Observations on the larval ecology of *Euchalcia emichi* (Rogenhofer & Mann, 1873) (Lepidoptera: Noctuidae, Plusiinae) in the East Aegean Island of Samos (Greece)

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Abstract: In Samos larvae of *Euchalcia emichi* have been recorded in the field for the first time in Europe. Larval hostplants are two species of *Alkanna* (Boraginaceae): *Alkanna tubulosa* Boiss. and *A. tinctoria* Tausch. Larvae and pupae are figured for the first time, described in detail and some aspects of their ecology are given (larval habitat, life cycle). Short taxonomic notes are given with respect to relationships within the European species of *Euchalcia* Hübner, [1821].

Beobachtungen zur Larvalökologie von *Euchalcia emichi* (Rogenhofer & Mann, 1873) (Lepidoptera: Noctuidae, Plusiinae) auf der griechischen Insel Samos (Ostägäis)

Zusammenfassung: Auf Samos wurden Raupen von *Euchalcia emichi* zum ersten Mal in Europa im Freiland aufgefunden. Raupennahrungspflanzen waren zwei Arten der Gattung *Alkanna* (Boraginaceae): *Alkanna tubulosa* Boiss. und *A. tinctoria* Tausch. Raupen und Puppen werden zum ersten Mal abgebildet sowie im Detail beschrieben. Schließlich wird auf einige Aspekte der Larvalökologie eingegangen (Larvalhabitate, Lebensweise der Raupen etc.). Schließlich wird kurz auf die systematischen Verhältnisse innerhalb der europäischen Arten der Gattung *Euchalcia* Hübner, [1821] eingegangen.

Introduction

Euchalcia emichi (Rogenhofer & Mann, 1873) is distributed from Anatolia across the Levant to Iraq and Iran. In Greece, it is known only from a few East Aegean Islands (Kalymnos, Nisyros and Samos, see Fibiger et al. 2010, Fritsch et al. 2014). In Samos first records of *E. emichi* date back to May 2009 in the Spatharei and Mytilinii area (Fibiger et al. 2010). Its preimaginal ecology is poorly known, especially in Europe. The only hints were given in a very short paper (Löbel & Drechsel 1996). These authors found larvae of *E. emichi* in Central Anatolia (Asia Minor, Turkey). They provide only a rough description lacking detail (no photo) and a few ecological details (young larvae in spun shelters in shoot tips, older ones openly on lower leaves). The hostplant was not precisely determined and thought to be a yellow flowering species of *Nonea* (Boraginaceae).

In late May 2014, the first and second author met for an excursion on the northern slopes of the Ambelos (Karvounis) mountain range in Samos where the second author and colleagues had found *E. emichi* at light several times since 2012. *Alkanna tubulosa* was the most likely Boraginaceae, but it was already too late for the larvae. Thus a trip was planned for April 2015 in order to reveal the unknown ecology of *E. emichi* on Samos. Iris Asal-Brunner joined the excursion. The results of this trip are presented here. Herbert Beck gives a detailed larval description based on living material sent to him. Larva and pupa are figured for the first time.

Material and methods

Fifty-nine larvae in all instars were found between 18. iv. 2015 and 27. iv. 2015 over large parts of the island of Samos. Additionally, a single cocoon was observed. The larvae pupated in captivity between 22. iv. and 5. v. 2015. Moths emerged after 10–15 days.

Between 7. and 9. iii. 2016 the first author visited Samos again and recorded 15 young to half-grown larvae (from sea level up to 800 m) as well as already one mature larva (near Pyrgos).

The terminology used to describe the bristles (setae) and primary lines of the larva is given in Beck (1974, 1999, 2000). Exact and reproducibly quantitative description of (noctuid) larvae is enabled using the topography of the setae (= chaetogram, or setal map).

The **primary lines** (normally present from L_2 and ± distinct by whitish to white, sometimes yellowish or reddish/red colour; in the penultimate and ultimate instar often covered and concealed by dark pattern elements):

- dorsal = middorsal line;
- subdorsal line below seta D2 and close to this;
- the epistigmatal line above seta SD1 (this above the spiraculum) and close to this seta;
- the stigmatal = spiracular line between seta L1 (behind the spiraculum) and seta L2, below the spiraculum;
- sometimes the area between the dorsal (through L1) and ventral border (through L2) is darkened or only the dorsal border is present as often in the Plusiinae.
- In the Plusiinae the middorsal line is often bisected and the area in between is the same ground colour as the zones (dorsal zone, subdorsal zone, etc.).
- An additional primary line at the Plusiinae and some other groups of the Noctuidae (*sensu* Hampson) is the interdorsal line, which runs longitudinal between setae D1 and D2.

