are oligophagous, feeding on *Festuca ovina* L. and *Dactylis glomerata* L. in captivity. Adults are extremely stenoecious requiring steep, sparsely vegetated slopes, almost exclusively associated with dark brown/blue green serpentine rocks against which they are perfectly camouflaged when resting with closed wings. The species appears only in low densities and has been observed mud-puddling and occasionally nectaring on flowers. Most of its habitat is inaccessible, but large scale inundation of the Devoll Gorge pose a serious threat to this scarce south Balkan endemic. Further studies are required to help fill the gaps in its distribution and evaluate its conservation status.

Zur Biologie und Ökologie von *Pseudochazara amymone* (Brown, 1976) (Lepidoptera: Nymphalidae, Satyrinae)

Zusammenfassung: Bis vor kurzem war kaum etwas bekannt über die Biologie und Ökologie von *Pseudochazara amymone* (Brown, 1976). Um etwas Licht ins Dunkel zu bringen, berichten wir über Habitatpräferenzen, dazu eine detaillierte Beschreibung der Präimaginalstadien und einige Hinweise zu Gefährdung und Schutz der lokalen Art. Die Raupen sind oligophag an Gräsern wie *Festuca ovina* L. und *Dactylis glomerata* L. (in Gefangenschaft). Die Imagines sind stenök und leben nur auf steilen, kaum bewachsenen Felshängen auf silikatischem, dunkelbraun bis blaugrün gefärbtem Serpentinitgestein, gegen das ihre Flügelunterseite hervorragende Tarnung bietet. Die Art wurde nur in kleinen Populationsgrößen beobachtet; Imagines saugen gelegentlich an feuchten Stellen oder auch an Blüten. Die meisten Fundorte sind wegen der steilen Lage kaum erreichbar. Allerdings sind die Pläne für mehrere großflächige Stauseen zur Stromerzeugung in der Devoll-Schlucht (einem wichtigen Habitat) eine ernsthafte Gefahr für die Erhaltung dieses lokalen und seltenen Südbalkanendemiten. Weitere Studien sind nötig, um die Verbreitung im Detail zu erforschen und die Gefährdung besser einschätzen zu können.

Introduction

Brown's Grayling (*Pseudochazara amymone* (Brown, 1976)) is one of the most enigmatic of all European butterfly species. Apart from the author's original description from northern Greece (Brown 1976) little has been published regarding this elusive Grayling. Failed attempts to locate the type locality (Cuvelier 2010) have led to several misleading hypotheses, resulting in speculation that the species may in fact be a rare hybrid (Kudrna et al. 2011). Although the species was purportedly rediscovered by Pamperis (2009) from 10 localities in Epirus and Greek Macedonia, there is no detailed evidence to confirm its presence in northern Greece (see Cuvelier 2010, Eckweiler 2012).

The butterfly is believed to have been discovered in Albania by Misja & Kurrizi (1984), who reported it as *Pseudochazara mamurra* (Herrich-Schäffer, [1846]), but this record remained unnoticed in a local journal for many years and has still to be verified. The first reliable record confirming the presence of *P. amymone* in Albania was published by Eckweiler (2012), but information regarding the exact location was excluded from his article in an attempt to protect exploitation by collectors. This however proved ineffective, as habitat photos published in his article revealed enough information to help locate the area in question, and by the following year commercial collectors had discovered the species (Verovnik et al. 2014). Without previous knowledge of Eckweiler's discovery, *P. amymone* was observed at three sites during our first faunistic survey to southeastern Albania in 2012. This triggered a more determined search in 2013 resulting in the capture of several female specimens for a rearing programme. As a result of these intense surveys, *P. amymone* is now known from three separate areas in Albania and at a total of 18 different sites (Verovnik et al. 2014), we can therefore speculate that its distribution may be more widespread in Albania and possibly in northern Greece (maps in Verovnik et al. 2014).

Pamperis (2009) reported the presence of Brown's Grayling at various altitudes ranging from 550–1400 m, in habitats with light shrubland, in clearings near the tree line, along forest roads, in light woodland, and in cultivated areas. According to van Swaay et al. (2010) it is known exclusively from sclerophyllous scrub habitats. Eckweiler (2012) is more precise in his description of the habitat in Albania and mentions stony slopes with some shrubs at an altitude of ca. 1100 m. Pamperis (2009) and Eckweiler (2012) indicate its sympatry with *Pseudochazara mniszechii* (Herrich-Schäffer, 1851) [ssp. *tisiphone* (Brown, 1980)], another endemic taxon from the southern Balkan Peninsula. *P. amymone* has only a single generation flying from the end of June to August (Pamperis 2009).

