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Preimaginal stages of *Smerinthus kindermanni*, and comparison with *S. ocellata* (Sphingidae)

Alexander Pelzer

Dorfstr. 20, D-30974 Wennigsen, Germany

Summary. The preimaginal stages of *Smerinthus kindermanni* Lederer, 1853 — egg, 5 larval instars and pupa — are described and figured. Diagnostic characters to separate this species from *S. ocellata* (Linnaeus, 1758) are defined.

Zusammenfassung. Die Präimaginalstadien von *Smerinthus kindermanni* Lederer, 1853 — Ei, 5 Raupenstadien und Puppe — werden beschrieben und abgebildet. Unterscheidungsmerkmale zwischen dieser Art und *S. ocellata* (Linnaeus, 1758) werden hervorgehoben.

Résumé. Les premiers états de *Smerinthus kindermanni* Lederer, 1853 — œuf, 5 états larvaires et chrysalide — sont décrits et illustrés. Les caractères diagnostiques de cette espèce par rapport à *S. ocellata* (Linnaeus, 1758) sont définis.

Key words: Sphingidae, *Smerinthus, kindermanni*, immature stages, ovum, larva, pupa, determination.

Introduction

The biology of *Smerinthus kindermanni* Lederer, 1853 is rather poorly known. The larval host plants have been stated to be willows (*Salix*) or rarely poplars (*Populus*; Salicaceae) in several faunistic reports, but apart from that information is scanty.

Butler (1880) gave a line drawing of the pupa and some details on coloration of the full-grown larva, stating that the larva is very well camouflaged. Pittaway (1993), apparently citing Shchetkin *et al.* (1988, not seen), described the full-grown larva and the pupa, adding a brief description of the egg.

In the Middle East, the ranges of *S. kindermanni* and *S. ocellata* (Linnaeus, 1758) overlap considerably. For faunistic purposes and for research in parasitoids, it would therefore be helpful to tell the two species apart also in their early stages. The diagnostic characters have so far been overlooked. E. g., a photograph of a green last instar larva of *S. kindermanni* in Pittaway (1993, plate C, fig. 3) shows them, while the drawing

of the same specimen (*l. c.*, plate 1, fig. 7) does not. Nevertheless, such features do exist, as is the case in the related sibling species pair *Laothoe populi* (Linnaeus, 1758), *L. amurensis* (Staudinger, 1892) (Pelzer, 1988).

This paper is based on own observations, obtained by breeding the species over several generations. The parent animals were from Turkey (Konya and Maraş provinces).

The insects were kept under room conditions, with maximum temperatures during the day between 20 and 25° C, dropping off at night. The insects were exposed to variable day lengths, according to season (spring to autumn).

As the main objective is the identification of living specimens, characters that are not visible with a hand lens (×20) in the intact animal are not dealt with.

Description of early stages

In dealing with hawk-moth larvae, two "mathematical" characters have proved useful. These are the *ratio of caudal horn length to clasper length* (H/C) and the *ratio of anal flap length to clasper length* (A/C). Anal flap length (*a*) and clasper length (*c*) are defined in fig. 1, *e*; caudal horn length is similarly defined as the distance between horn base and the tip of the (straight) horn. These characters are quite reliable as they do not change between successive moults.

Egg. The egg is macroscopically very similar to that of *S. ocellata* (Shchetkin *et al.*, 1988, after Pittaway, 1993). It is yellowish green, shiny, often developing a shallow depression after some days of development. — The larva hatches after about 8 days.

First instar larva. As is usual in Smerinthine hawk-moths, numerous secondary setae make the larva appear rough. It is yellowish green and has a faint whitish subdorsal line. The head is round, the claspers are conspicuously pointed. The reddish-brown caudal horn is rather long. The ratio of horn length to clasper length (H/C) is about 2.2, the ratio of anal flap length to clasper length (A/C) is about 0.7. — This stage lasts for about 4 days.

Second instar larva. The larva appears to be very rough because of numerous tubercles representing chitinous swellings at the

bases of the tiny setae. It is whitish green. The head is pointed, bluish green, with yellow edges. The tubercles on top of the vertex ('main tubercles') are enlarged and tinged with orange on the inside. The markings consist of a whitish subdorsal line and 6½ oblique lines, all of rather low contrast. The horn is pale reddish brown, the tubercles and spiracles are white. H/C is about 2.0, A/C is about 0.6. — This stage lasts for about 3 days.

