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Description of the pupae of three western Palaearctic noctuids (Lepidoptera: Noctuidae: Heliothinae)

Popis kukel tří druhů západopalearktických můrovitých (Lepidoptera: Noctuidae: Heliothinae)

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Pupae, comparative morphology, taxonomy, Lepidoptera, Noctuidae, Western Palaearctic region

Abstract. The pupae of the following three western Palaearctic species of the Noctuidae (subfamily Heliothinae) are described: *Chazaria incarnata* (Freyer, 1828), *Pyrrhia victorina* (Sodoffski, 1849), and *Brithys crini* (Fabricius, 1775). The main morphological characters are illustrated and compared with related noctuid moth species, and the differences are discussed. The systematic status and position of described species in currently used systems is also discussed from the point of view of morphology of their pupae.

INTRODUCTION

This paper continues the work of Patočka (1996) and Patočka & Turčáni (2005). The taxonomic position of some noctuids is still not quite clear and various authors (e.g. Beck 2000, Fibiger & Skule 2007) place the same species in different subfamilies, tribes or genera. Its main aim is to study the external morphology of pupae and apply the results to poorly resolved questions regarding the taxonomy position of species/genera within the Noctuidae. However, it is difficult to propose changes in the currently used system only on the basis of the pupal stage, since species treated here originate from a single zoogeographical region. Other related species from different areas may have different morphological characters.

In the lepidopteran pupa, the external morphology is not covered by hairs and/or scales, and it is thus relatively easy to find many characters which may be used for identification but also to propose hypotheses on phylogenetic relationships (Patočka & Turčáni 2005). Here we describe the pupal morphology of species which have not been described in previous papers, or which were described incompletely, usually due to the lack of material.

MATERIAL AND METHODS

The pupae were loaned from the following institutions: National Museum of Natural History in Leiden (Naturalis, the Netherlands), the Zoological Museum in Amsterdam (ZMA, the Netherlands), and the Zoologisches Museum der Alex. von Humboldt Universität Berlin (ZMAHUB, Germany). Additional material comes from the Hungarian Natural History Museum Budapest (HNHM, Hungary) and the collection of the senior author. The methodology used is the same as in Patočka (1996) and Patočka & Turčáni (2005). Examined pupae originating from museums were usually pinned on extra pins without collecting data and we were only able to identify country of origin from adults in the same series.

RESULTS

Subfamily **Heliothinae**
Tribe **Heliothini**

Genus ***Chazaria*** Moore, 1881

Identification of this genus using the key to the genera of the family Noctuidae in Patočka & Turčáni (2005) leads to couplet 157. In that couplet, *Chazaria* differs distinctly from *Chloantha* Boisduval, Rambur et Graslin 1836, by many characters, e.g. by a conspicuously differentiated cremaster and much longer seta D2 (Figs 1, 6-8).

Pupae of *Chazaria* are characterised by a spindle-like body with the postclypeus and labrum shifted to the anterior end. The border between genae and proboscis is strongly oblique. Labium and prothoracic femora are large, prothoracic legs short. Antennae are much shorter than mesothoracic legs, and the latter are shorter than proboscis. Metathoracic legs are concealed (Fig. 1). Cremaster is big and conspicuously differentiated. Setae D2 are situated rather far from each other, long, spur-like, and parallel; L1 are much shorter and bristle-like (Figs 6-8).

This genus does not occur in Central Europe. One species ranges from southern Europe to Asia Minor and Eastern Europe (Anonymus 2007).

Chazaria incarnata (Freyer, 1838)
(Figs 1-8, 18)

