

Notes on the early stages of *Scoparia ambigualis* (Treitschke, 1829) and *Eudonia pallida* (Curtis, 1827) (Lepidoptera: Pyralidae)

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Synopsis

Accounts are given of the ova and larvae of *Scoparia ambigualis* (Treitschke, 1829) and *Eudonia pallida* (Curtis, 1827); it is noted that the early instars of the latter occurring from the autumn to spring differ from those occurring in the summer.

Key words: Lepidoptera, Pyralidae, *Scoparia ambigualis*, *Eudonia pallida*, ovum, larva.

Introduction

The ovum of *Scoparia ambigualis* was described from captive material as long ago as 1901, together with a brief account of the first instar larva. A fuller description was published in 1921. The larva was not found in the wild until 1986, the final instar was not described until 2004 and the other instars do not appear to have been noted until now. The ovum and first and last instars of *Eudonia pallida* were described from captive material in 1924, but apparently it was not until 2003 that a larva was found in the wild, and was described the following year. This paper provides observations on the ovum and early instars of *S. ambigualis* and a fuller account of the ovum and instars of *E. pallida*, noting that in the latter species there is a difference, both in the habits and appearance of the early instars, between those occurring in the autumn to spring and those in the summer.

Scoparia ambigualis (Treitschke, 1829)

Buckler (1901: 188) appears to have been the first to give an account of the ovum and the first, but no other, instar from ova that he had received on 18 August 1871. He does not illustrate either and all that he says is:

‘The egg is rather ovate in shape, of a pale brown colour, changing to darker and finally to greyish-brown before hatching.

The young larvae began to hatch on the 20th of August. They were at first very pale drab with brown heads and plates.’

Schille (1921: 46), whose paper deals only with the ova of certain species, gives a comprehensive description of the ovum, as follows:

‘The egg is 0.42 m/m long, 0.32 m/m wide, large compared to the size of the moth, lying type [meaning longest axis parallel to the substrate], very broad in proportion to length, oval, evenly shallowly rounded towards both ends, after having been deposited light reddish white, dull, barely shining, smooth, under

strong magnification the surface appears to be densely covered with extremely fine, deep dimples, coarse.'

(‘Das Ei ist 0.42 *m/m* lang, 0.32 *m/m* breit, zur Faltergröße groß, Liegetypus, im Verhältnis zur Länge sehr breit, oval, zu beiden Enden gleichmäßig flach abgerundet, nach Ablage licht rötlichweiß, matt, nur wenig glänzend, glatt, bei starker Vergrößerung erscheint die Oberfläche mit äußerst feinen, tiefen Grübchen dicht besetzt, derb.’)

Schwarz (1965: 167–168) provides references for the published biology of 23 species of Scopariinae. Under *S. ambigualis* he refers to Schille's account of the ovum, and says that he, Schwarz, has completed the description by figuring a micropyle of the ovum (1965: 164, fig. 3). He states that Buckler illustrates the larva, even though he does not, and mentions that Hasenfuss (1960: 170) describes the chaetotaxy of the larval head, although in fact Hasenfuss also figures the chaetotaxy of the prothoracic plate and pinaculum immediately before the first spiracle (1960: 170, fig. 182). Schwarz ends by saying that the pupa is undescribed.

Bland was apparently the first to have noted the larva in the wild when he found one in 1986 feeding on the superficial layers at the base of the stem and upper part of the root-stock of *Valeriana officinalis* L. Unfortunately, as he acknowledged, he made no larval description (Bland, 1987: 40–41).

It was not until 2004 that the final instar was described (Smith, 2004: 103–107; Heckford & Sterling, 2004: 148–151) from larvae found amongst various species of moss, with Smith providing both photographs and a figure of the larva.

Thus, apart from Buckler's brief description of the first instar larva, hitherto the early instars appear to be undescribed.

Biology

On 4 July 2006, I found a pair of mating *Scoparia ambigualis* on the Isle of Skye, North Ebudes, Scotland (V.C. 104). They were kept in a container with the moss *Polytrichum commune* Hedw. and the following observations were made from the resulting ova, which were laid after a few days.

In their first instar, when they were offered only *Polytrichum commune*, the larvae spun some fine silken strands at the junctions of the stems and the leaves of this moss, which appeared to serve as ‘cushions’, and curled up on these strands when not feeding. Often there were several larvae to each moss stem but no more than one larva rested on the silken strands at any one junction of stem and leaves. Although parts of the strands touched both the stem and upper surface of the leaves, the larvae did not attach themselves to either substrate. Seen without magnification the larvae appeared to be suspended in mid-air above the leaves. This habit of resting on a ‘cushion’ of fine silken strands on the leaves and with several larvae to a stem continued into the second instar. Unlike one of the earlier instars of *Eudonia pallida* described below, the larvae did not produce silken tubes in any instar.