P. amymone was considered "Vulnerable" (VU) according to the IUCN Red List (van Swaay et al. 2011), but in the light of new information its status has recently been upgraded to "Endangered" (EN) due to small area of occupancy, limited number of locations and predicted continuing decline caused by habitat destruction (Verovnik et al. 2014). Acquiring additional knowledge on the ecology of this species should therefore be a top priority. In this article we set out to describe the species' life cycle and provide a more detailed description of its habitat requirements in Albania. We also describe adult variation to assist with identification and to help separate *P. amymone* from its syntopic relative, *P. mniszechii tisiphone*.

Materials and methods

The authors followed the taxonomy and nomenclature used in Fauna Europaea (2014), where the taxon *amymone* is dealt with as a separate species (in contrast to, e.g., Eckweiler 2004).

The butterflies were sampled for oviposition with an entomological net. 4 ♀♀ of *Pseudochazara amymone* were collected in 2013 in the gorges near Korçë, and an additional 5 ♀♀ were captured in the Devoll Gorge. All individuals were immediately placed into netted pots (laying cages), 2–3 females per pot. Each pot contained a clump of *Festuca ovina* L. and a water-filled receptacle containing nectar-rich flowers on which the females could feed. The pots were individually enclosed by a wire frame and covered with a fine nylon net bag. Each bag was firmly fastened to the rim of the pot using an elastic band. An access hole, big enough to insert a hand, was made at the top of each bag so that fresh flowers could be added each day, and this opening was secured with a plastic clip. In addition, a cotton pad, impregnated with a water solution containing 20% fructose, was placed at the top of each cage.

Circa 50 ova were laid while travelling around Albania, a majority of the ova were laid on the netting and the wire hoops supporting the cage, with only a few oviposited on the grass blades of *F. ovina.* A further 27 eggs were laid in transit through Serbia. On 31. vii. 5 ♀♀ were transported back to the U.K. in individual cardboard boxes, each containing some damp tissue stretched across their lids to avoid desiccation. These specimens were transferred to netted cages containing established plants of *F. ovina* and left in a warm sunny position inside MGP's conservatory. After a settling-in period ovipositing was resumed when temperatures inside the conservatory rose above 29° C.

On hatching, L_1 larvae were transferred into four individual netted pots each containing an established clump of *F. ovina*. During the summer months the pots were left outside under a cold frame (a small glass topped, aluminium framed enclosure use to protect plants from adverse weather) with its glass side panels removed to increase ventilation. The pots were brought inside MGP's conservatory during late September when night temperatures dropped dramatically. During L_3 larva skin moult a supplementary light source was implemented to increase the day length and to induce feeding.

All equipment used for the breeding programme, including cages and bottles, was sterilized prior to the start of the rearing experiment.

The survey area

Preliminary surveys in the Mali i Moravës Mountains and Devoll gorge in southern Albania were carried out from 10.–12. vii. 2012, and these regions were revisited from 20.–24. vii. 2013 (Verovnik el al. in press). During our surveys, *Pseudochazara amymone* was discovered in three gorges in the Mali i Moravës Mts., just south of the city of Korçë. One of the gorges was located south-east of Boboshticë village (Fig. 1), the other two were east of Drenovë village (Fig. 2), all with altitudes ranging from 1000–1200 m. The gorges have extremely steep rocky slopes, making them difficult to access, and are characterised by their sparse vegetation. There is a small stream running through each gorge where many butterfly species were observed mud-puddling in the heat of the day.

The second of our surveyed areas, south of Gramsh in the foothills of the Maja e Valamarës, was visited on 10. vii. 2012 and from 22.–24. vii. 2013 when several localities along the road through the Devoll gorge were surveyed, at altitudes ranging from 400–700 m. These included a sector west of Maliq town (Fig. 3) at the upper entrance to the gorge, and several areas close to the villages of Gjinkas, Moglicë and Bratilë (Fig. 4) where the geology is similar to that of the region south of Korçë, but in these localities the rock formations appear slightly darker. Separating these areas, just south of Strelcë village, is a small area composed of calcareous rocks, where *P. amymone* was not recorded.

Field observations

Korçë

In early July 2012 only a few fresh specimens of *P. amymone* were observed, indicating the start of the butterfly's flight period. In this area the species was flying together with the more abundant *P. mniszechii tisiphone* along with a few specimens of *Pseudochazara anthelea amalthea* (Frivaldsky, 1845). At the time of our second visit in late July 2013 the species had been on the wing for a considerable time in each of the surveyed localities and many of the ♀♀ were already worn, and several of the ♂♂ in tatters. Apart from two specimens that were observed nectaring, a ♀ on an *Acantholimon* sp. and a ♂ on a yellow-flowering *Centaurea* sp., most specimens, if undisturbed, were either mud-puddling or had settled on rocks with their wings closed (Figs. 5, 6), a perfect camouflage against the colouration of the rocks, making them hard to detect by predators. By contrast, both sexes of *P. mniszechii tisiphone* were commonly seen nectaring on *Acantholimon* and *Centaurea*. Concurring with Eckweiler's (2012) observation, *P. amymone* was very skittish, easily disturbed, and most specimens flew off when

Figs. 1–4: Habitat pictures of *Pseudochazara amymone* from Albania. **Fig. 1:** SE of Boboshtice, Korçë, 20. vii. 2013. **Fig. 2:** E of Drenovë village, Korçë, 21. vii. 2013. **Fig. 3:** W of Maliq town, Gramsh, 22. vii. 2013. **Fig. 4:** SE of Bratilë, Gramsh, 24. vii. 2013. — All photos by the authors.

approached. They could only be photographed when mud-puddling, when settled on rocks or during cloudy weather. The ratio of *P. m. tisiphone* : *P. amymone* was roughly 10 : 1.

