The mystery of the preimaginal stages of *Cucullia celsiae* Herrich-Schäffer, [1850] solved in Cyprus, and second record of *Cucullia gozmanyi* (G. & L. Ronkay, 1994) in Greece (Lepidoptera: Noctuidae)

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Abstract: In April 2018 eggs and larvae of *Cucullia celsiae* have been recorded on *Scutellaria cypria* Rech. F. (Lamiaceae) in the field in stony garigues and embankments with rocks or bare ground in the Western part of Cyprus. The preimaginal stages and the larval habitat are described and additionally figured for the first time. Moreover, *Cucullia gozmanyi* is reported for the second time from Greece.

Aufklärung des Mysteriums der ersten Stände von *Cucullia celsiae* Herrich-Schäffer, [1850] sowie die zweite Meldung von *Cucullia gozmanyi* (G. & L. Ronkay, 1994) aus Griechenland

Zusammenfassung: Im April 2018 wurden Eier und Raupen von *Cucullia celsiae* in Westzypern im Freiland in steinigen Garrigues und steinigen bis feinerdereichen Böschungen an *Scutellaria cypria* Rech. f. (Lamiaceae) gefunden. Die Präimaginalstadien und das Larvalhabitat werden beschrieben und zum ersten Mal abgebildet. Zudem wird *Cucullia gozmanyi* zum zweiten Mal für Griechenland gemeldet.

Introduction

Cucullia celsiae is a quite distinct, relatively small species of the genus *Cucullia* Schrank, 1802 (subgenus *Calocucullia* Ronkay & Ronkay, 1987, often regarded as full genus) with dichromic brown-grey forewings (Fig. 1) and a quite early flight time from late January (in the South) to late May or early June (in the more northern higher mountains). It shows an eastern distribution with records from the Balkans (North to Romania and Croatia), Turkey, the Levant (Kravchenko et al. 2007, 2015), Cyprus, the Caucasus region and the Middle East (N-Iraq, Iran) (Hacker 1989, Ronkay & Ronkay 1994, Fauna Europaea 2018). Its preimaginal stages and their ecology remained indeed nearly unknown so far. The species has been named after *Celsia* which is nowadays a subgenus of *Verbascum* (Scrophulariaceae). This plant was supposed to be the hostplant at that time.

Rebel (1903) gives a description of the larva, found by Haberhauer in Bulgaria (Slivno) reputedly on *Hesperis desertorum* Velen. (nowadays usually named *Hesperis tristis* L., Brassicaceae). Because of that publication most following authors listed *Hesperis* as hostplant (e.g. Lepiforum 2018, translated from German: "The larval foodplant of *Cucullia celsiae* is not, as supposed by Spuler, *Celsia* (see under etymology), but *Hesperus* [sic] *desertorum* instead").

No other record of preimaginal stages and foodplants has been reported during 120 years until now (e.g. Beck 2000). As the moth has been found near Delphi and Arachova in the Parnassus region (Central Greece) I searched (among other targets) for *Hesperis* and *C. celsiae* in May 2016 and 2017 during short stays, but I had no success. The same resulted from a trip to Cyprus in April 2017.

In late May 2017 I shortly visited the North of the Peloponnese after my stay in Delphi. Above Rozena (near the Ekklisia Agios Vlasios) I found *Cucullia* larvae of the subgenus *Shargacucullia* Ronkay & Ronkay, 1992 unknown to me on *Verbascum (Celsia)* on steep and hot cliffs and embankments. I thought to have found *C. celsiae* (psychological factor), but the larvae in fact resulted in imagines of *Cucullia gozmanyi*. This explains the quite unusual link of the two species and regions in this paper.

These flops goaded me to further activities in 2018. I compared the known sites in Cyprus where *C. celsiae* seemed to be not rare as moth between February and early April. Additionally an Austrian colleague (Franz Grünwald, Salzburg) had seven specimens at light near Pano Panagia (Paphos district) during a partly joint stay in Cyprus in late February 2018 (Fig. 1). He kindly gave me the exact location and as I again stayed in Cyprus in early April 2018 I planned to solve the mysterium around *C. celsiae* this time.