Pattern elements (= elem.) are ± clearly defined very small areas within the zones (i.e. between the primary

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lines) which are differently coloured than the ground colour. The shape of these elements may be longish = L-, point-shaped = P-, or irregularly = I-elem.; combinations, e.g. LI-elem., are possible.

Results

Host plants, habitats and distribution in Samos

In Ambelos some 20 larvae were found only on the whitish flowering *Alkanna tubulosa* Boiss. (Fig. 28). This plant is absent in other regions of the island. Elsewhere larvae were found on the blue *Alkanna tinctoria* (L.) Tausch. (Fig. 23), which is not present in most parts of Ambelos.

Larval habitats are most often sunny and sparsely vegetated places such as rocky areas (Fig. 26), embankments (Fig. 23), roadside verges (Figs. 29, 31), walls or grazed grasslands (Fig. 25). Sometimes larvae were found in semi-shady places with denser vegetation, such as along walls in olive groves (Fig. 30).

Larvae have been found in most parts of the island between elevations of 5 m (Psili Ammos, Fig. 27) and 850 m above sea level (Karvounis Oros, Ambelos). The only larger areas without records are the westernmost parts of the island (Oros Kerkis) and the north coast. In the southern and western area of Kerkis *A. tinctoria* occurs at lower levels up to 250 m, but a search for larvae was not successful there. The westernmost records of larvae were from the northeastern slopes of Kerkis up to about 800 m northwest of Marathokambos (Fig. 26).

Sites with larval records or distinct larval traces: northern side of Ambelos (Lazarou, several places), just above Vourliotes in direction of Moni Vronda, Pyrgos (several places), between Myli and Koumaradei, Spatharei, northwest of Marathokambos (several places from the village to about one km south of Kosmadei), Psili Ammos, Klima, Mytilinii (several places, especially in the northwest).

Life cycle

During the second half of April 2015 young (Figs. 1–3, 5; from first instar, above 800 m, mid-April) and fully-grown larvae (Figs. 12–14; lower regions and/or late April) could be found. In late April most larvae had already pupated in lower regions and only the characteristic traces had been left (old shelters partly with empty skins, feeding scars, droppings). It should be mentioned that the spring of 2015 in Samos was extremely wet and cold. Thus development of everything was about 10–14 days later than usual.

2016 larvae (except one mature larva, the caterpillars were generally smaller than in late April 2015) could be already found in early March. Both *Alkanna* species were already flowering in lower elevations.

Young larvae usually live within spun shelters (Figs. 4, 8) constructed at the very tip of a shoot. There they consume the youngest leaves and especially the flower buds. Half-grown larvae construct their shelter usually on the lower side of the developing cincinnus near the tip. During the last instar, larvae usually live openly on the plant without any shelter. They are camouflaged very well by their whitish-green colour and hairs imitating those of the plants.

Pupation only rarely occurs in a cocoon between leaves and shoots of the hostplant in nature (there is a single record of a prepupa near Mili by the first author, Figs. 17, 18). In most places where the larvae had already finished feeding, no cocoon was found. The first author recorded a single mature larva on its way to pupation near Marathokambos on the edge of a path. Thus it is very probable that most larvae will pupate at some distance from their hostplant in a cocoon either between leaves of other plants or in litter.

Description of larva

Young larvae up to the penultimate instar (e.g., Figs. 6, 7) bear large black tubercles, each bearing a bristle, and black, heavily sclerotised prothoracic and anal shields, the colour of the latter changes to green in the last two instars. In young larvae, bristles are dark, but whitish in penultimate and last instars. Immediately after a moult larvae are dark, often almost blackish (Fig. 5), but after feeding is resumed younger larvae show a creamy ground-colour while in the last two instars they become greenish with whitish markings.

In the last instar (Figs. 10–13), larvae are dark to bluish green with distinct interdorsal lines (see terminology above), white bristles arising from small black tubercles on whitish warts and numerous smaller white points (the base of tiny spines) and thin whitish dashes (the attachment of muscles = sutures) that are usually arranged in lines but are themselves of irregular shape.