Devoll gorge (Gramsh district)

In the Devoll gorge only a few specimens of *P. amymone* were observed during our two year survey. In 2012 only a single fresh ♂ of *P. amymone* was recorded. In 2013 the area was revisited 12–14 days after the previous year's visit at which time ♀♀ were found to be mainly worn suggesting that the species might fly earlier in the gorge, possibly a result of the very hot climate and the fact that the gorge is at a lower elevation, or it may have been an earlier season. It was noticeable, after examination, that specimens from the Devoll gorge were darker compared to those from the area around Korçë.

A majority of sightings were made in areas with dark brown/blue green rocks, identified as serpentine as part of a large ophiolitic formation (Koller at al. 2006), and not in the vicinity of other rock types present in the gorge. The behaviour of *P. amymone* was similar to that observed at the sites near Boboshticë, i.e. several butterflies were seen mud-puddling. One ♀ was photographed on a pink flowering *Scabiosa*, being predated by a Crab spider (Fig. 7). Butterfly activity diminished during the hottest part of the day, commencing ca. 11:00, when several ♀♀ were observed resting in the shade of rocks, showing a reluctance to move. Interestingly, not a single individual of *P. mniszechii tisiphone* was observed during the two survey years in this region, *P. anthelea amalthea* being the only other recorded *Pseudochazara* species. The habitat in the Devoll gorge was similar to the localities near Korçë, i.e. steep rocky slopes with sparse vegetation and in close proximity to a river.

Rearing report

Larval growth

Hatching commenced on 31. vii. 2013. Measuring 2.5–3 mm at eclosion, the larvae appeared to feed slowly and had only grown to 4.5–5 mm in length by 29. viii., increasing to 6 mm on 5. ix. prior to skin moult.

On 24. ix. the largest L_2 larva had reached 9 mm before ecdysis. At this stage three of the biggest larvae were placed into individual plastic pots and fed cuttings of *F. ovina* and *Dactylis glomerata* L. Initially they fed well on cut grass but then regressed, showing signs of a possible viral infection, consequently dying. On 4. x. the largest L_3 larva was measured at 10 mm in length, growing to 11 mm by 22. x. and to 13 mm on 25. x. at which time it appeared to be skin changing. At this stage a supplementary light source was implemented to increase the day length and to induce feeding.

By 27. x. the first L_4 larva had emerged measuring 13 mm on 28. x., increasing to 17 mm on 29. x. prior to ecdysis.

On 14. xi. the most advanced L_5 larva measured 19–20 mm in length, increasing to 25–26 mm by 19. xi. and 28 mm by 9. xi.

By 19. xii. this L_5 larva had buried itself in the soil next to the rim of the pot and by 21. xii. had pupated. On the morning of 28. xii. a second L_5 larva, measuring 28 mm, was observed patrolling the rim of the pot, looking agitated, searching for a place to pupate and by 26. xii. it too had buried itself into the soil and had pupated by 30. xii. A third larva pupated on 7. i. 2014.

The first (♂) imago emerged on 23. i. 2014, 33 days after pupation.

Description of preimaginal stages

Ovum

The eggs are 1.4 mm long (± 0.1 mm) and 1.2 mm wide (± 0.1 mm), milky-white in colour, barrel shaped with a depression at the apex with 18–19 longitudinal ribs and a series of faint transverse spherical keels (Fig. 8). A pattern of indentations (dimples) can clearly be seen at the depression (Fig. 9). Before hatching the egg turn grey in colour revealing the developing larva within.

L_1 stage

L_1 larvae consume part of or their entire eggshell after eclosion (Fig. 10). At this stage the larvae are ca. 2.5–3 mm in length, sandy-buff coloured, with a series of pale (bole) brown stripes (Fig. 11). These dorsal, subdorsal and lateral bands are clearly visible compared to other faint abdominal streaks. Each abdominal and thoracic segment is covered with a number of short, inconspicuous, stubby, blunt-ended hairs and a series of transverse dark spots. The head is pitted (indented like a golf ball), with short, milky-white setae; the stemmata are dark, virtually black, and there is a random pattern of brown 'blotches' on the head capsule. The mouthparts are muddy brown by comparison. After the larva has digested food, a dark green colouration, possibly the contents of the gut, is visible beneath the larval skin at the anterior portion of the abdomen (Fig. 12). Prior to skin change the larva resembles a 'typical' *Hipparchia* (Fabricius, 1807) larva (MGP, pers. obs.). The ground colour is pale, virtually white with contrasting (taupe) brown coloured dorsal and lateral bands, mid-brown longitudinal stripes and a tan coloured spiracular band (Fig. 13). Ventrally the ground colour is also a pale milky white colour, with an irregular covering of taupe brown and tan coloured speckles covering not only the venter but also the legs. The spiracles are inconspicuous, faintly ringed white, enclosed within the tan coloured spiracular band. Prior to ecdysis the cervix is a pale milky-white colour (Fig. 14). At skin moult the larva measured 6 mm in length and the discarded head capsule 0.8 mm in width.