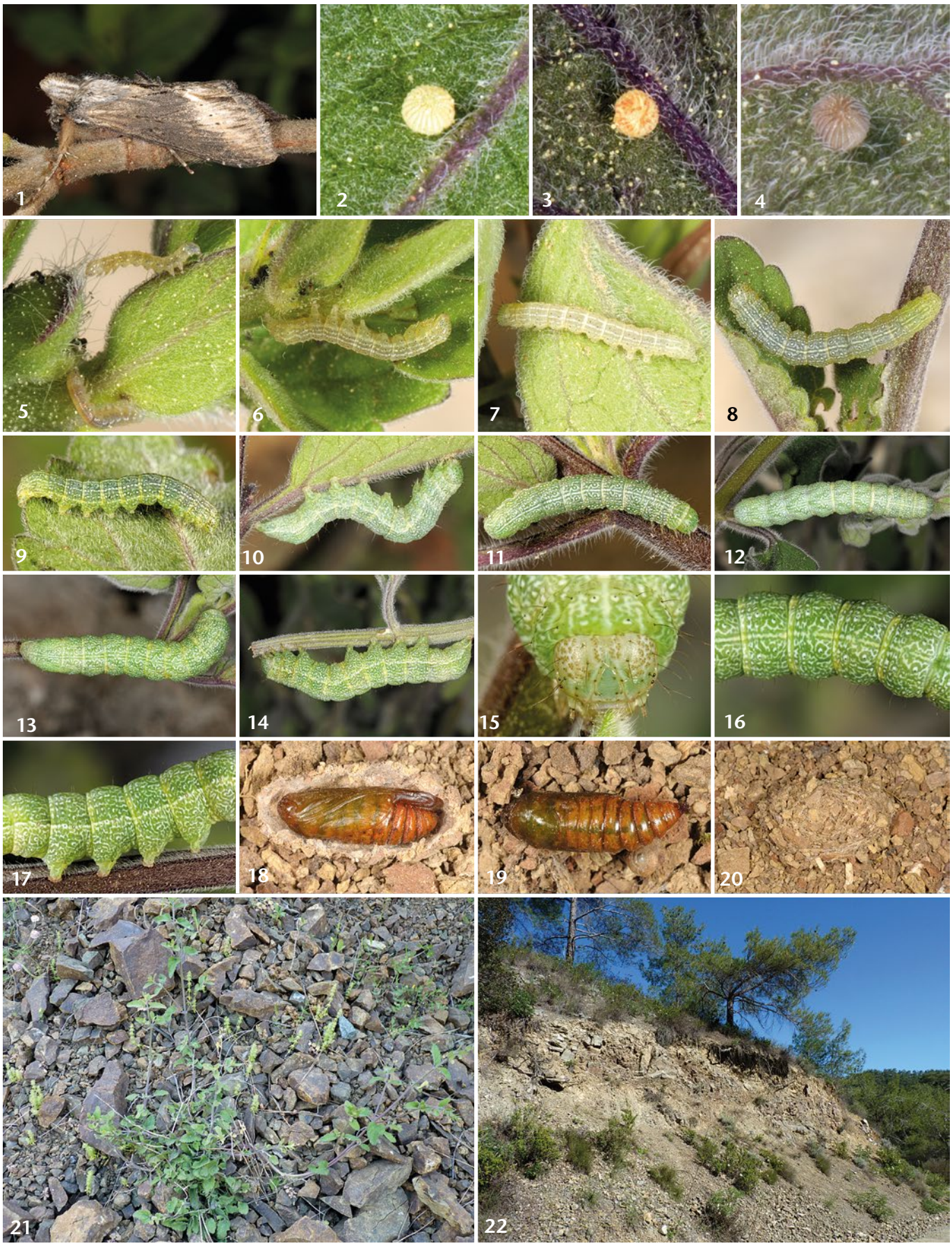
But according to the online flora of Cyprus (Hand et al. 2018), no *Hesperis* species is listed for this island. Other Brassicaceae that may match the local *C. celsiae* range included e.g. endemic *Arabis* species on rocks in the Troodos Mountain range, *Alyssum, Biscutella, Turritis* and the usual ruderals like *Sinapis, Hirschfeldia* or *Eruca*. I did not believe that these ruderals could host the larvae because the distribution pattern of *C. celsiae* would have been different then. Thus I decided to concentrate on *Arabis* on rocks and to investigate also all other Brassicaceae, Scrophulariaceae and Asteraceae in the known moths record sites.