As the larvae grew they dispersed, but in all instars when they were not feeding they would usually curl up with their heads just above abdominal

segments 10, no longer on 'cushions' of silk but beneath or amongst a mixture of frass and silken strands.

In their early instars the larvae ate only the leaves of the moss, producing pale greenish or yellowish granular frass, which in later instars became reddish brown. As they grew the larvae were offered the mosses *Rhytidiadelphus loreus* (Hedw.) Warnst. and *Dicranum scoparium* Hedw. as well as *Polytrichum commune*, and also fragments of dead fronds of *Pteridium aquilinum* (L.) Kuhn, which were all plants and material amongst which I had found larvae previously in Devon, England. The larvae readily ate all the mosses, including the stems of *Polytrichum commune* and *Dicranum scoparium*, but none of the fragments of *Pteridium aquilinum*.

Description

Ovum. Ovum phase *ca* 12 days. Asymmetrically ovoid, surface slightly dimpled. Pearly white at first, after a few days turning orange; a day or so before hatching the larva can be seen, without the aid of magnification, lying in a semi-circle, the black head being particularly noticeable.

The ovum must have some plasticity when laid because the surface that comes into contact with the substrate tends to mould itself to the substrate, and what can best be described as the upper surface is comparatively flat when seen from above. The ova were laid in straight rows of between two and six which were either fixed to the container, at the junction of the base and side, or in straight rows along the stems of the moss, with the more pointed pole of one ovum overlapping a small part of the more rounded pole of the next ovum.

Larva. *First instar.* Head shiny, black, labrum and clypeus dull greenish black; prothoracic plate slightly translucent, pale olive brown; body dull greenish or yellowish white with greenish gut contents usually visible, pinacula small but conspicuous, sclerotized, pale olive brown, the four dorsal pinacula on thoracic segments 2 and 3 not rhomboid as they are in the final instar but almost oval, but, like the final instar described by Heckford & Sterling (2004: 148–151), there is no sclerotized area straddling the median area posterior to these pinacula on those two segments; peritremes of spiracles pale olive brown; anal plate slightly translucent, pale olive brown; thoracic legs translucent whitish with some black markings on femur and tibia; ventral and anal prolegs translucent whitish, without the almost square black mark within the planta which later instars have, crochets black.

Later instars. As the larva grows the head becomes yellowish brown, orange-brown or honey-brown, the prothoracic plate becomes pale brown but remains slightly translucent, the body colour becomes grey, sometimes with a greenish tinge and sometimes dark, almost blackish, grey, and yellowish grey posteriorly, the pinacula become larger, grey or dark grey and always slightly darker than the body colour, the four dorsal pinacula on thoracic segments 2 and 3 become more rhomboid, the anal plate becomes grey or dark grey and similar in colour to that of the pinacula on abdominal segment 9, and an almost square black mark develops within the planta.

***Eudonia pallida* (Curtis, 1827)**

Chrétien (1924: 36–38) describes the ova and the first and last instar larva from ova laid by one or more captive females. He says that the ova were

ellipsoid and compressed at the edges, initially yellowish white, becoming rose, and that larvae emerged 10–12 days after the ova were laid. He provided the larvae with moss, species not stated, which they ate little by little. The larvae over-wintered when very small within thin silken strands amongst the moss. The only description that he gives of the first instar is that after several days their appearance became glassy, glossy, with a faint green tint; that given of the final instar is similar to that set out below, which was made from my observations of larvae found in January and again in September 2008.

It appears that it was not until 2003 that the larva was discovered in the wild, when one individual, possibly in its third instar, was found within a very small, frass-covered, silken ball spun to the moss *Calliergonella cuspidata* (Hedw.) Loeske on 19 April, at Gwithian Green, Cornwall, England (V.C. 1). In captivity the larva produced a silken gallery along the stem of the moss and because it was reluctant to leave this it was difficult to observe. It was noted that in this instar the larva appeared to have a brown head and prothoracic plate and a brown body with slightly darker pinacula (Heckford & Sterling, 2004: 151–152). A fuller description was provided of the final instar, which more or less agrees with the one set out later in this paper, based on larvae found in January and September 2008.