Third instar larva. The general colouring is the same as that of the second instar. The ground colour is even more whitish. I have not observed a yellowish green phase in this instar. The subdorsal line is restricted to the thorax, as in all *Smerinthus* species I have seen. On the first abdominal segment, it bends upward, thus forming the upper half of a first oblique line. The oblique line entering the horn is broader and more conspicuous than the others. The main tubercles are tinged with red, mainly on their insides. H/C is about 1.5, A/C is about 0.7. — This instar lasts for about another 4 days.

Fourth instar larva. In this instar, two colour phases occur. One is very reminiscent of the third instar, the other one is yellowish green with more conspicuous markings. In both forms, the spiracles are orange brown with white centres. The caudal horn is blue, at least on top. H/C is about 1.4, A/C is about 0.7. — This instar lasts for about 5 days.

Fifth larval instar. Again, there are two colour phases: whitish blue-green and yellowish green. The latter is said to be more common (Shchetkin *et al.*, 1988, after Pittaway, 1993). The head is rounded without enlarged main tubercles. The spiracles are contrasting brown with white centres. The claspers are still distinctly pointed. The caudal horn is blue with blackish tip. H/C is about 1.2, A/C is about 0.8. — This last instar lasts remarkably longer, i.e. from 8 to 10 days.

In the *prepupal phase*, the back of the larva becomes suffused with reddish brown. The wandering phase lasts for about 1 day, and it takes another 5 days before pupation takes place.

Pupa. Deep mahogany brown, but otherwise resembling *S. ocellata* (Shchetkin *et al.*, 1988, after Pittaway, 1993). Somewhat less shiny than *S. ocellata.* The minimum time observed between pupation and eclosion of the adult moth was 19 days. Colour changes prior to hatching are slight; however, the wing pattern

is discernible rather early during development. — This is the hibernating stage.

Comparison with *S. ocellata*

The egg of *S. kindermanni*, though glossy, appears to be more wrinkled and dull in comparison with *S. ocellata*, where it is less wrinkled and even more shiny. It is probable that there are (at least statistical) morphological differences in the micropylar area. However, these do not show up at ×20 magnification.

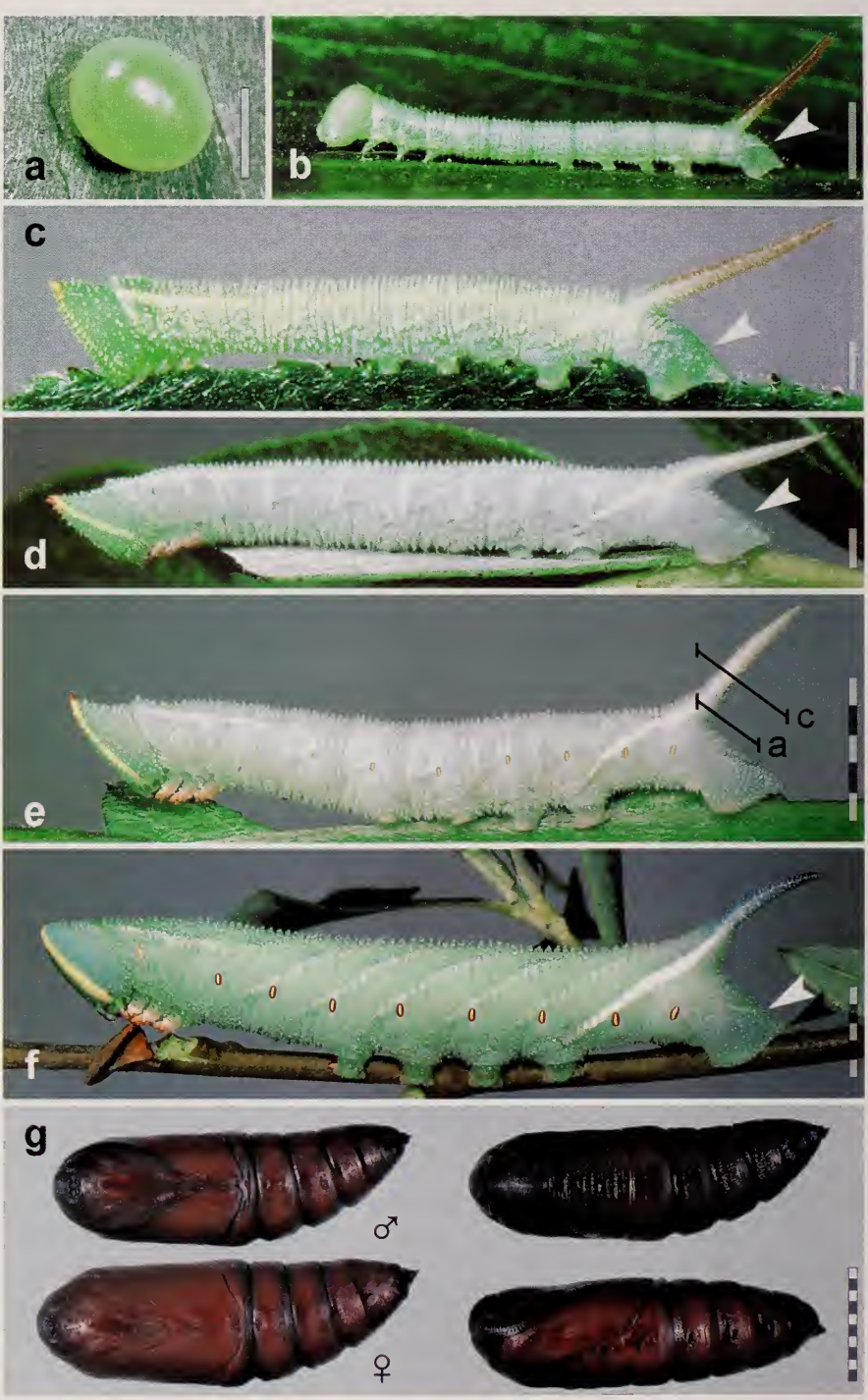
In the first instar of *S. kindermanni* the caudal horn is light reddish brown and relatively long. In *S. ocellata* (see e.g. Pelzer, 1995) it is darker brown and short (H/C 1.3 to 1.7). The clasper is less pointed (A/C ≈ 0.7).