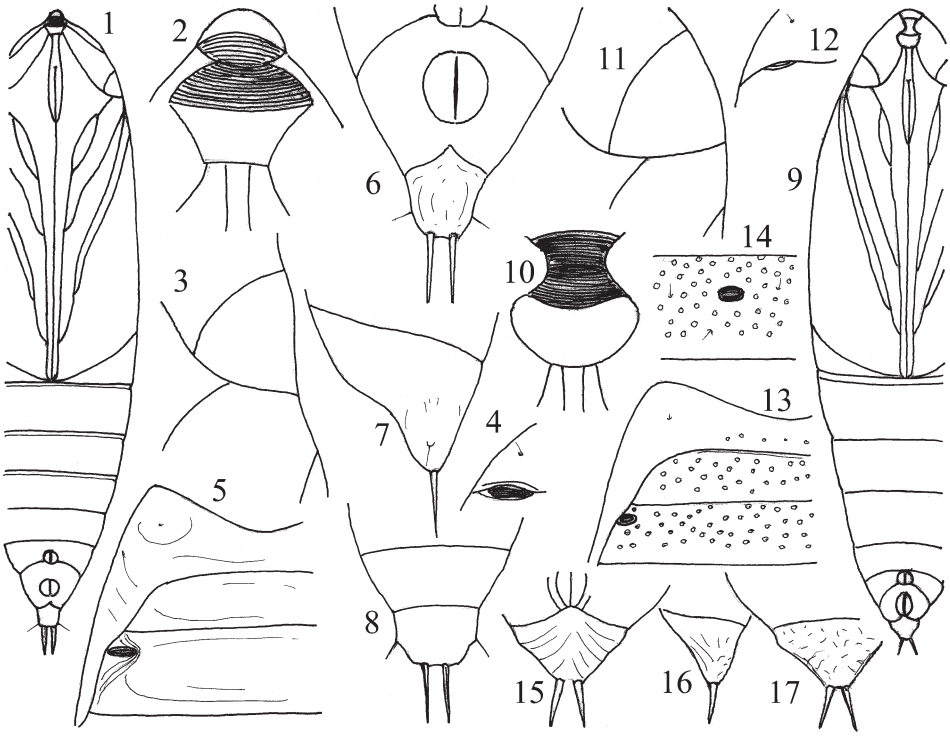
Material examined. l male pupa from Croatia, coll. HNHM.
Description of pupa (Fig. 1)**.** 18.0 × 5.2 mm, reddish ochre brown; exuvia brighter, rather opaque. Sculpture fine, base of abdominal segments 5-7 with dense, moderately-sized punctures. Setae tiny. Postclypeus elevated, blackish in colour. Labrum trapezoidal (Fig. 2). Thoracic spiracle slit-like with dark margins (Fig. 4). Metanotum moderately deep with arch-like emargination, frontal projections rather pointed. Abdominal spiracles narrowly elliptical (Figs 5, 18). Transition between segment 10 and base of cremaster oblique on ventral side (Fig. 7). Cremaster big, slightly tapering to end, slightly clubbed close to setae L2 but not cut out between setae D2. Setae D2 more tapering to the end and obtuse in lateral view (Figs 6-8). Their shape is described in the description of genus.
Ecology and distribution. The larva feeds on herbs, e.g. Silenaceae spp. It is distributed in the Mediterranean region, Eastern Europe, and south-western Asia (Kravchenko et al. 2007).

Genus ***Pyrrhia*** Hübner, 1821

The morphology of the pupa of this genus was described by Patočka (1996). Five species are distributed in Europe and four of them occur in central Europe and Slovenia (Nowacki & Fibiger 1996).

Pyrrhia victorina (Sodoffski, 1849)
(Figs 9-17)

In the identification of this species using the key to the genus *Pyrrhia* in Patočka & Turčáni (2005), couplets 1 and 2 need to be modified as follows:



Figs 1–17. 1–8: *Chazaria incarnata* (Freyer, 1828), 9–17: *Pyrrhia victorina* (Sodoffski, 1849). 1, 9 – pupa ventrally; 2, 10 – labrum area, ventrally; 3, 11 – oculus area, ventrally; 4, 12 – thoracic spiracle area, dorsally; 5, 13 – metanotum, base of abdomen, left side, dorsally; 6, 15 – end of abdomen, ventrally; 7, 16 – ditto, laterally; 8, 17 – ditto, dorsally.

Obr. 1–17. 1–8: *Chazaria incarnata* (Freyer, 1828), 9–17: *Pyrrhia victorina* (Sodoffski, 1849). 1, 9 – kukla ventrální pohled; 2, 10 – labrum a okolí, ventrální pohled; 3, 11 – oculus a okolí, ventrální pohled; 4, 12 – hrudní spirákulum a okolí, dorzální pohled; 5, 13 – metanotum, báze zadečku, levá strana, dorzální pohled; 6, 15 – konec zadečku, ventrální pohled; 7, 16 – dtto, laterální pohled; 8, 17 – dtto, dorzální pohled.

1 Setae D2 on cremaster long and slender, longer than cremaster dorsally and only slightly thickened at base. ... . *P. umbra* (Hufnagel, 1766)

– Setae D2 on cremaster medium in length, not longer than cremaster dorsally and thickened close to base. 2

2(1) Setae D2 on cremaster separated by moderate distance and convergent. .... *P. purpurina* (Denis et Schiffermüller, 1775)

– Setae D2 on cremaster inserted close together and divergent (Figs 15-17). ..... *P. victorina*

Material examined. 1 male pupa from Croatia, coll. Naturalis; 1 male pupa from Croatia, coll. ZMA.