The only other published record of larvae being found in the wild of which I am aware of is that of Wegner & Kayser (2006: 25–26). They state that four larvae, which they do not describe, were found on 20 April 2003 within silken tunnels amongst the moss *Pleurozium schreberi* (Brid.) Mitt. and two moths emerged on 11 and 12 July 2003. Interestingly, the locality where they had previously found a considerable number of adults was a dry heath with *Calluna vulgaris* (L.) Hull. In the British Isles, *E. pallida* usually occurs in damp or wet habitats such as marshes, fens and bogs although it has also been found in mossy areas on sand dunes.

Biology

In January and September 2008 I collected larvae at Dawlish Warren National Nature Reserve, Devon (V.C. 3), a Site of Special Scientific Interest, and during late May to early June 2008 obtained ova from three moths caught at the same locality. The larvae found in the wild differed from those reared from ova, both in appearance and also in their habits in the early instars, described below. The moths resulting from the ova had a slightly shorter wingspan than those from larvae found in the wild but otherwise looked macroscopically similar. Genitalic preparations were made but these did not reveal any differences.

On 6 January 2008 I found five larvae, all about 4 mm in length, low down amongst the moss *Calliergonella cuspidata* in a damp, but not marshy, area. Each larva was within a semi-translucent, whitish silken tube attached to the moss, which had no plant material or frass adhering to it (Fig. 1); in captivity the larvae would emerge from these tubes to feed. From the next instar until they pupated they created frass-covered balls or loose spinings, but not tubes,

amongst frass and moss and they would usually remain within these. The frass was granular and yellowish brown or reddish brown.

The larvae were kept indoors and accepted *Calliergonella cuspidata*, *Pseudoscleropodium purum* (Hedw.) Fleisch. and another species of ground-dwelling moss that I was not able to identify. Moths were reared from all the larvae between 27 February and 2 April 2008.

During a return visit on 21 May 2008, I saw several adults flying from about 21.00 hours in the same area where I had found the larvae. I caught one female, which was kept in a container without any potential larval foodplant and 35 ova had been laid by 23 May 2008. On 6 June 2008, in a different area at the same locality, viz. sand dunes with an extensive area of moss, I caught two females each of which I kept in separate containers with some *Calliergonella cuspidata*; within a few days both females had laid several ova. As the initial colour and subsequent changes of colour do not entirely match Chrétien's observations, I set out mine later in this paper.

In their first instar, when they were offered only *Calliergonella cuspidata*, the larvae spun some fine silken strands between the leaves of this moss and also at the junctions of the stems and leaves, which, like those produced by *Scoparia ambigualis*, appeared to serve as 'cushions' on which they curled up when not feeding. Again, like the larvae of *S. ambigualis*, although often there were several larvae to each moss stem no more than one larva rested on the silken strands at any one junction of stem and leaves or between leaves. In this instar the larvae ate the leaves of the moss as well as parts of the stem or branch, but only where this was green and towards the tip. The frass was pale green and granular.

From the next instar until they pupated they created frass-covered balls or loose spinings amongst the moss, like those produced by the larvae found in January, and the larvae usually remained within these; at no stage did they spin silken tubes. The frass was yellowish brown or reddish brown and granular. The larvae accepted the same mosses as those collected in January. All were kept indoors and moths emerged between 28 July and 2 September 2008.

On 13 September 2008, in the same area as on 6 January 2008, I found one larva, about 3 mm in length, again situated low down amongst the moss *Calliergonella cuspidata* and within a semi-translucent, whitish silken tube attached to the moss. This was kept indoors and it was clear from the frass produced that the larva fed from time to time, but I never saw it do this, or leave its tube. By the end of the month the larva was about 4 mm in length; I was only able to note this by encouraging the larva out of its tube. By 18 October 2008 it appeared to have gone into diapause because not only was frass not being produced but both ends of the tube had now been sealed, with the larva just visible within. At that stage I introduced a species of *Sphagnum* into the container to prevent desiccation. I looked at it from time to time and on 27 December 2008 noticed that both ends of the tube were open. The larva was now about 5 mm in length and feeding in a loose spinning amongst the *Sphagnum*. It fed on this until it spun a cocoon towards the end of January 2009 and a moth emerged on 24 February 2009.



Fig. 1. Larval tube, with larva, of *Eudomia pallida*; i.2008.

Photo: R. J. Heckford



Fig. 2. Early instar larva of *Eudomia pallida*; i.2008.

Photo: R. J. Heckford



Fig. 3. Penultimate instar larva of *Eudonia pallida*; i.2008.