L_2 stage

Immediately after eclosion the head capsule and the prolegs are a light (artichoke) green colour (Fig. 15). As the capsule hardens it turns a pale honey colour, lighter than the L_1 capsule with a series of faint transverse stripes across the head (Fig. 16). The short milky-white hairs have grown in length, particularly around, and immediately above, the mouthparts. A wide milky white subspiracular band is present directly above the venter. The scattered speckles are now denser in the ventral region and cover the proximal region of the prolegs and the thoracic and abdominal legs. Prior to skin moult the larva measured 9 mm in length and the head capsule 1.3 mm in width.

L_3 stage

Similar to L_2 stage, the head and prolegs are a pale green colour immediately after eclosion. The faint stripes on the head capsule are more conspicuous. As the larva develops, all the longitudinal bands and lines become darker (Fig. 17). Superficially these stripes appear a uniform brown colour but on closer inspection one can see that they are composed of brown speckles, denser at the edges, on a light (biscuit) brown background. Prior to skin moult the larva measured 13 mm in length and the head capsule 1.75 mm in width.

L_4 stage

The head capsule and prolegs are, as in the previous stages, pale green after eclosion. Once hardened, the frontal triangle and adfrontal area remain a pale (artichoke) green colour (Fig. 18). The labrum and mandibles are buff coloured but rusty red at their edges; the maxillary palps, spinnerets and antennae are a milky grey-white shade. Abdominally, the dark, taupe brown, longitudinal bands extend into the anal area (Fig. 19). The black, white ringed, spiracles are more visible. At skin moult the larva measured 17 mm in length, the head capsule 2.35 mm in width.

L_5 stage

In addition to the head and prolegs, the anal area is pale (artichoke) green colour after moult (Fig. 20). Six distinct dark brown stripes transverse the head capsule. Fine white setae with wart like bases cover the frontal triangle and the vicinity of the stemmata. The sides of the frontal triangle are delineated with dark brown stripes. The dorsal band is virtually black, edged with fine milky-white lines on either side. The spiracles are well developed, particularly the large black spiracle in the prothoracic segment. The short, fine hairs that cover the entire body are now clearly visible. The crochets of the midabdominal and anal prolegs are ginger coloured while the pretarsal claws of the thoracic (true) legs are dark brown. The venter, including the abdominal legs, have a silvery-green tinge (Fig. 21), with a greenish-grey medioventral line running the entire length of its body.

Table 1: Ovipositing chronology. — Note: Numerals in brackets refer to the number of ova laid on the second day.

Date	No. of ova	No. of ♀♀	Dates of hatching	No. of days to hatch
22.–28 vii. 2013	ca. 50, in Albania	7 ♀♀	31. vii. 2013	–
29.–30. vii. 2013	ca. 27, in Serbia	6 ♀♀	–	–
1. viii. 2013	11	5 ♀♀	15.–16. viii.	14–15
2. viii. 2013	11	5 ♀♀	16. viii.	14
3. viii. 2013	12	4 ♀♀	–	–
4. viii. 2013	3	4 ♀♀	–	–
5. viii. 2013	9	4 ♀♀	19. & 21. viii.	14–16
6. viii. 2013	5	3 ♀♀	20. viii.	14
7. viii. 2013	11	2 ♀♀	20.–22. viii.	13–15
8. viii. 2013	4	2 ♀♀	–	–
9. viii. 2013	1	2 ♀♀	23. viii.	14
10. viii. 2013	3	2 ♀♀	24. viii.	14
11. viii. 2013	3	2 ♀♀	24.–25. viii.	13–14
12. viii. 2013	7	2 ♀♀	25. viii.; 26. viii. (4)	13–14; 13–14
13. viii. 2013	2	2 ♀♀	26.–27. viii.	13–14
14. viii. 2013	9	2 ♀♀	28. viii.; 29. viii. (5)	14; 14

Prior to pupation the larva measured 28 mm in length and the head capsule 3.65 mm in width (Fig. 22).

Prepupal stage

Virtually all the markings are reduced at this stage of development (Fig. 23). The body colour is paler and the dark bands and stripes have faded to a mid-grey/brown (pale taupe) colour. The only body parts that appear black are the spiracles. The larva curls itself into a 'c' shape prior to pupating.