Material and methods

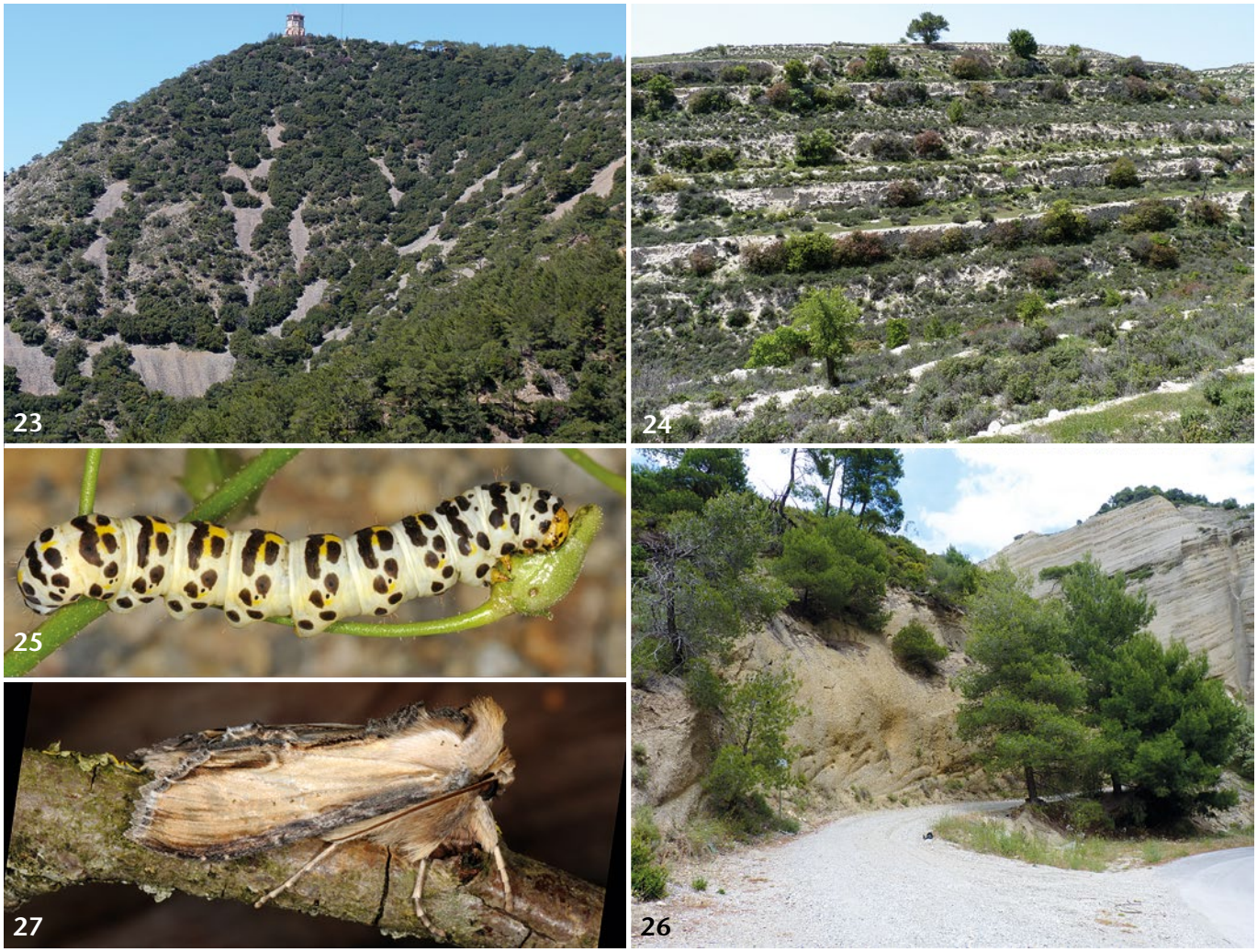
Three larvae and traces of other already pupated larvae of *C. gozmanyi* have been found in the Peloponnese (above Rozena near the Ekklisia Agios Vlasios, 550 m) in S-Greece on 23. v. 2017. The larvae have been reared successfully, and a ♂ hatched in late winter 2018 (Fig. 27).