Photo: R. J. Heckford



Fig. 4. Final instar larva of *Eudonia pallida*; i.2008.

Photo: R. J. Heckford

I assume that in the wild the larvae will also go into diapause during the winter, and probably for a much longer period, and so those found on 6 January 2008 probably resulted from small larvae that had gone into diapause the previous autumn, and were not the result of larvae hatching in the winter.

As can be seen from the descriptions below, the larvae found in January and September differed considerably in one main respect from those resulting from the ova laid in late May and June; this was in the colour of the body. The larvae found in the wild all had a dark chocolate-brown body colour when they were about 3–4 mm in length, and this body colour eventually became purplish grey in the penultimate instar and then pale grey or yellowish grey in the final instar. In contrast, the bodies of the larvae resulting from the ova were more or less pale yellow in all instars, apart from the first few days after eclosion when they were colourless and in the later instars when greyish body contents were observable. At no stage was the colour of the bodies of these larvae chocolate-brown or purplish brown. Another difference was in the colour of the head and prothoracic plate in the early instars; those found in January and September had the head and prothoracic plate dark brown or black, those resulting from the ova had the head brown and prothoracic plate darker brown. Moreover, the sclerotised area on thoracic segment 2 posterior to the dorsal pinacula was quite noticeable on the larvae found in January and September, but was either obsolete or hardly visible on the larvae resulting from the ova.

I had not previously noticed significant differences in the colour of the larvae of other bivoltine, or partially bivoltine, *Microlepidoptera*.

Although I was able to photograph three instars of the larvae found in January, unfortunately I was not able to take adequate photographs of the larvae resulting from the ova to show these differences.

To date the species has been regarded as univoltine in the British Isles, with adults usually occurring in May and June, although they have been recorded in August and September. However, if ova laid in the wild in May and June produce larvae at about the same time as those in captivity, and if moths result in the same year, then the species appears to be either bivoltine or partially so, at least at Dawlish Warren.

I was not able to find larvae in the wild in June or July 2008 despite searches being made at Dawlish Warren on various occasions and I do not know if this was because larvae do not usually hatch until the autumn, or they hatch in the summer, but I was simply unsuccessful in finding them. The larvae of a number of species of *Microlepidoptera* construct silken tubes amongst their foodplants, no doubt both as protection from the elements as well as from predators. As already noted, the larvae found in January and September made tubes, but those resulting from the ova did not. If larvae hatch in June or July in the wild and complete their growth in the summer but, like those in captivity, do not make tubes, then presumably the reason for this is that they do not need to do so because they do not go into diapause.

Descriptions of larvae found in January and September 2008

Early instar (Fig. 2). Length 4 mm. Head: labrum and clypeus shiny dark brown, remainder shiny black, or shiny black with some dark brown marks; prothoracic

plate shiny black; body dull dark chocolate-brown, sometimes becoming slightly paler chocolate-brown posteriorly, pinacula large, shiny, sclerotized, black, or very dark brown, with black setae, the dorsal pinacula on thoracic segments 2 and 3 not appearing to change shape significantly during the growth of the larva, unlike those of *S. ambigualis*; thoracic segment 2, but not thoracic segment 3, with an undivided, narrow, almost straight sclerotized area, without setae, posterior to the dorsal pinacula, straddling the median area, this sclerotized area appears in each instar and is more or less concolorous with the body colour of that segment and by the penultimate instar the anterior margin is slightly produced medially or sometimes this sclerotized area is divided medially to form two elongate triangles; peritremes of spiracles black; anal plate shiny, slightly darker than the surrounding body colour; thoracic legs: femur and tibia shiny, slightly translucent chocolate-brown, outer edge of each marked black posteriorly, tarsus translucent, dark honey-brown; ventral and anal prolegs semi-translucent, dark reddish brown, crochets black.

Next instar. Length unrecorded. Similar in appearance to the previous instar.

Penultimate instar (Fig. 3). Length 9 mm. Head, including labrum and clypeus, shiny, yellow-brown with darker brown markings, adfrontal sutures and stemmata black; prothoracic plate shiny, slightly translucent, black; body dull dark purplish grey, becoming paler posteriorly, pinacula large, slightly shiny, sclerotized, darker than body colour, with either one or two small black marks usually towards the centre from which a black seta arises; peritremes of spiracles black; anal plate slightly darker than body colour, with black speckling; thoracic legs: femur and tibia dark greyish, outer edge of each marked black posteriorly, tarsus dark honey-brown; ventral and anal prolegs semi-translucent, same colour as body, a black mark within the planta just above the crochets on the outer edge of the planta (this mark was not visible in the earlier instars), crochets black.

