A contribution to the larval ecology of the Forester *Adscita capitalis* (Staudinger, 1878) (Lepidoptera: Zygaenidae)

Wolfgang Wagner & Gregor Markl

Dr. Wolfgang Wagner, Baseler Str. 6, 70619 Stuttgart, Germany; wolfgang@pyrgus.de
Prof. Dr. Gregor Markl, GUZ, Universität Tübingen, Schnarrenbergstrasse 94+96, 72076 Tübingen, Germany; markl@uni-tuebingen.de

Abstract: The ecology of *Adscita capitalis* (Staudinger, 1878) has never been studied in its westernmost habitats in Europe. We here present results from field studies in the Kozani district of northern Greece (West Macedonia) conducted in 2024. Unlike results from Asia Minor, where larvae feed on *Helianthemum canum* (L.) Hornem. (Cistaceae), the host plant in the Kozani region is *Erodium absinthoides* Willd. (Geraniaceae) in stony, gappy nutrient-poor pastures preferably on hilltops. Cistaceae are neglected by ovipositing females and also most L_1 larvae did not accept *Helianthemum* in rearing experiments. The moths fly between mid-May and mid-June at altitudes around 1000 m. The eggs are deposited singly or in small groups on the pinnately leaves of the host plant. The young larvae enter an estivation diapause from late June or the first half of July to at least September and feed again in autumn. They usually hibernate in the third-to-last or penultimate instar and are mature in April. For the first time, all preimaginal stages of this rare species are illustrated.

Ein Beitrag zur Larvalökologie des Grünwidderchens *Adscita capitalis* (Staudinger, 1878) (Lepidoptera: Zygaenidae)

Zusammenfassung: Die bislang im europäischen Teil der Verbreitung unbekannte Präimaginalökologie von *Adscita capitalis* (Staudinger, 1878) wurde 2024 in der nordgriechischen Präfektur Kozani (Westmakedonien) untersucht. Abweichend von Ergebnissen aus Kleinasien erfolgt die Eiablage in der Region ausschließlich an *Erodium absinthoides* Willd. (Geraniaceae) und nicht an Sonnenröschen (*Helianthemum canum* (L.) Hornem., Cistaceae). Die Mehrheit der L_1-Raupen nahm Sonnenröschen in Züchtungsexperimenten nicht an. Die Falter fliegen bei Kozani von Mitte Mai bis Mitte Juni in Lagen um 1000 m. Die Eier werden einzeln oder in kleinen Gruppen an die fiedrigen Blätter der Raupennahrungspflanze abgelegt. Ab etwa Ende Juni bis Mitte Juli beginnen die Raupen mit einer Sommerdiapause, fressen im Herbst nochmals und überwintern im dritt- oder vorletzten Stadium. Ausgewachsen sind sie dann im April. Erstmals werden alle Präimaginalstadien dieser seltenen Art abgebildet.

Introduction

Foresters (Zygaenidae: Procridini) are by far not as popular as their sister group, the burnet moths (Zygaenini). They are much more difficult to identify and usually show a quite uniform greenish appearence. Only at genus level, by the acute (*Jordanita* Verity, 1946) and obtuse (*Adscita* Retzius, 1783) antenna tips, species groups are comparatively easy to separate. One of the rare exceptions that is easily recognized at species level, is *Adscita capitalis* (Staudinger, 1878). Both males (fig. 1, 2) and – to a lesser extent – females of this small *Adscita* species have strongly clubbed antennae (fig. 3) and are, thus, conspicuous on the very first glance.

Adscita capitalis is essentially a western Asian species with a main distribution in Asia Minor (Turkey, Efetov et al 2010). Its European outposts are very isolated and surely constitute relic populations of a formerly more extensive distribution. Besides the two mountains Kerkis and Karvouni on Samos Island (Greece, East Aegean Islands, geographically already belonging to Asia Minor), only small and local populations in the Republic of Northern Macedonia (Drenowski 1921, 1930) and one in northern Greece in the prefecture of Kozani (near Drepano, Göhl et al 2012) have been reported. *Adscita capitalis* is a very elusive species. Confirmed records are rare and observations on the habitat and especially preimaginal biology even scarcer. In Naumann et al (1999), the habitat is still wrongly characterized ("Inhabits damp meadows"). Only Efetov et al. (2010) have recorded oviposition on *Helianthemum canum* above 2500 m in Anatolia and could rear the species to imago with *Helianthemum*.

In early June 2022, the second author was lucky to photograph a fresh male (fig. 1) of this species near Skiti some 20 km west of Drepano at an altitude of 1120 m. He realized the significance of this photo and find not before the spring of 2024, and in early June 2024, both authors met in Greece to study the ecology of the species.