For *C. celsiae* a trip to W-Cyprus (Paphos region) was conducted between 1. and 8. iv. 2018.

But the goal could not be achieved so easily. At the already mentioned site near Pano Panagia and also other



Figs. 1–24: ***Cucullia celsiae,*** *Cyprus*. — **Fig. 1:** ♂ (from a light trap near Ano Panagia, 23. II. 2018, Franz GRÜNWALD leg.). **Fig. 2:** Field egg not too long after oviposition (Kefalos bridge, 6. IV. 2018). **Fig. 3:** Field egg, a few days after oviposition (Kefalos bridge, 6. IV. 2018). **Fig. 4:** Field egg, prior to hatching of the larva (Kefalos bridge, 6. IV. 2018). **Fig. 5:** Larva in the first instar (e.o. rearing, Kefalos bridge). **Figs. 6–7:** Larva in the second instar (Kefalos bridge). **Figs. 8–9:** Larva in the third instar (Ano Panagia). **Fig. 10–11:** Larva in the penultimate instar (Ano Panagia). **Fig. 12–17:** Larva in the last instar (Agios Therapon). **Fig. 18–19:** Pupa, cocoon removed (e.l. rearing Agios Therapon). **Fig. 20:** Cocoon, fetched out of the soil (e.l. rearing Agios Therapon). **Fig. 21:** Host plant on gravel in a steep embankment in the pine forest (Kefalos bridge, 6. IV. 2018). **Fig. 22:** Larval habitat in a steep embankment in open pine woodland (Ano Panagia, 6. IV. 2018).



Figs. 23–24: ***Cucullia celsiae,*** *Cyprus*. — **Fig. 23:** Larval habitat, screes and embankments in open woodland (Kykkos Monastery, 6. IV. 2018). **Fig. 24:** Larval habitat, grazed limestone garrigue near Lofou with scree, stone walls and rocky to earthy embankments, 7. IV. 2018). — **Figs 25–27:** ***Cucullia gozmanyi,*** Peloponnese. — **Fig. 25:** Fully-grown larva in the field (23. V. 2017). **Fig. 26:** Larval habitat with *Verbascum daenzeri*. **Fig. 27:** ♂ (e.l. ex rearing). — All photos by the author, *Cucullia celsiae* from Cyprus (western part), *C. gozmanyi* from North Peloponnese (Greece).

known (by moths collectors) sites like the Kefalos bridge at the river Mylikouri (North of Agios Nikolaos) mainly only pine woodland with *Cistus* and partly *Genista* undergrowth dominated. Other plants, more suspicious for *Cucullia celsiae,* included *Crepis fraasii* Sch. Bip. (Asteraceae), *Biscutella didyma* L. (Brassicaceae) and finally the endemic *Arabis purpurea* Sm. Scrophulariaceae were lacking there completely. None of these plants delivered the wished larva. *Crepis* hosted larvae of two *Polymixis* species and *Ammoconia aholai* Fibiger, 1996, *Arabis* and *Biscutella* (also *Turritis*) *Anthocaris cardamines* (Linnaeus, 1758).

After many hundreds of *Crepis* and *Arabis* I concluded that these must be the wrong plants. In the evening of the 5. IV. 2018 I walked down a woodland track near Ano Panagia for the third (and as I said to myself also the last) time. While carefully investigating all possible vegetation near the forest road I found some plants of *Scutellaria cypria* Rech. F. (Lamiaceae). I remembered having found the interesting geometrid moth *Orthostixis cinerea* Rebel, 1916 on that plant in late February 2018. New, small feeding scars caused my interest and so the first second instar larva of *C. celsiae* fidgeted in typical *Cucullia* manner in my open hand. After that targeted search was possible and very successful.