Pupa

All larvae pupated approximately one centimetre below the top of the soil, next to the rim of pot. Initially each newly formed pupa is straw coloured (Fig. 24), with distinct dark lines delineating each segmental fold. The internal organs are clearly visible beneath the translucent wing casing, as are the lateral stripes, particularly the dorsal band. After 24 hours the pupa turns a golden brown colour covered with a coating of very fine, barely visible, white powder (Fig. 25). The anal and head sections are darker, almost rust coloured, and the dorsal band and spiracles are still visible beneath the pupal casing (particularly the spiracle in the prothoracic segment). The abdominal segments are delineated by fine dark lines and the wing casing, if compared to the rest of the pupa, is honey coloured with a protrusion at the mesothorax. The pupa, measuring 15 mm, darkens prior to emergence.

Adult description

(Compare Figs. 26–29.)

The adult butterfly of *P. amymone* has already been described by Brown (1976) and Pamperis (2009). Having examined at length the external characteristics of many specimens of both species, we present a list of key points to help identify and separate *P. amymone* from the congeneric species *P. mniszechii tisiphone*. In addition we describe sexual variation and compare wing measurements. Both species are prone to variation and therefore the key points made below should only be considered as a guideline for identification purposes.

Pseudochazara amymone wing measurements

According to Brown (1976), the forewing of the ♂ holotype measures 26 mm and the 3 ♂♂ paratypes average between 26 and 27 mm. This concurs with a measurement made by MGP of a ♂ specimen on loan from J. Brown, which measures 27 mm (Fig. 26). The forewing length of a second specimen on loan, a ♀, was measured 28 mm (Fig. 27). Specimens collected by MGP, RV, FF, Nikola Micevski and Duncan Trew from Albania are, by comparison, smaller than the specimens collected in Greece near Ioannina by Brown. The forewings of 21 ♂♂ were measured. Lengths (basis to apex) range from 22.9 mm to 25.5 mm with an average of 24.3 mm (± 0.1 mm). The forewing measurements of 15 ♀♀ were also taken and they vary from 23.5 mm to 27.5 mm with an average of 25.3 mm (± 0.1 mm).


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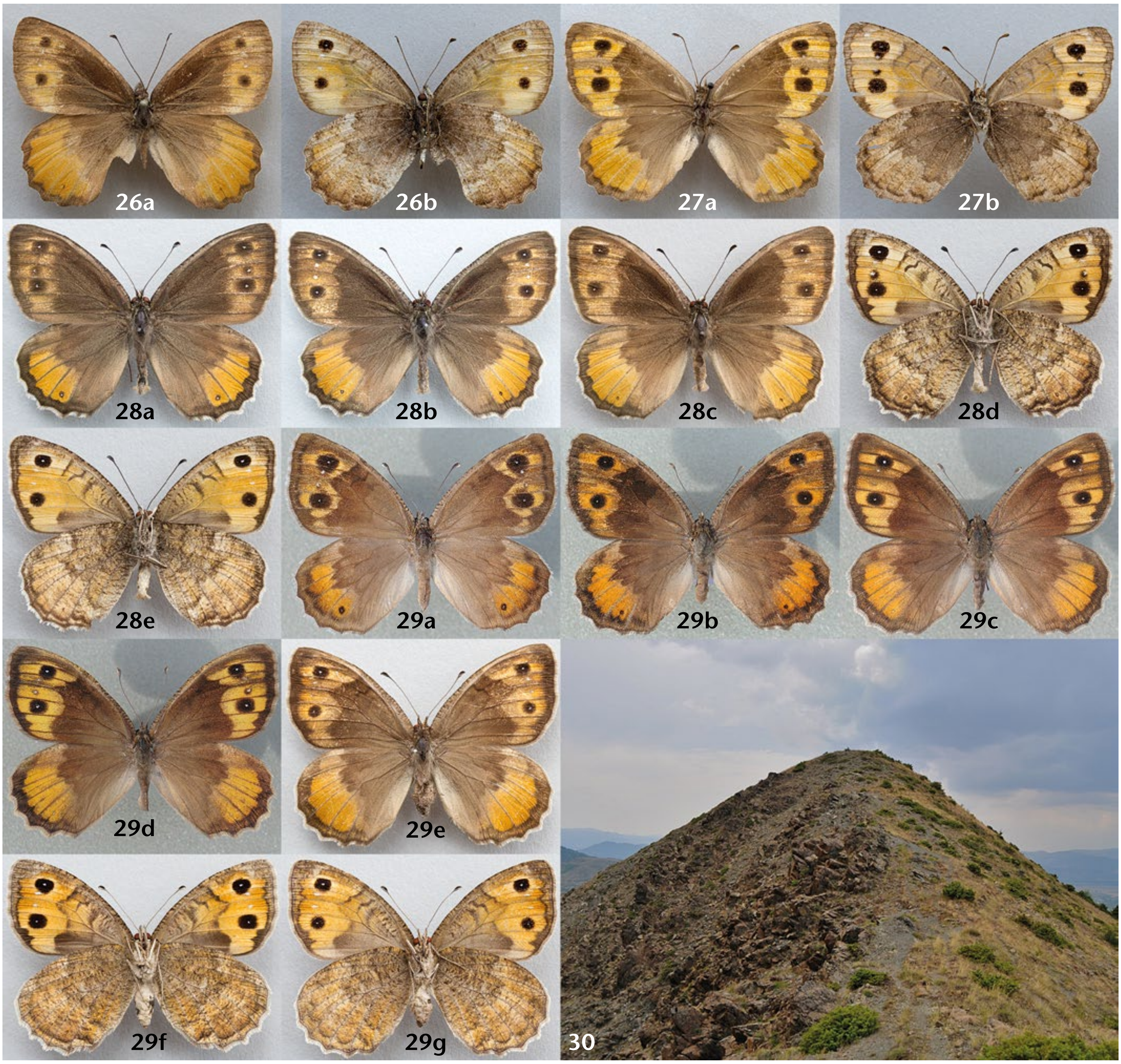