The larva of *E. emichi* differs especially from the larvae of the *modestoides* species-group by the large whitish, straight and blurred-edged interdorsal line, which continuously runs between the longitudinals through /D1 and /D2 (touching these points). With exception of *E. chlorocharis* (Dufay, 1961) (this with the interdorsal line of similar width as at *E. emichi*, but the line is sinuous) in the *modestoides* species-group the whitish interdorsal line is ± indistinct and consists of broken whitish areas; in the last instars *E. emichi* has no subdorsal line which is present in the larvae of the *modestoides* group; in the *modestoides* group the whitish and irregularly large lines of the bisected dorsal line (dorsal at the D1-spot and touching this) are similar to the subdorsal line whilst in *emichi* these lines (of the bisected dorsal line) are clearly linear and have throughout the same distance to each other (contrary to species of the genus *Autographa* Hübner, 1821). A whitish to greyish epistigmatal line, one third to one half SD1–L1 above SD1 (width one half of the diameter of the whitish tubercle spot SD1) is

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indistinct (more distinct only by a longish LI-elem. from the front margin to the middle of the segment) because very similar to the whitish sutures in the subdorsal zone. The stigmatal line is restricted to the dorsal margin (as usual in Plusiinae), of same width as the epistigmatal line; between L1 and L2 there are 3 to 4 whitish P-elements (width one diameter of the tubercle spot L1 = one quarter SD1–L1), possibly the stigmatal suture.

Integument finely spined (length of the spines ca. one diameter of a tubercle). Width of the whitish base-spots of D1, D2: 1.5 of L1-spot = one sixth to one seventh D1–D1, A1 (= S1).

Head (Fig. 16), neck-shield, anal-shield, thoracic legs and cuffs of the prolegs up to L_4 black. In the penultimate and especially the ultimate instar head centrally throughout greenish with parallel margins (only at P1 a bit narrowed), rest of the hemispheres black, only behind the ocelli ± greenish.

Anteclypeus and antennae (especially basal parts) white, postclypeus greenish brown, labrum dark brown.

Description of pupa

The pupa (Figs. 19–21) is of typical Plusiinae shape with large, protruding proboscis. The dorsal side is entirely blackish. On the ventral side, some parts are greenish-yellow, especially in the center between tips of antenna sheaths which elongate cranially along some fissures and also partly into wing sheaths. Cranial parts of ventral abdomen creamy. The cremaster is broadly rounded with a few orange to brown coloured hooks. Spiracles are light brown. Pupation occurs in a dense white cocoon.

Discussion

Habitually the larva is close to *E. modestoides* Poole, 1989, *E. chlorocharis* and *E. consona* (Fabricius, 1787). Therefore, in spite of the very different appearance of the respective adults (see below), the remark in Goater et al. (2003: 208) is of interest: "*E. chlorocharis* belongs, despite its rather *modestoides*-like external appearance, to the *E. emichi* species-group." The larvae of the above-mentioned European species are characterized by the chaetotaxy of the body and the head-pattern (the greenish central area including the frons to the caudal margin of the head, the large black lateral stripes and hemispheres). In Fibiger et al. (2012: 245) the remark of Goater et al. (2003) is no longer repeated and the *emichi* species-group comprises only the brownish species of *Euchalcia* Hübner, 1821. In summary, in spite of some external similarity between the adults of *E. modestoides* and *E. emichi,* there are marked differences in the larva: In the adults of *E. emichi* the crosslines are exactly parallel and the antemedian line is clearly separated from the whitish (not ochreous) surrounded orbicular stigma; in the *modestoides* species-group the antemedian is angled into the orbicular stigma. These very different adult characters allowed to expect a different pattern at the larva of *E. emichi*. Therefore the knowledge of this larva was expected with great interest.

Ecologically, *Euchalcia emichi* is a typical member of the genus *Euchalcia* which is most diverse in dry-warm steppe climate of the Near and Middle East (especially from Anatolia to Iran). The larvae feed on spring-flowering species of *Alkanna* and the moths (Fig. 22) fly in early summer. Dry and hot periods of summer and early autumn are passed inactively as well as the winter (as known in congeners presumably as first instar in a silken cocoon).

In years with a warm spring (as 2016), the first larvae are mature already in March and moths are supposed to start flying in April.

Alkanna tinctoria is a widespread Mediterranean species (Rechinger 1965) especially of lower elevations. The existence of this plant should be the main determining factor for the moth's distribution in East Aegean Islands. Because of the general abundance of *A. tinctoria* it is very probable that *E. emichi* will be found in many more islands near to the Anatolian coast.

In Samos, *A. tubulosa* only occurs in a quite small area in the Ambelos region where it is readily used by larvae. This plant also occurs in Anatolia. Löbel & Drechsel (1996) found larvae in Anatolia on an undetermined, yellow flowering *Nonea* species (determination of the genus not verified; confusion with *Alkanna*?). In rearing, larvae refused other Boraginaceae such as *Myosotis* or *Echium,* but partly accepted *Pulmonaria* which is the hostplant of some related *Euchalcia*.