In the second larval instar of *S. kindermanni* the spiracles are inconspicuously coloured, the main tubercles on the vertex are tinged lightly with orange, and the horn is light. In *S. ocellata* the spiracles are dark; the main tubercles are red, comparatively larger than in *S. kindermanni*, bulging, and the horn is darker (H/C ≈ 1.5, A/C ≈ 0.7).

In the third larval instar of *S. kindermanni* the horn is light, the spiracles are colourless, and the main tubercles are pink to orange. In *S. ocellata* the horn has a dark streak on its upperside, the spiracles are dark, almost blackish, and the main tubercles are bright red. The claspers end in almost rectangular tips from this instar onwards (H/C ≈ 1.6, A/C ≈ 0.8).

In the fourth larval instar of *S. kindermanni* the main tubercles are whitish yellow on the outside and reddish on the inside. The spiracles are orange brown with white centres. In *S. ocellata* the main tubercles are red to dark red on the inside. The spiracles are brown with white centres (H/C ≈ 1.3, A/C ≈ 0.9).

The fifth instar *S. kindermanni* is said to be shorter and much more slender than *S. ocellata* when fully grown; also, the anal horn is said to be more stout but less erect (Pittaway, 1993). On the average, *S. kindermanni* is somewhat smaller than *S. ocellata*. However, there is no way of telling the two species apart on the basis of general body or caudal horn shapes. In *S. ocellata* (see e.g. Pelzer, 1991), the lateral oblique stripes are often emphasised dorsally by a dark border. The spiracles are almost black with white centres (H/C ≈ 1.2, A/C ≈ 0.9).



In *S. ocellata* red or brown subdorsal spots are common from the third instar onwards. Similar spots are likely to occur in *S. kindermanni* as well, but I did not see any examples. In general, the colouring of *S. ocellata* is more contrasting. Especially the so-called countershading is much more pronounced: the belly is conspicuously darker than the back (de Ruiter, 1956).

The prepupa of *S. ocellata* is hardly suffused with brown but tends to darken all over. The countershading becomes even more conspicuous than before.

The pupa of *S. ocellata* (see e.g. Pelzer, 1996) is very dark brown, almost black, and glossy as if polished.

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Fig. 1. Preimaginal stages of *Smerinthus kindermanni*: *a* - egg; *b* — *f* 1st to 5th instar larvae; g — pupae: female (♀) in ventral view, male (♂) in ventral, lateral and dorsal views.

In *e* definition of anal flap length (a) and clasper length (c). *White arrowheads* point to tip of anal flap in *b* to *d* and in *f, black arrowhead* points to tip of clasper in *f*. *Scale bar*: division in mm.