Figs. 5–7: Adults. **Fig. 5:** ♂, E Drenovë vill., Korçë, 21. vii. 2013. **Fig. 6:** ♀, W Maliq town, Gramsh, 22. vii. 2013. **Fig. 7:** ♀, predated by a crab spider, SE Bratilë, Gramsh, 22. vii. 2013. — **Figs. 8–10:** Ova. **Fig. 8:** 31. vii. 2013. **Fig. 9:** Close-up of depression, 1. viii. 2013. **Fig. 10:** Partially consumed eggshell, 2. viii. 2013. — **Figs. 11–14:** L_1 larva. **Fig. 11:** 2.5–3 mm, 1. viii. 2013. **Fig. 12:** 3.5–4 mm, 2. viii. 2013. **Fig. 13:** 6 mm, 2. ix. 2013. **Fig. 14:** 6 mm, prior to moult, 5. ix. 2013. — **Figs. 15–16:** L_2 larva. **Fig. 15:** 6 mm, after moult, 6. ix. 2013. **Fig. 16:** 7.5 mm, 15. ix. 2013. — **Fig. 17:** L_3, 13 mm larva, 25. x. 2013. **Fig. 18:** L_4, 17 mm larva, head capsule detail, 29. x. 2013. **Fig. 19:** L_4, 17 mm larva, 29. x. 2013. — **Fig. 20:** L_5, 17 mm larva after moult, 14. xi. 2013. **Fig. 21:** L_5, 19–20 mm larva, ventrum detail, 14. xi. 2013. **Fig. 22:** L_5, 28 mm larva, 9. xii. 2013. **Fig. 23:** prepupal larva, 19. xii. 2013. **Fig. 24:** newly formed pupa, 21. xii. 2013. **Fig. 25:** pupa, 6. i. 2014.

Figs. 26a, b: paratype ♂ (ups., uns.), coll. J. Brown. **Fig. 27a, b:** paratype ♀ (ups., uns.), coll. J. Brown. **Figs. 28a–28e:** ♂♂ ups. (**a–c**), uns. (**d, e**) variation. **Fig. 29a–29g:** ♀♀ ups. (**a–e**), uns. (**f, g**) variation. — Specimens not to identical scales. — **Fig. 30:** SE of Boboshticë village, Korçë, 20. vii. 2013.—

Morphological comparison of *P. amymone* and *P. mniszechii tisiphone*

- *P. amymone* is generally smaller in size compared to *P. mniszechii tisiphone*. 48 specimens (19 ♂♂, 29 ♀♀) of *P. mniszechii tisiphone* from Albania and N. Greece were measured for a comparative study. The ♂ forewing measurements (basis to apex) range from 25–28 mm with an average of 26.7 mm (± 0.1 mm), and the ♀ forewing measurements vary from 26–32 mm with an average of 29.3 mm (± 0.1 mm). If we compare these statistics with those of *P. amymone* we can work out that, on average, ♂♂ of *P. mniszechii tisiphone* are 9.9% and ♀♀ 15.8% larger. Comparatively, *P. amymone* is closer in size to *P. graeca* (Staudinger, 1870).
- The underside hindwing of *P. amymone* has a dentate band separating the paler postdiscal from the darker discal area. Lighter scaling adjacent to the proximal edge of this band highlights this demarcation. This delineation is not so obvious in *P. mniszechii tisiphone*.
- The undersides hindwings of *P. amymone* are extensively irrorated with dark scales. The mottling on the

underside hindwings of *P. mniszechii tisiphone* is lighter and not so conspicuous.