Materials and methods

On 8. vi. 2024 both authors investigated the area above Skiti (app. 1100 m, Askio mountains, Kozani prefecture, West Macedonia, Greece) and found a few imagines. Two females were captured for oviposition in captivity. On 10. and 11. vi. 2024, the first author reinvestigated the habitats, because *Helianthemum* had not been accepted for oviposition by the females. On this occasion, some 40 eggs and 20 young larvae were found on *Erodium absinthoides*, more exactly on the Balkan-endemic subspecies *Erodium absinthoides* subsp. *guicciardii* (Boiss.) Maire & Petitm. Later on the same days, the captured females oviposited some 30 eggs on this *Erodium* species as well.

The larvae were subsequently reared at home in Germany on potted *Erodium absinthoides* var. *amanum* derived from a southern German perennial nursery. On 26. x. 2024, two additional, older larvae could be found in the field above Skiti. After hibernation, some pupae and imagines resulted from this rearing in the spring of 2025.

Results and discussion

Host plant and habitat

During the first field work in June 2024, we especially searched in patches with much *Helianthemum* species,



All figures show *Adscita capitalis* from Skiti, district of Kozani, all from first author except **fig. 1** (second author). If no date is indicated, rearing images are from early spring 2025. — **Fig. 1:** Male (1. VI. 2022). **Fig. 2:** Eggs found in the field on *Erodium absinthoides*, 10. VI. 2024. **Fig. 3:** L_1 larva in front of the mine hole in a leaf tip of Erodium, 13. VI. 2024. **Fig. 4:** L_2 larva feeding with forebody inserted in the mine, 24. VI. 2024. **Fig. 5:** L_3 larva, 24. VI. 2024. **Fig. 6:** L_4 larva, 10. VII. 2024. **Fig. 7:** Half-grown larva in summer diapause (14. VIII. 2024). **Fig. 8:** Half-grown larva in rearing in early autumn feeding again (23. IX. 2024). **Fig. 9:** Half-grown larva in autumn found in the field (24. X. 2024), less contrasty form. **Fig. 10:** Fully-grown larva, intermediate form. **Figs. 11**–12: Fully-grown larva, contrasty form with pure white subdorsal fields. **Fig. 13:** Cocoon, taken out of the soil, view on outer earthy layer. **Fig. 14:** Cocoon, inner silky and dense layer. **Fig. 15:** Male pupa with heavily clubbed tips of antenna sheaths. **Fig. 16:** Female pupa with a bit less clubbed tips of antenna sheaths. **Fig. 17:** Male pupa with already stretched abdomen prior to hatching. **Fig. 18**: *Erodium absinthoides* plant in larval habitat (two eggs found). Flower shoots (right hand side) already withered. Flowering *Thymus* (above) is the most important nectar plant in the habitat. 11. VI. 2024.



Fig. 20: Larval habitat in autumn with active larvae, 24. x. 2024. **Fig. 21:** Larval habitat in spring with grazing cattle, 19. iv. 2025. **Fig. 22:** Male on *Thymus*, 8. vi. 2024. **Fig. 23:** Male antennae (e.o. rearing, spring 2025).

bearing in mind the results of Efetov et al. (2010) who mention *Helianthemum canum* as host plant in Asia Minor. We eventually observed a few moths of both sexes, but could not establish any coincidence of moths and *Helianthemum*. The moths had been recorded especially in sparsely vegetated, stony patches (fig. 19) with only low-growing plants with or without *Helianthemum*. Two females were captured to obtain eggs in captivity, but they refused oviposition (only two eggs obtained) on various *Helianthemum* species taken from their habitat. On the next day, the first author reinspected the habitats and scanned the available plant species which might be suitable for an *Adscita* species. It emerged, that the occurrence of a particular *Erodium* species had a quite good coincidence with the moth individuals recorded two days before. When this plant was offered to the two females in captivity, they started oviposition almost immediately. On the next day, this *Erodium* species, determined as *Erodium absinthoides* ssp. *guicciardii*, (fig. 18) was searched for eggs in the field. Some 40 eggs, 10 empty egg shells and 20 larvae mainly in the first, but partly up to the third instar, were detected in the area, both in known imaginal habitats and in nearby new patches without former imaginal records. The inhabited plants always grew in loose groups interspersed by open ground and very low-growing vegetation. The larval habitats were restricted to very stony, scarcely vegetated patches (figs. 19–21), often on crests, plateaus or other, very shallow and only slightly pending slopes, always on limestone. A typical companion species was the pamphagid grasshopper *Glyphotmethis heldreichi* (Brunner von Wattenwyl, 1882) and – later in the season - *Chazara briseis* (Linnaeus, 1764) (Nymphalidae). The habitats did not differ much in their structure from the pictures (especially fig. 2) in Efetov et al. 2010 – despite the difference in altitude. Also other habitats known to the first author (e.g. on Samos island) are similar: stony, scarcely vegetated crests near the tops of mountains. The host plants on Samos are still unknown. Previous searches on the very scarce Cistaceae in these habitats in late March and April during several years before 2020 remained unsuccessful. Literature research revealed that there occurs a closely related *Erodium* species in these mountain top habitats: *Erodium vetteri* Barbey & Major which may represent the host plant on Samos. Direct field confirmation is, however, still lacking.