Between 5. IV. and 7. IV. some 25 larvae (most of them L_1–L_3, 3 L_4 and 2 already L_5) and 15 eggs of *C. celsiae* could be found in different parts of the western part of Cyprus: NE of Pano Panagia (Paphos district), several places in open pine woodland between 600 and 800 m; Kykkos Monastery and adjacent places to the SE between 1000 and 1150 m (Nicosia district); Kefalos bridge at the river Mylikouri (North of Agios Nikolaos, Paphos district); between Agios Therapon and Lofou (several places, 640–780 m), Limassol district

The larvae have been reared in Germany with hostplant from the refrigerator and also a potted plant. This rearing resulted in about 15 cocoons.

There is no doubt about the identification of the larvae because most of the so far and in the strict sense unidentified caterpillars have been found in sites where *C. celsiae* is known to be common and because no other *Cucullia* species is possible. All other Cyprian species are well-known to the author (except the sporadic and rare coastal semi-desert species *Cucullia syrtana* Mabille, 1888).

Results and discussion

Cucullia celsiae Herrich-Schäffer, [1850]

Egg

The egg (Figs. 2–4) is a typical, small, hemispherical *Cucullia* egg with about 25–28 ribs that converge in the distal micropyle region. The colour is creamy yellow at first (Fig. 2). Lateron large reddish spots appear (Fig. 3) and prior to hatching the egg (Fig. 4) becomes greyish brown. The total development time has not been observed because only eggs from the field have been investigated. But judging from "young", yellowish eggs the time from oviposition until the hatching of the larva may not exceed 7–8 days above 22°C (thus supposedly a few days more in cooler mountain sites).

Larva

In the first instar (Fig. 5) the larva is whitish to yellowish with black bristle points. The head is of the same colour without special markings.

In the second instar (Figs. 6–7) the larva is pale yellowish green. White, in places broken longitudinal lines appear. The black bristle points are now surrounded by white colour. The head shows black setae points and already some brownish spots.

From the third instar onward (Figs. 8–9) the larva is green with extended white markings. Besides the longitudinal lines many additional white pattern elements appear. The black bristle points have neighbouring large white flecks. In the central dorsal part of the abdomen short white dashes are found to each side of the dorsal line. These dashes divergate to the front part to the segment where they often converge with other elements.

The penultimate (Figs. 10–11) and last (Figs. 12–17) instars are similar to each other and are characterized by a still denser netting of white elements that almost mask the dark green ground colour. The black bristle points are very small and the neighbouring white fleck is much larger than in the third instar. The intersegmental skin is often light yellowish green. The head (Fig. 15) is greenish, on the upper side more creamy-white with a characteristic pattern of grouped olive to brownish flecks. This pattern is very similar to that of *Cucullia xeranthemi* Boisduval, 1840 or *Cucullia gnaphalii* (Hübner, [1813]). The setae points are more or less of the same colour as these flecks. The stigmata are creamy with narrow black border.

Prior to pupation the white markings mostly disappear and the larva is quite uniform green then.

I believe that the characters of the larva can be regarded as derived and are aimed at making the larva cryptic and well camouflaged on its hostplant. The many white elements correspond with the light hairs of the plant.

It is furthermore quite imaginable that *C. celsiae* could have developed from Asteraceae-feeding ancestors. I think that it is not necessary to separate *C. celsiae* in a separate genus *Calocucullia*. It may be more appropriate to classify *Calocucullia* as a subgenus of *Cucullia*.

In Rebel (1903) a description of the larva is given that Haberhauer has beaten reputedly from *Hesperis*. This description circumscribes a green larva with many white longitudinal elements. This is quite close to the real *C. celsiae* larva. But the other details (small, monochrome green head, sharp dark green confinement of the white lateral line, body significantly tapered towards head, very large distance between the fourth pair of prolegs and the last pair, etc.) are either not precisely reproduced, trace back to a larva with aberrations, reflect adaptations to other hostplants etc. or refer to another species. The truth about this can hardly be brought to light any more. But it is recommended to search for the larva of *C. celsiae* in continental Europe in the field (on *Scutellaria* in the first place, see below) in order to dispel the last doubts. It is very improbable but not completely impossible that there can be larger discrepancies to Cyprus.

