

Description of the larva of *Helenoscoparia nigritalis* (Walker, 1855) (Pyraloidea: Crambidae: Scopariinae)

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Abstract: The authors describe the recently discovered larva of *Helenoscoparia nigritalis* from St Helena Island and provide information on external appearance, chaetotaxy, habitats and biology. The larva is compared with those of two European species: *Scoparia ambigualis* (after the description in Smith, 2004) and *Eudonia lacustrata* (after original material).

Key words: Chaetotaxy, host plants, habitat, biology, St Helena Island.

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INTRODUCTION

St Helena is a remote island in the South Atlantic Ocean, about 1200 miles west of the South Angolan Coast. It was discovered in 1502 when it was covered with forest and shrub land consisting of endemic woody Asteraceae and Malvaceae. St Helena became a stopover for vessels carrying goods and people from Europe to Africa and India. For several hundred years the island was the property of and operated by the East India Company. The original vegetation was largely eradicated and replaced by introduced plants from various parts of the world, although the cryptogam plants such as lichens and mosses were less affected. Many invertebrate species were imported to the island, but their effects on endemic invertebrates are difficult to gauge due to the lack of historical observations.

At present, about 120 species of Lepidoptera are known from St Helena. The number of endemics is comparatively low except in a few groups, among which are the members of the subfamily Scopariinae (Crambidae) with 577 species globally (Nuss *et al.*, 2021). Currently, five species of Scopariinae are known from the island. The first two species were described in the first report on the Lepidoptera of St Helena written by Walker (in Melliss, 1875), and the other three by E. Wollaston (1889). The species were placed originally in the genus *Scoparia* Haworth, 1811, which is distributed worldwide (Nuss *et al.*, 2021) and has tympanal organs. Because the Scopariinae from St Helena lack tympanal organs, Nuss (1999) described the genus *Helenoscoparia* Nuss, 1999 and placed all species from St Helena in it, speculating

that their deficit was due to the absence of bats as natural enemies on St Helena.

Even in Europe, little was known about the biology and morphology of Scopariinae larvae. Brief descriptions were given by Hasenfuss (1960); Smith (2004) described the larva of *Scoparia ambigualis* (Treitschke, 1829) and Heckford (2009, 2011) published detailed descriptions of other species; illustrations followed in Lepiforum (2021) and brief descriptions of several species in Muus (2012). The biologies of the great majority of these species remain unknown, perhaps because of their generally secretive behaviour: they feed on lichens or mosses and live in silken tunnels in the substrate. Although adults can be very common, larvae are very difficult to find.

The situation on St. Helena is similar. *Helenoscoparia transversalis* (Wollaston, 1879) and *H. nigritalis* (Walker, 1875) are common and widespread on the island: *H. transversalis* mainly in middle and higher altitudes and *H. nigritalis* (Fig. 1) particularly at lower and middle altitudes.



Figure 1 - Adult of *H. nigritalis* at Heartshape waterfall (2018, photo T. Karisch)

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Helenoscaparia lucidalis (Walker, 1875) is fairly widespread in the highlands, but *H. scintillulalis* (Wollaston, 1879) is restricted to a small area at the tops of the mountains and is rather uncommon. *Helenoscaparia helenensis* (Wollaston, 1879) was considered to be a very rare species of the cloud forest zone of the mountains, but it was found locally and sometimes quite common during intensive research in 2017 and 2018, and occurs between about 600 and 800 m a.s.l. (Karisch, 2018). Occasionally, huge numbers of *Helenoscaparia* have been observed. Karisch (2001) reports more than 1,500 specimens of *H. nigritalis* at light in one night, R. Cairns-Wicks (in litt., 2020) found several thousands of *H. transversalis* at Mt. Pleasant in 2020.

Despite the abundance of some *Helenoscaparia* species, nothing was known about the larvae until in 2017 the first author found a larva of *H. nigritalis* under lichens covering a rock at Cabbage Tree Road. In 2018 the second author found larvae at Burnt Rock and later on at several other localities.

METHODS AND MATERIALS

This study is based on observations and collected larvae of *Helenoscaparia nigritalis*. Nocturnal observations were made at Cabbage Tree Road near the junction to Taylor's on 6th and 9th March 2017 by T. Karisch, R. Cairns-Wicks and D. Pryce. During daytime, the species was observed and collected at Burnt Rock on 3rd November 2019 by L. Fowler. The larvae were stored in 70% ethanol.