Erodium absinthoides is a perennial with thickened, deep-ranging roots as storage organ for water and nutrients. Most of its leaves originate from the same level at the plant base (leaf rosette), except for the smaller leaves of the flower stems. Generally, the plant may flower between March and October, but because of the typical summer drought in these habitats, most flowers appear between late March and May. At least the inner, younger leaves of the plant hibernate green and, thus, provide food also in late autumn or very early in spring where – typical for many foresters – larval activity already starts

in late February or March. This is earlier compared to most burnets, except for winter-developing species like *Z. rhadamanthus* (Esper, 1789) or *Z. lavandulae* (Esper, 1783). All eggs in the field (fig. 2) were found on living ground leaves, none on the more or less already desiccated stem leaves.

Erodium absinthoides occurs from the Carpathians and the Balkans across Asia Minor to the Caucasus and possibly Iran. Its range, therefore, coincides to a large extent with the forester moth's distribution and may be the host plant also in parts of the Republic of North Macedonia or in Asia Minor. Together with related species such as *Erodium vetteri* on Samos, the genus *Erodium* may be the most important one for *Adscita capitalis*. In captivity, larvae only very reluctantly accepted *Erodium cicutarium*; this attempt was aborted soon due to higher larval mortality. *Helianthemum* was accepted by only about 10% of L_1 and L_2 larvae and also this feeding attempt was consequently soon aborted. When offered *Erodium absinthoides* again, the larvae started feeding quickly.

Although the two captured females refused oviposition on *Helianthemum*, *Helianthemum canum* is a host plant in the high mountains of Asia Minor according to Efetov et al. (2010). Hence, there appear to exist regional differences or habitats where both genera or even only *Helianthemum* are used. This needs further field work.

Life cycle

Adults are on the wing in early summer from mid- or late May to July, according to the site and its altitude. Near Skiti, a fresh male was found by the second author on 1. vi. 2022 (fig. 1). In 2024 (8. vi.), most individuals were already very worn. Near Drepano (700–800 m, about 20 km from Skiti), Göhl et al (2012) recorded imagines on 5. vi. 2011. Thus, the flight period appears to start in warmer years in mid- or late May, in cold years as 2022 rather in early June, in the Kozani prefecture at altitudes between 700 and 1120 m. The flight period is presumably short and ends in hot years like 2024 around 10. vi., in cold years in late June. Only in high-altitude habitats above about 2000 m, e.g. in Anatolia, the main flight period is in July and sometimes even extends to early August (Efetov et al 2010). In lower habitats (1100 m) of the same Anatolian mountain, the flight time is similar to the Kozani region in late May and early June (30. v. and 5. vi. 1993). The same is true for Samos island at 1150 m (2. vi. 1992, Mollet 1995).

The observed imagines often took nectar from low-growing *Thymus* pads. When not feeding, they rested on stalks some centimetres or decimetres above ground. Near Drepano, fast and low flying, swarming males were recorded at noon (Göhl et al 2012), most probably searching for newly hatched females by their pheromones. In foresters, such swarming is often very short and confined to a specific time of the day. For example, a swarming of *Jordanita subsolana* (Staudinger, 1862) was observed by the first author at about 9:30 to 10:00 in late June 2025 in a thistle-rich habitat near Santiago de la Espada (southern Spain), where also *Adscita bolivari* (Agenjo, 1937) and *Zygaena trifolii* (Esper, 1783) occurred. In this time interval, more than 10 males were observed, afterwards not a single specimen. Near Kozani in 2024, we did not observe any swarming, most probably because of the early end of the flight period in this year.

Eggs were deposited typically singly or more rarely in small groups (2–3, very rarely 4) on the leaves of the host plant (fig. 2). The hatched L_1 larva (fig. 3) bores into a tip of the feathery leaf and partly lives in this mine. From L_2 instar (fig. 4) onwards (fig. 5: L_3) they only bore into the leaf with their forebody and never disappear completely. Older larvae do not construct mines at all and consume whole leaves or are scraping.