Description of pupa. 14.5-15.8 × 4.5-4.9 mm, spindle-like (Fig. 9), purple brown and almost opaque. Sutures and incisions darker. Sculpture moderately fine, moderately scabrous somewhere. Puncturation (Figs 13-14) shallow, widely spaced on notum, denser on abdominal segments 1-8, denser and deeper on the base of middle abdominal segments. Setae tiny, visible

on segments 8 and 9 only at 50 × magnification (otherwise invisible). Postclypeus and labrum (Fig. 10) shifted to frontal end of pupa, border between genae and proboscis oblique (Fig. 9). Postclypeus elevated in the centre, black in colour. Labrum arch-like, rounded caudally and laterally (Fig. 10). Border between proboscis and oculus long, border between prothoracic leg and antenna relatively short (Fig. 11). Profemora relatively big. Proboscis extending far beyond mesothoracic legs, the latter extending beyond antennae. Metathoracic legs concealed or inconspicuous (Fig. 9). Thoracic spiracles slit-like with dark frame (Fig. 12). Metanotum widely arched with shallow median emargination; frontal projections rather sharply rounded (Fig. 13). Abdominal spiracles narrowly elliptical (Fig. 14). Abdominal segment 10 merging with cremaster slightly obliquely on ventral side (Fig. 15). Cremaster tapering in ventral, dorsal and also lateral view, its surface moderately wrinkled (Figs 15-17). Setae D2 on cremaster, moderately long, enlarged at base, spur-like, widely separated from each other and divergent. Cremaster not emarginate between their bases.

Ecology and distribution. The larva feeds on *Dictamnus* and allegedly also on *Salvia* (L. Traxler, pers. comm.). It is distributed in south-eastern Europe and Asia Minor (Anonymus 2007).

Tribe **Glottulini**

Genus ***Brithys*** Hübner, 1821

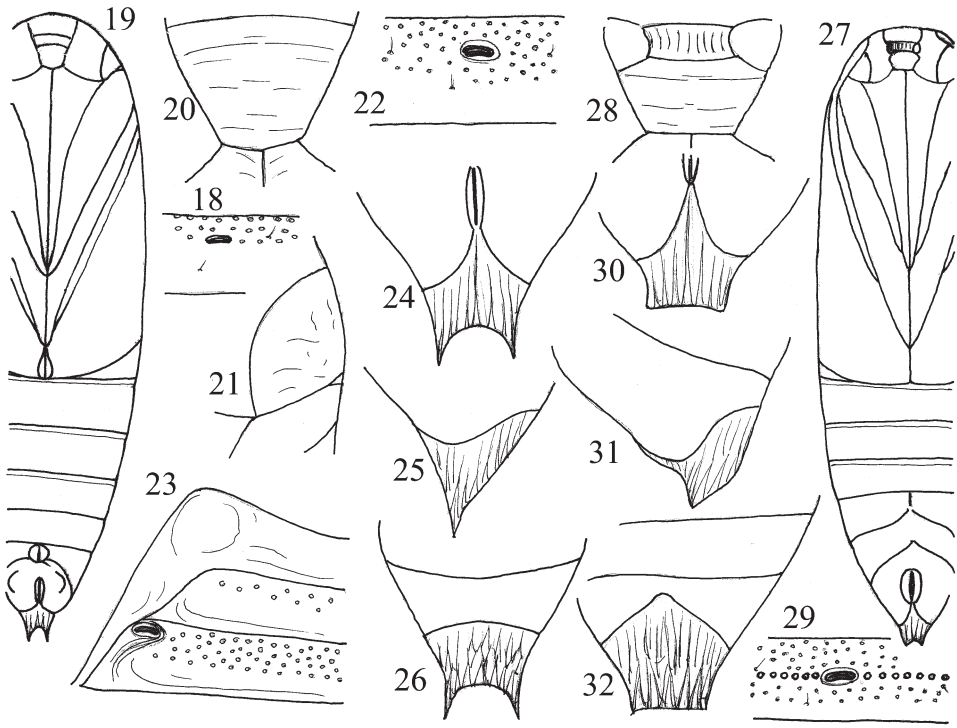
Identification of the genus *Brithys* leads to couplet 2 in the key to the genera of the family Noctuidae in Patočka & Turčáni (2005). It differs from the genera *Brachionycha* Hübner, 1819, and *Asteroscopus* Boisduval, 1828, mainly by the shape of the cremaster, which is longitudinally furrowed and ribbed and bears teeth in corners (Figs 24-26, 30-32) (not with a disc-like, clubbed spur at the end as in the latter two genera). *Brithys* also differs by concealed prothoracic femora (Figs 19, 27). The genus *Xanthodes* Guenée, 1852, also has a concealed labium but differs from *Brythis*, *Brachionycha* and *Asteroscopus* mainly by the proboscis, which is not shortened and extends far beyond prothoracic legs, and by the slightly differentiated cremaster with only moderately short, blunt and divergent setae D2.