Final instar (Fig. 4). Length 13–14 mm. Head yellowish orange or shiny yellowish brown or brown with black markings, labrum and stemmata black or stemmata white and area around them black; prothoracic plate shiny, translucent, and either blackish, dark brown or pale brown, sometimes with the posterior part of the head and body colour showing through; body dull pale grey or yellowish grey, becoming paler posteriorly, pinacula large, slightly shiny, sclerotized, darker than body colour, with either one or two very small black marks usually towards the centre from each of which arises a dark brown seta, the sclerotized area posterior to the dorsal pinacula straddling the median area, mentioned under the description of the early instar, is often raised in the final instar; peritremes of spiracles black; anal plate similar in colour to the pinacula on abdominal segment 9, with a few black marks; thoracic legs: femur and tibia dark greyish, outer edge of tibia marked black posteriorly, tarsus sclerotized, yellowish brown; ventral and anal prolegs translucent greyish, a black mark within the planta just above the crochets on the outer edge of the planta, crochets yellowish brown to dark brown.

Larval instars. According to observations that I made of one larva, it had four instars that lasted as follows: 6 January to 13 January; 14 January to 20 January; 20 January to 28 January; 28 January to 10 February. The larva spun a cocoon on 10 February and a moth emerged on 4 March.

Pupa. Pale yellowish brown; enclosed within a strong cocoon made of moss fragments, usually with frass attached. As previously recorded (Heckford & Sterling, 2004: 151–152), the exuviae are yellowish brown and not extruded on emergence of the adult.

Descriptions of ova laid in May/June 2008 and resulting larvae

Ovum. Description based on ova laid by the female caught on 21 May 2008. Ovum phase about 12–14 days. Symmetrically ovoid, flattened, finely reticulate. Pearly white/whitish green at first, turning very pale yellow after about three days, after about four days very pale rose but with the centre remaining very pale yellow, after about five days very pale orange with a very pale translucent white centre and after about six days, apart from the centre remaining the same, slightly darker orange and remaining this colour until 1 June 2008; on 2 June 2008 very small black dots were visible inside some of the ova and within two days these dots had become comparatively large and were clearly heads. On 5 June 2008, the first larvae emerged, the remainder within a few days.

Of the 35 ova laid by that female, seven were deposited singly, four were in pairs and the remainder were in one batch, all on the base of the container.

Each female caught on 6 June laid some ova on the moss, usually attached to a leaf but occasionally on the stem, but most were deposited on the base of the containers, usually in small batches. Those on the moss were all laid singly.

Unlike the ovum of *Scoparia ambigua*, the surface that comes into contact with the substrate does not mould itself to that surface.

Larva. *First instar.* Head very dark smoky grey, ocelli black; prothoracic plate slightly translucent pale smoky grey; body initially colourless except for some orange-red body contents showing through, but after a day or so body becoming very pale yellowish white with no orange-red body contents and then very pale yellow with the gut contents green, after about three days pale yellow with the gut contents no longer visible; pinacula small and not very conspicuous, sclerotized, very pale grey; peritremes of spiracles concolorous with body; anal plate very pale smoky grey; thoracic legs colourless and slightly translucent; ventral and anal prolegs colourless and slightly translucent, crochets reddish brown.

Second instar. Length 4 mm. Head brown, prothoracic plate darker brown; body pale brownish yellow, body contents green; pinacula small, not very conspicuous, sclerotized and slightly darker than body; no obvious sclerotized area on thoracic segment 2; otherwise similar in appearance to the previous instar.

Later instars. These were similar in appearance to the second instar except that the head becomes more reddish brown, the prothoracic plate becomes rather translucent, the body contents show grey anteriorly, the pinacula become larger and more conspicuous and the peritremes of spiracles become black.

Acknowledgements

I am very grateful to Mr P. Chambers (Senior Ranger, Dawlish Warren National Nature Reserve) and Mr N. C. Ward (Natural England) for granting me permission to record and collect at Dawlish Warren, Dr M. Nuss (Dresden) for referring me to and providing me with a copy of the relevant part of Wegner & Kayser's paper, Mr M. R. Honey (Natural History Museum, London) for obtaining copies of certain papers for me, Dr K. Sattler (Natural History Museum, London) for assisting me with German translations, and Mr M. F. V. Corley (Faringdon) for confirming my tentative identification of one of the mosses.

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