The larva feeds until L_4 (fig. 6), sometimes only L_3 or rarely L_5, and then estivates from late June or early July until at least September (fig. 7). After first autumnal rainfalls, it becomes active again (fig. 8–9) and feeds until early or mid November. Two such larvae (which entered winter diapause about a week later) were found in the field on 26. x. 2024. When temperatures remain low for a longer period, the larva enters winter diapause until February. This can happen in the penultimate or third-to-last instars. The number of moults is not fixed in neither burnets nor foresters - it varies in many foresters usually from 6 to more than 10 (most often 7–8). Besides individual differences under the same environmental conditions, the number of moults may depend on development speed (temperature and food quality), number of development interruptions (dormances) and sex.

As in many other forester species, the larvae of *Adscita capitalis* become active very early in spring, presumably in February or latest in March. Judged from rearing experiences, larvae should be mature (figs.10–12) in the Kozani region between late March/early April and at latest early May. A second hibernation as is not unusual in other foresters (albeit to a lesser extent than in burnets) has not been observed in rearing, but may occur sometimes in the field, supposedly more common at high-altitude habitats. Pupation occurs in the upper soil in a typical two-layered cocoon (earthy, loose outer layer and dense, silky inner layer, figs. 13–14).

Larva

The larva has already been described in detail by Efetov et al (2010). However, only one mature larva was depicted. According to current observations, the larvae are somewhat variable and occur in two forms. In the one described by Efetov et al (2010) and also observed near Kozani (figs. 9–10), the subdorsal zones are heavily suffused with reddish brown to creamy colour and the larvae are less contrasty. Most larvae, however, showed a very bright, contrasty colour with pure white subdorsal zones and dark wine-red lateral parts (figs. 11–12).

Many Procridinae larvae are quite variable, either in one population (e.g. *Adscita mannii* (Lederer, 1853), *Adscita obscura* (Zeller, 1847)) or regionally (e.g. subspecies of *Adscita geryon* (Hübner, 1813): different colouration of alpine populations) or both. Other species like the related *Adscita dujardini* Evetov & Tarmann 2014 or *Adscita albanica* (Naufock, 1926) show a lower intraspecific variability. Moreover, the latter pair is easily separated as larvae due to different, but obviously quite stable colouration.

In the case of *A. capitalis,* the differences in the proportion of larval colouration may be caused by small genetic differences due to long isolation of the European relic populations. Further research would be necessary, both genetical and concerning the host plants in Anatolia.

Pupa

In contrast to most other *Adscita* and *Jordanita* species, the otherwise typical Procridinae pupa is easily recognized due to the antenna sheaths, where the heavily clubbed tip is already visible. This is of course more striking in male pupae (figs. 15, 17) than in female ones (fig. 16). As in other Zygaenidae, the pupa bores out of the usually vertically created cocoon with a head-up position prior to eclosion to faciliate emergence.

Threats

The Askio mountains near Kozani have suffered severe changes in the last years. The first author still remembers them as a remote, partially heavily grazed (goats and sheep), but extreme species-rich region. Many rare species that are in Greece only found there (e.g. *Proterebia afra*) occur in this anthropogenic steppe paradise.

In the last decades, however, this changed drastically. On the one hand, this mountain range has been brutally developed for renewable energies. Many new and broad dirt roads have been constructed up to the crests for giant wind turbines. Moreover, large parts of precious steppe habitats and southern slopes have fallen victim to huge photovoltaic systems and have been completely flattened by bulldozers. This development is still going on.

On the other hand, the grazing pressure is severely decreasing in most regions of the Askio mountains as in the whole Balkans. This leads to felting of the vegetation, more bushfires and shrub and finally tree encroachment. Last but not least, the traditional sheeps and goats are more and more replaced by cattle with a tendency (at least at the *A. capitalis* sites, fig. 21) of year-round grazing, supplementary alimentation in winter and thus nitrogen accumulation. All factors together represent a severe threat for the biodiversity of the Askio mountains (despite the quite large extension of this (pseudo) steppe mountain range) and also to the very rare species described in the present contribution.

Even if decarbonization is an urgent need to fight global warming, it is not acceptable to play off the climate crisis in such a rigorous manner against the at least equally severe crisis of biodiversity, especially as other, much better possibilities like photovoltaics on surface-sealed parking lots, Agri-PV and others exist.

Unfortunately similar developments can be observed all over Europe and counteract any so-called “Nature Restoration Regulation” of the European Union.

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