Pupa

The pupa (Figs. 18–19) is a typical *Cucullia* without special characters. The colour is reddish brown with greenish brown thorax and wing sheets and a dorsal line of the same greenish colour. The proboscis sheet is darker redbrown and well developed with a bit widened and obtuse rear part. This rear part ends shortly in front of the beginning of the cremaster. The cremaster itself is broadly rounded without special markings or hooks as it is the case with other *Cucullia*, too. The pupa is quite similar to that of *C. xeranthemi* (colour, shape, proboscis sheet, cremaster) or some similar species of the Asteraceae-type.

Host plant and larval habitat

The larva is linked to *Scutellaria cypria* in Cyprus. All larvae and eggs have been recorded only on this plant. In captivity the larvae refused *Arabis purpurea*, *Cardamine pratensis* L., *Aubrieta* sp., *Alliaria petiolata* (M. Bieb.) Cavara & Grande (all Brassicaceae), *Stachys recta* L., *Glechoma hederacea* L., *Lamium maculatum* L. and *Origanum vulgare* L. (all Lamiaceae). Thus the larva is most probably monophagous on the genus *Scutellaria*. As *Scutellaria cypria* is endemic to Cyprus it is expected that the larvae live on related *Scutellaria,* e.g. *Scutellaria alpina* L., *S. albida* L. or *S. orientalis* L. in the Balkans. In all other parts of the distribution of *C. celsiae* also *Scutellaria* species occur. The highest species numbers of *Scutellaria* are found in Asia Minor (34 species), Iran (58 species) and the southern part of the former Soviet Union (148 species) (Minareci & Pekönür 2017).

Scutellaria cypria occurs in two subspecies in the West of Cyprus (Hand et al. 2018). The ssp. *elatior* with stems up to about 10–40 cm is found between 400 and 1150 m in the whole Troodos range and its surroundings. The ssp. *cypria* is a very small plant of rocks and similar pla-

ces between 525 and 1950 m in the Troodos *s. str.* (only Nicosia district). All larval records refer to *Scutellaria cypria* ssp. *elatior,* but it is probable that the other subspecies is also used. As there are also intermediate forms it is not yet clear if the two subspecies are really valid. In the Northeast of Cyprus another *Scutellaria* species, *S. sibthorpii* (Benth.) Halácsy, is found. Whether this species can also be used by *C. celsiae,* remains to be investigated in the field.

Scutellaria cypria and thus *C. celsiae* are species (larval habitat see Figs. 21-24) of steep embankments (Fig. 22) with rocks, screes, gravel and open fine soil substrate which is partly still moving (but not too much). It also occurs on other spots with bare or stony ground in open pine woodland. In the Troodos range it occurs on ophiolithic (mostly volcanic and usually acidic) ground (Figs. 21–23). Another ecological niche are stony limestone garigues and limestone cliffs with earth-rich crevices (Fig. 24) where the plant and the larvae could be observed e.g. near Agios Therapon. In grazed regions the plants often grow under the cover of small thorny subshrubs.

Thus the plant has a broad variety of site conditions from acidic to limestone ground. The common factor is the availability of open ground or rocks, stones or scree. These types of habitats and thus the plant and larvae are especially common in the Troodos/Paphos forest range and more local in the periphery. As the plant often occurs in small numbers on strictly confined places that are isolated through woodland or agricultural land, it is necessary that the moths are very mobile and stray through the landscape. Many of the records in lower regions (below the plant distribution) in Cyprus may result from such straying specimens.

But locally the plant might also occur lower as recognized at the moment. So *C. celsiae* is recorded for Marathounta near Paphos in 320 m (Lepiforum 2018) which is quite far away from other known places. But as *Orthostixis cinerea* (only on *Scutellaria*) has also been found there, it is quite probable that *Scutellaria* has local occurrences there e.g. in North-facing cliffs or boulders of surrounding hillsides.