For comparison, larvae of Scopariinae were collected among the mosses *Hypnum cupressiforme* and *Brachythecium rutabulum* at the base of *Tilia cordata* trees in a forest south of Sollnitz near Dessau (Germany) on 3rd May 2020.

For optical study, some preserved larvae were washed in deionised water, carefully heated in 5 % solution of potassium hydroxide, and then dissected in 70 % ethanol. The body was opened ventrally with small scissors. The entrails were removed and the integument spread on a slide, passed through a graded ethanol series, washed in absolute ethanol, stored for about three hours in Euparal essence and then mounted in Euparal on a slide and covered with a cover slip.

For SEM micrography, larvae of *H. nigritalis* were dehydrated in ethanol series (80%, 90%, 95%, absolute), then transferred to 50:50 ethanol/acetone and to 100% acetone for 10 minutes per change. The specimens were dried in a K850 Critical Point Dryer (Emitech), working with liquid CO₂, and then coated with gold (Balzers SCD 004 sputter coater) and examined in a Hitachi S-2400 scanning electron microscope (acceleration voltage 18 kV) at Halle University. SEM was not used for the comparative study of *E. lacustrata*.

The nomenclature of setae follows Hasenfuss (1960), Hayden (2011), Mally *et al.* (2017) and Subramonian & Chitra (2019), of pinacula, Smith (2004), and of pupa, Patočka (1999).

The slides and coated larva are stored in the collection of the Museum für Naturkunde und Vorgeschichte Dessau. The identification of the larvae was confirmed by breeding (larvae from Cabbage Tree Road and Sollnitz) and mtDNA barcoding (larvae from Burnt Rock and Sollnitz). Barcoding was undertaken by Advanced Identification Methods – AIM GmbH, Leipzig (AIM, 2020) and the sequences were compared with all data in the Barcode of Life Data System (www.boldsystems.org).

RESULTS

The specimens from St Helena were identified from their barcodes as *H. nigritalis* with a likelihood of more than 99 %, the specimen from Sollnitz as *E. lacustrata* (Panzer, 1804) with a likelihood of 100 %. The barcodes of our material are stored in BOLD.

Description of the larvae

Larva, particularly the tergites, dirty yellowish or pastel green; head, prothoracic shield and pinacula blackish or very dark brown; last instar 8–11 mm long.

Head (Figs 2, 3):

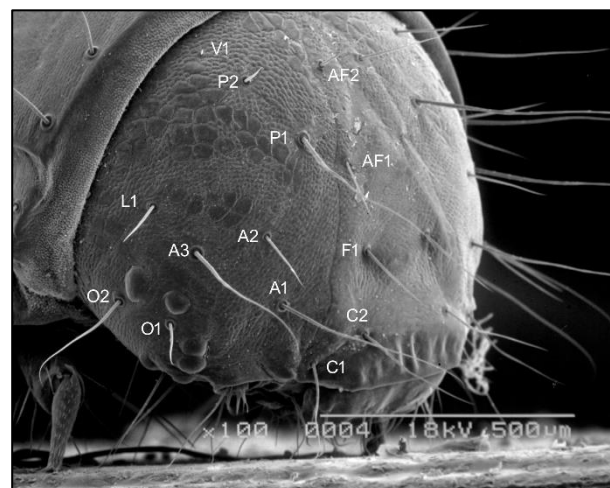


Figure 2 – Head of *H. nigritalis* (anterolateral).

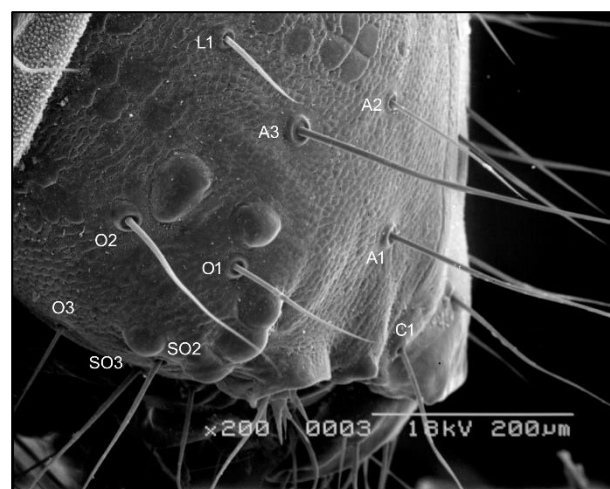


Figure 3 – Head of *H. nigritalis* (lateral).