Pupae of *Brithys* are larger, moderately stout, spindle-like and obtuse at the ends. The labium is concealed. The proboscis is short, at most slightly extending beyond the prothoracic legs. The prothoracic femora are concealed (Figs 19, 27). The cremaster is wide from ventral and dorsal view, emarginate at the end, and terminating in a shorter or longer tooth at the corners. It has a longitudinally ribbed and furrowed sculpture (Figs 24-26, 30-32).

One species of the genus is distributed locally in western Europe and the Mediterranean region. The species also lives in Africa, southern and eastern Asia, and Australia (Herbison-Evans & Crossley 2007) but not in Central Europe (Nowacki & Fibiger 1996, Fibiger & Skule 2007).

Brithys crini (Fabricius, 1775)
(Figs 19-32)

Material examined. 2 male, 5 female pupae from Italy; 2 female pupae from Spain, coll. Patočka and ZMAHUB.



Figs 18–32. 18: *Chazaria incarnata* (Freyer, 1828), 19–26: *Brithys crini* (Fabricius, 1775) from Italy, 27–32: *Brithys crini* from Spain. 18, 22, 29 – area around spiracle on abdominal segment 5, laterally; 19, 27 – pupa ventrally; 20, 28 – labrum area, ventrally; 21 – oculus area, ventrally; 23 – metanotum, base of abdomen, left side, dorsally; 24, 30 – end of abdomen, ventrally; 25, 31 – ditto, laterally; 26, 32 – ditto, dorsally.
Obr. 18–32. 18: *Chazaria incarnata* (Freyer, 1828). 19–26: *Brithys crini* (Fabricius, 1775) z Itálie. 27–32: *Brithys crini* ze Španělska. 18, 22, 29 – spirákulum 5. zadečkového segmentu a okolí, laterální pohled; 19, 27 – kukla, ventrální pohled; 20, 28 – labrum a okolí, ventrální pohled; 21 – oculus a okolí, ventrální pohled; 23 – metanotum, báze zadečku, levá strana, dorzální pohled; 24, 30 – konec zadečku, ventrální pohled; 25, 31 – dtto, laterální pohled; 26, 32 – dtto, dorzální pohled.

Description of pupa (Fig. 19)**.** 20-24 × 6.5-8.0 mm, red to blackish brown, glossy, intersegments between segments 5-7 brighter, brownish red. Sculpture (except of cremaster) moderately fine, locally medium scabrous. Puncturation present on abdominal segments 2-7, denser at the base of segments 5-7 (Figs 22-23, 29). Labrum trapezoid (Figs 20, 28). Labium and prothoracic femora concealed. Mesothoracic legs extending beyond antennae (Figs 19, 27). Thoracic spiracle slit-like. Abdominal spiracles narrowly elliptical, with a slightly brighter frame, sitting in elliptical fields (Figs 22-23, 29). Cremaster wide in ventral view with conspicuous ribs and furrows, emarginate at the end with two horns (Figs 24-26, 30-32).

The individuals from Italy do not bear an enlarged transverse row of pits near the spiracles on middle abdominal segments (Fig. 22). They also have a less conspicuous, elevated and darkened postclypeus, the caudal side of labrum is bent (Fig. 20), the proboscis does not reach the prothoracic legs, the antennae are slightly shorter than mesothoracic legs, the latter ones

touch exposed ends of metathoracic legs (Fig. 19), the genae are adjacent to the prothoracic legs and oculi to proboscis at point (Fig. 21), and the cremaster has long teeth in the corners in ventral and dorsal view, prevailing longitudinal ribs and furrows on its dorsal side, and appears sharply wedge-like in lateral view (Figs 24-26).