- The underside forewing of *P. mniszechii tisiphone* has a silver-grey flush permeating from the basal area into the discal region. This is absent or greatly reduced in specimens of *P. amymone.* In particular S1b has extensive silvery-grey scaling in its basal portion. *P. amymone*, by contrast, has a dark, virtually unicolourous brown wedge-shaped marking covering the proximal half of this space.
- In relation to the wingspan, ♂♂ of *P. amymone* have wider upperside hindwing postdiscal bands.
- The ♂ upperside forewings of *P. amymone* have, to a lesser or greater extent, a suffusion of dark scales covering the postdiscal bands, similar to *P. graeca coutsisi* (Brown, 1977). *P. mniszechii tisiphone* rarely has this dark suffusion and, if present, the scaling is usually not so extensive. The upperside hindwing bands of *P. amymone*, by contrast, are a bright, ochreous colour.
- The white spots at S3–S4 on the upperside forewings of *P. amymone* are small, sometimes barely visible and occasionally absent. By comparison, both sexes of *P. mniszechii tisiphone* have two very prominent white spots on their upperside forewings between the larger (S2 and S5) black ocelli, and these white spots are clearly visible through to the undersides.
- The veins of *P. mniszechii tisiphone,* particularly those intersecting the orange bands, are more pronounced, highlighted with a suffusion of dark scales.
- The upperside forewing outer margins of *P. amymone* are more convex making the wing shape appear more rounded.
- The markings in the underside forewing cell of *P. mniszechii tisiphone* are washed out and faint if compared to the conspicuous specks and streaks visible in the corresponding cell of *P. amymone.*
- The upperside hindwing of *P. mniszechii tisiphone* often have a conspicuous white spot in the postdiscal band at S3, not present in *P. amymone.*
- The upperside and underside submargins of *P. amymone* are darker than *P. mniszechii tisiphone,* particularly the underside hindwing submarginal line and the margins of the underside forewing which have a distinct dentate marking at S1b.
- The upperside hindwings of *P. mniszechii tisiphone* have a suffusion of pale orange scales forming a line, only broken by intersecting veins, between the darker marginal and submarginal lines. This is not so conspicuous in specimens of *P.amymone.*

P. amymone is close to *P. graeca coutsisi* in size and markings, but this species has not been recorded in any of the habitats that were surveyed, nor in the Republic of Albania in general (Verovnik & Popović 2013). The most distinctive external characteristic separating *P. graeca coutsisi* from *P. amymone* is the upperside hindwing orange band. This is very obvious, wide and bright in *P. amymone*, but suffused and duller in *P. graeca coutsisi.* Specimens of *P. graeca* (Staudinger, 1870) from southern Greece have bright orange bands but they are nearly always two-toned, proximally paler, whilst the orange bands on the upperside hindwings of *P. amymone* are a more uniform ochre colour.

Variation

P. amymone shows a high degree of cryptic adaptation to the environment in as much as it perfectly mimics the colouration of serpentine rocks. Similar to *P. graeca* in Greece, where the northern and southern populations show a clinal colour variation (Anastassiu et al. 2009), both sexes are prone to variation. Females in particular are extremely variable and there is also considerable variation amongst specimens from individual colonies; specimens of *P. amymone* from Devoll, Gramsh area, for example, appeared to be darker than those from the sites close to Boboshticë, Korçë.

- The white pupils contained within the black ocelli at S2 and S5, can be well-defined, made up of only a few white cells or absent altogether (blind).
- The size and shape of the black ocelli at S2 and S5 varies, and occasionally a third black ocellus is present at S3.
- The number of white (occasionally black) spots on the upperside forewing postdiscal band at S3 and S4 is irregular, usually it is two, sometimes only one and very occasionally they are absent altogether.
- The shape of the dentate bands separating the dark basal from the paler postdiscal areas is irregular. In some specimens it is more rounded, in others more sagittated.
- The width and the shade of colour of the postdiscal bands varies.
- The amount of dark scaling on the upperside forewing band, between the two black ocelli at S3- S5, is variable, occasionally forming a streak at V4.
- The upperside wing shape is not constant, sometimes it is elongated, other times less angular.
- The size and colour of the black ocellus on the upperside hindwing at S2 is irregular. Usually it encompasses a white eyespot but occasionally the spot itself appears virtually white and sometimes it is absent altogether.
- The submarginal band of the underside hindwing varies in width and intensity.
- As already documented, the sizes of specimens, regardless of their location, are variable.

Foodplants

In captivity larvae of *P. amymone* feed on *Festuca ovina, F. ovina* var. *glauca* Lam. and *Dactylis glomerata.* In all probability final instar larvae will, in nature, eat a wide variety of Poaceae species during their final instar. In captivity MGP has observed that the larvae of many species (particularly those of genus *Hipparchia*) feed happily on a selection of grass after hibernation. Understandably L_1 and L_2 larvae, only possessing small mandibles, prefer grasses with finer blades to feed on during the early stages of their development (e.g. *F. ovina*). Compared to other Poaceae species, *F. ovina* has an open, well-ventilated habit, possibly creating a more suitable environment in which small larvae can hibernate (MGP, pers. obs.). MGP also observed that final instar larvae of many satyrid species do not grow to full size if fed exclusively on *F. ovina*, and that other species like *D. glomerata* are eagerly accepted in their final instar.