The hostplant choice of *C. celsiae* was surprising at first because no other European *Cucullia* lives on Lamiaceae. But regarding the habitat requirements of *Scutellaria* (which are similar in some *Scutellaria* species occurring in the Balkans, Turkey, Iran or the Levant) it fits perfectly in the habitat pattern that is known from *C. celsiae* moths records: rocky slopes, sunny woodland with open ground on slopes, stony garigues and open maquis, screes. In Israel (Kravchenko et al. 2007) woodland clearings are reported as habitat. This corresponds well with the sites in open pine forest in Cyprus.

A similar change of hostplant as in *C. celsiae* took place in *Cucullia campanulae* Freyer, [1831], feeding on *Campanula* (Campanulaceae), which clearly derived from Asteraceae-feeding ancestors (closely related: *Cucullia balsamitae* Boisduval, 1840 on *Chondrilla,* Asteraceae).

According to my results the larvae of *C. celsiae* do not live on *Hesperis* or any other Brassicaceae in Cyprus. It is also quite improbable that they use *Hesperis* in Bulgaria. It is much more expectable that they use available *Scutellaria* species there. It is not clear whether Haberhauer (*in* Rebel 1903) has associated the larva with the wrong plant (he has beaten the larva, perhaps both plants occurred there), or another mistake occurred.

Life cycle

The egg is laid singly and obviously always on the lower side of the leaves of stems, especially those that will flower a few weeks later.

Even if the plant has a quite long flowering time from mainly April to November (peak in May), the most larvae feed on younger leaves and flower buds and are often already pupated when the main flowering time starts.

The larvae rest on the lower sides of leaves (when young) and on the stems or the developing inflorescences where they are very well camouflaged. At disturbance they drop from the plants to the ground where they twitch back and forth in the typical *Cucullia* manner. When the older larvae move, they commute their front body similar to larvae of the geometrid genus *Charissa* Curtis, 1826.

The larval development is very fast and lasts from hatching from the egg to the construction of the cocoon in warm conditions (above 22°C) only 14–17 days. In the field with cooler nights the larva should need about three weeks or even longer. In early April 2018 most larvae have been still quite small, but also mature ones have been recorded in Agios Therapon (640 m) in very sunny sites.

The main larval time in Cyprus should be April and the first half of May (according to spring temperatures). Larvae after mid-May should be exceptional, perhaps except for the highest regions or in cool years. In other regions (e.g. Balkans) the larvae are most likely to occur in May and the first half of June.

According to rearing observations pupation occurs in a dense cocoon in the soil typical for *Cucullia*. A more loose outer web is continued inwards in a very dense cocoon (Fig. 20). The pupa aestivates and hibernates (then presumably the moth has developed already partially) and the moths appear in spring (especially in February and March in Cyprus).

Cucullia gozmanyi (G. & L. Ronkay, 1994)

Three larvae (Fig. 25) and traces of three already pupated others have been recorded on *Verbascum (Celsia) daenzeri* (Fauché & Chaub.) O. Kuntze (determined after Zografidis & Strid 2017) in steep, open embankments and the bottom parts of high cliffs in open woodland interspersed with agricultural land (Fig. 26). The same

cliffs hosted *Papilio alexanor* (Esper, 1800) (one older butterfly and half-grown to fully-grown larvae). The flight time should have been in late March to mid-April in this southern site.

Cucullia gozmanyi is an SE European and presumably also Asian species with European records from NE Italy, E Austria, SE Czech Republic, Slovakia, Slovenia, Hungary, Romania, Serbia, Bulgaria and European S-Russia (Ronkay & Ronkay 1994, Fauna Europaea 2018). The records from South Greece (Peloponnese) indicate a more extended distribution in Greece (where ist was only known from the Rhodope Mountains so far, Beshkov 2017) and possibly also other parts of the S-Balkans (Albania?). It is also probable that the species will be found in Asia Minor in future.

The species remained hidden in Greece until now most probably because of its early flight time and possible confusion with other very similar members of the subgenus *Shargacucullia*.

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