On the other hand, the female pupae from Spain have an enlarged row of pits near the spiracles on middle abdominal segments (Fig. 29), the postclypeus is narrow, elevated and darkened, the caudal side of labrum is straight and not bent (Fig. 28), the proboscis extends beyond the prothoracic legs, the antennae are conspicuously shorter than the mesothoracic legs, which are concealed by forewings that meet each other shortly (Fig. 27), and the cremaster is domed dorsally in lateral view, with short teeth in the corners in ventral and dorsal view, and has more irregular ribs and reticulations on the dorsal side (Figs 30-32).

Pupae from both regions are thus morphologically relatively different; they may represent two distinct subspecies or species.

Ecology and distribution. The larva of *Brithys crini* feeds on *Pancratium maritimum* in Europe (Mazzei et al. 2007) and on other plants of the family Amaryllidaceae elsewhere. The species is considered as pest in some regions (Herbison-Evans & Crossley 2007).

DISCUSSION

The subfamily Heliothinae in the sense of Fibiger & Skule (2007) includes two tribes with very different pupal morphology: The Heliothini are characterised by an unusually large proboscis, which extends far beyond the prothoracic legs and shifts the labrum and postclypeus to the anterior end of the pupa. The large proboscis might be an adaptation to a long adult lifespan, travel on long distances, and therefore high energy consumption. Indeed, several species of this tribe are known as migrants. The cremaster has lost its fixing function (Patočka & Turčáni 2005), and its adaptation to a supporting function in this tribe is common to the family Noctuidae – via the reduction of its setae to only two D2 setae which are long, more or less robust and pointed, and adapted to aid in the eclosion from the cocoon.

The tribe Glottulini, with its single European genus *Brithys*, belongs to the few Noctuidae with the whole labium concealed. They also have a conspicuously shortened proboscis and cremaster with two horns. This co-adaptation is analogous to the family Notodontidae and is probably the result of a similar lifestyle: the adults are short-lived and do not need to feed extensively, thus the mouthparts are strongly reduced. A short cremaster with two horns is an adaptation to pure supporting function; its fixing function has been lost (probably as in *Pheosia* Hübner, 1918, or *Pterostoma* Germar, 1812, from the family Notodontidae).

Based on pupal morphology, we therefore suggest an arrangement of two subfamilies, the Heliothinae and the Glottulinae (including the genus *Brithys*), as listed by Nowacki & Fibiger (1996). This position of *Brithys* seems to be more likely than its inclusion into the subfamily Heliothinae as in Fibiger & Skule (2007) or as a separate tribe Glottulini in the subfamily Hadeninae as in Beck (2000). However, the morphology of pupae reflects a limited set of morphological characters over the entire lifetime of an individual, and we therefore only consider the division as a recommendation for taxonomists to consider in the future placement of noctuid species.

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SOUHRN

V práci jsou uvedeny popisy a nákresy hlavních morfologických znaků kukel tří západopalearktických druhů čeledi Noctuidae (podčeledi Heliothinae): *Chazaria incarnata* (Freyer, 1828) a *Pyrrhia victorina* (Sodoffski, 1849), které reprezentují tribus Heliothini, a *Brithys crini* (Fabricius, 1775), který reprezentuje tribus Glottulini. Z hlediska morfologie kukel jsou tyto triby velice odlišné: tribus Heliothini se vyznačuje neobyčejně velkým rozvojem proboscisu, který daleko přesahuje střední nohy a vytlačuje labrum a postclypeus kukly až na její přední konec. Tribus Glottulini s jediným evropským rodem *Brithys* patří k nemnohým Noctuidům, kteří mají zakryté celé labium a přitom mají značně zkrácený proboscis a dvojrohý kremaster. V práci se rovněž diskutuje systematický status a pozice popsaných druhů můr v současném systému z hlediska morfologie jejich kukel.

Rozdíly v morfologii zkoumaných kukel indikují, že by mohly patřit do dvou rozdílných podčeledí (Heliothinae a Glottulinae (s rodem *Brithys*), jak to uvádějí Nowacki a Fibiger (1996). Z tohoto hlediska je méně vhodné přiřadit rod *Brithys* k podčeledi Heliothinae ve smyslu práce Fibiger a Skule (2007) anebo k podčeledi Hadeninae, kam ji řadí Beck (2000) jako samostatný tribus Glottulini. Kukly *Brithys crini* ze Španělska se navíc morfologicky liší od kukel z Itálie.