Alkanna areolata Boiss. occurs as a third *Alkanna* species in Samos. It also has blue flowers, but is distinguished from *A. tinctoria* e.g. by having far fewer glandular hairs. *A. tinctoria* is described as follows: "planta canescens, dense setosa" (Rechinger 1965). It is very probable that *A. areolata* (which we did not find during our visit) is also used as a larval hostplant. In Samos *A. tubulosa* and *A. areolata* are classified as rare, *A. tinctoria* as scattered (Duell & Kalheber 2011).

The mature larvae live exposed, but are well camouflaged by their bluish green colour with white elements and setae which blend with the hairy leaves, stems and fruits of the plants. We often found the larvae only when carefully beating the plant. The shelters of younger larvae are also constructed very inconspicuously in the tip or underneath the cincinnus, but are often betrayed to the experienced eye by droppings or dead parts of the plant.

Euchalcia emichi uses a large variety of larval habitats provided that one of its hostplants occurs. It is found on rocks, embankments, roadsides, walls, pastures or in olive groves. We also found it on plants growing in gaps on a bridge. Most larval habitats share full sun exposition and only sparsely vegetated ground. The larvae therefore can fully benefit from the spring sun and

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Figs. 1–5: Karvounis, Lazarou northern side, 800 m, 18. IV. 2015. **Fig. 1:** L_2-larva, shelter artificially opened. **Fig. 2:** Young larva, taken out of shelter. **Fig. 3:** Young larva, shelter opened. The wet droppings and feeding scars are typical. **Fig. 4:** Shelter of young larva in tip of *Alkanna tubulosa*. **Fig. 5:** Half-grown larva soon after a moult. At this stage larvae appear almost black, but soon brighten up after feeding. — **Fig. 6:** Half-grown larva, 2.1 km S Vourliotes, 24. IV. 2015, photo: D. FRITSCH. — **Fig. 9:** Larva in penultimate instar, shelter opened, above Marathokambos, 800 m, 26. IV. 2015. — **Figs. 7–8, 10–13, 16:** Pyrgos, 400 m, 19. IV. 2015. **Fig. 7:** Penultimate instar, shelter opened. **Fig. 8:** Well concealed shelter of a penultimate instar on *Alkanna tubulosa*. **Fig. 10:** Larva after last moult, shelter partially opened. **Fig. 11:** Larva after last moult, shelter opened. **Figs. 12–13:** Last instar, living freely on the plant. **Fig. 16:** Last instar, head. — **Fig. 14:** Last instar, freely on plant, 3.7 km NW Mytilinii, 20. IV. 2015, photo: D. FRITSCH. — **Figs. 15, 17–18:** south of Moni Megalis Panagias, 380 m, 21./21. IV. 2015. **Figs. 15:** Fully-grown larva on *Alkanna tinctoria;* **17–18:** Well concealed cocoon on *Alkanna tinctoria,* and detail of other cocoon. Most larvae, however, pupate away from hostplant. — **Figs. 19–21:** Pupa, e.l. from Pyrgos, 30. IV. 2015; dorsal, ventral, lateral views. — **Fig. 22:** Imago, e.l. from Samos, 2015, photo: D. FRITSCH. — **Fig. 24:** Larva on *Alkanna tinctoria* on open soil, NW of Neochori, 320 m (biotope see Fig. 25), 20. IV. 2015.

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Figs. 23, 25–27: Larval habitats with stands of *Alkanna tinctoria*. **Fig. 23:** Open soil on small embankment, NW of Neochori, 320 m, 20. IV. 2015. **Fig. 25:** S of Moni Megalis Panagias, 380 m, 21. IV. 2015. **Fig. 26:** On rocky slope, NW of Marathokambos, 700 m, 22. IV. 2015. **Fig. 27:** Near the coast on small embankment in foreground; Psili Ammos, 5 m, 20. IV. 2015. — **Figs. 28–31:** Habitats with *Alkanna tubulosa*. **Fig. 28:** Near Pyrgos, 20. IV. 2015. **Fig. 29:** Roadside embankment, Pyrgos, 20. IV. 2015. **Fig. 30:** In an old olive grove, Pyrgos, 20. IV. 2015. This habitat is one of the most densely vegetated examples. Most habitats show more open soil or rocks. **Fig. 31:** Typical larval habitat on rocky roadside embankment, Pyrgos, 20. IV. 2015. — All photos (if not explicitly indicated otherwise) by first author. Material from Samos, all photos except pupa and imago (rearing photos) taken in the field.

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development is accelerated. Because of this diversity of habitats over a large altitudinal range (from sea level up to at least 850 m in Samos and presumably much higher in Anatolia; the adult moths are most frequent between 900 and 1030 m in Samos) there is no great threat to the species at present, though it is clear that *E. emichi* suffers from general land utilisation by man (development of all kinds) as most other species do.

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