Discussion

Our surveys have revealed crucial information regarding the potential distributional range of *P. amymone* in the southern Balkans. The species has only been observed in a specialised habitat where dark brown and/or dark blue green rocks, identified as serpentinite, occur. All the observed serpentine rocks are found on a larger ophiolitic formation as a part of the Western Albania ophiolites. Ophiolites are pieces of oceanic plate that have been thrust upwards (obducted) onto the edge of continental plates and are usually an assemblage of mafic and ultramafic lavas and hypabyssal rocks found in association with sedimentary rocks like greywackes and cherts (Coleman 1981). A detailed description of the southern Albanian ophiolites, also called the Mirdita ophiolites, was published by Koller at al. (2006). They divided the Mirdita ophiolite belt into several massifs, namely: Voskopoja, Rehove (Rehovë), Morava (Mali i Moravës), Devolli (Devoll gorge), Vallamara (Maja e Valamarës), Shpati (Shpatë) and two smaller massifs of Luniku (Mali i Lunikut) and Stravaj. So far, Brown's Grayling has been recorded by the authors in Mali i Moravës, the Devoll gorge and in the vicinity of Voskopoja (Verovnik et al. 2014). It is unclear why the species is only present in areas where these characteristic rock formations occur, but based on the available literature, we can make a logical assumption. Due to their physical and chemical composition, ultramafic soils (including serpentines) are famous for their distinctive flora and vegetation, as compared to adjacent non-serpentine areas (Asenov & Pavlova 2009). Serpentine soils usually have a high magnesium content compared to the percentage of calcium, and contain large quantities of heavy metals such as nickel, chromium and cobalt, and are poor in basic nutrient elements such as nitrogen, phosphorus and potassium (Karataglis et al. 1982). From this we can surmise that the sparse vegetation observed in areas where P. amymone occurs may possibly be the result of these geological factors, i.e. a combined effect of lack of basic nutrients and the toxic influence of magnesium and other heavy metals, combined with a high pH value of the soil. Another factor implied in the vegetation scarcity represent the steepness of the slopes in the surveyed habitats. This could prevent a build-up of soil that would encourage a more luscious plant growth, i.e. the erosion of the slopes and rapid leaching of the soluble compounds may prevent the accumulation of soil materials (Radford 1948). A change in soil composition was observed on one of the surveyed ridges in the Mali i Moravës massif (Fig. 30). On the northern part of the slope (right of photo), where soil has collected, the amount of vegetation is considerably greater. No *Pseudochazara* species were recorded on this slope but several other species that were not present on the southern slope (left of photo) were recorded.

Taking into account the geological similarities and considering the close proximity to other ophiolitic massifs in Albania and northern Greece, e.g. the Rehovë massif, we can assume that *P. amymone* may have a much wider distribution in the Balkans. This assumption is in line with the distribution model developed for the species which suggests high correlation between butterfly presence and ophiolite geological formations (Verovnik et al. 2014). Most of the potentially suitable habitats in the known localities are inaccessible due to the steepness of their slopes, which to some extent safeguards these populations from human impact. One assumes this is also the case in other potential areas where the species has not been found, and this could make any evaluation of distribution very difficult. Unfortunately, most of the Devoll gorge is due to be flooded to make way for the construction of three hydroelectric power plants which will result in wide scale destruction of the species' habitat (Statkraft 2013). These factors make *P. amymone* a high priority species requiring further studies and conservation.

There are no peculiar traits regarding the larval development of *P. amymone*. The species is oligophagous, at least in captivity, accepting both *Festuca ovina* and *Dactylis glomerata* as host plants. It is therefore unlikely that host plants are the limiting factor regarding the distribution of *P. amymone*, while microclimatic conditions, which can affect other large satyrids, may be a defining factor (Kadlec et al. 2009). The adult behaviour of *P. amymone* is similar to that of other large satyrids, but unlike other species from the same group, feeding on flowers has only occasionally been observed (authors, pers. obs.). The densities of adult *P. amymone* at each site is low if compared to some other species of the same genus, i.e. those living in a greater numbers where the habitat is suitable, e.g., *P. cingovskii* (Gross, 1973) (Verovnik et al. 2013), *P. graeca* (Staudinger, 1870), *P. beroe* (Herrich-Schäffer, [1844]), and *P. geyeri* (Herrich-Schäffer, 1846) (authors, pers. obs.). Whether this scarcity is due to suboptimal habitat or short flight period remains to be seen.

Apart from publishing the first detailed account of the larval stages of *P. amymone*, our aim in presenting this paper is to help others identify the species and its habitats in the hope that this will encourage further field surveys in the southern Balkan Peninsula to acquire further knowledge, additional distribution data, and to gather more information to help recognise potential threats.

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