Orthognathous, brown; epicranial suture present; frons with P1 about half as distant from AF1 as from P2, P2 closer to V1 than to P1; AF1 slightly more dorsal in the

adfrontal area, AF2 slightly dorsal of lower end of median suture; F1 closer to ventral margin of frontal area than to the middle; C1 on lateral end, C2 straight below F1 at clypeus margin; clypeus margin with distinct undulations; A1, A2 and A3 forming a nearly right-angled triangle, distance between A1 and A2, A2 and A3 nearly equal, between A1 and A3 about 1.5 times longer; L1 above upper stemma, fairly close to A3; six stemmata, arranged in a semicircle, anterior part with three attached stemmata, the others isolated; O1 just below the middle of the distance of stemma 2 and the three attached stemmata, O2 oblique below stemma 1; SO2 and SO3 ventral between stemmata 5 and 6.

Thorax (Figs 4, 5):

Prothoracic shield with long XD1 and XD2, XD2 closer to SD1 than to XD1; SD1 closer to SD2 than to XD2, with longer seta than SD2; dorsal setae D1 and D2 fairly long, about the same separation as XD1 and XD2, positioned in postmedian area of shield; prespiracular plate formed as a lateral plate, bisetose, L1 and L2 at anterior margin; subventral pinaculum bisetose, setae long, approximated.

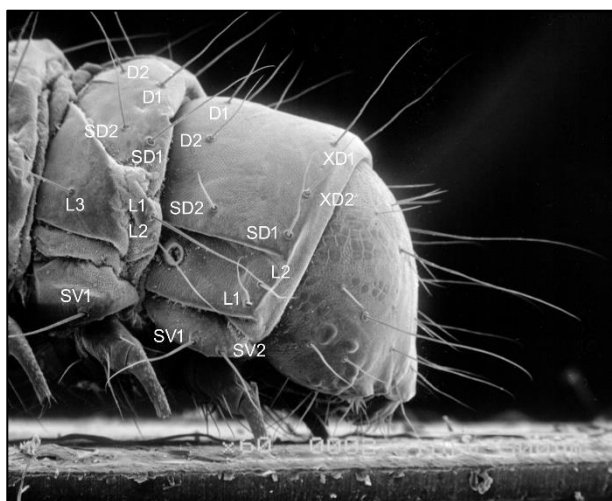


Figure 4 – Head and first thoracal segments of *H. nigritalis* (lateral).

Thoracic segments 2 and 3 each with broad, semi-circular dorsal pinaculum with two strong and long dorsal setae (D1 and D2) and two long, approximated subdorsal setae (SD1 and SD2); three long lateral setae, two very close at anterior pinaculum, another further apart on posterior pinaculum; a single seta on subventral pinaculum (SV1); four fairly short setae at the semi-circular sclerotisation at the base of the legs, and one very short seta just caudal of that sclerotisation; femurs and tibiae with four setae each.

Abdomen (Figs 5, 6):

A1–2: dorsal, subdorsal and subventral pinacula unisetose; lateral pinaculum bisetose; ventral with two pinacula, medio-ventral with three shorter and approximated setae, ventrally with one short and fine seta.

A3–6: one long seta on each dorsal and on the subdorsal pinaculum, lateral (subspiracular) pinaculum bisetose; subventral pinaculum with stronger SV1; base of prolegs with two semicircular sclerotisations, medio-ventrally with three setae, MV2 slightly closer to MV1 than MV3 to MV1, ventral sclerotisation unisetose.

A7: long, strong D1 and D2, D1 slightly antero-lateral on pinaculum, subdorsal plate unisetose; lateral (subspiracular) pinaculum bisetose; subventral pinaculum with one rather long central seta; medio-ventral pinaculum bisetose, ventral pinaculum unisetose.

A8: long, strong D1 and D2, D1 lateral on pinaculum; subdorsal plate unisetose; lateral (subspiracular) pinaculum bisetose; subventral pinaculum with one rather long central seta; medio-ventral pinaculum unisetose, ventral pinaculum unisetose.

A 9: dorsal pinaculum with very long D1 in postmedian half; subdorsal pinaculum with stout SD1 in dorsal area and fine, rather long SD2 postero-ventrally; L1 long, strong, placed more posteriorly; medio-ventral and ventral pinacula unisetose.

A 10: D1 long; L1–3 very long, in slightly dorsally arched line; SV1–4 rather stout, SV1 closer to SV2, SV2, 3 and 4 nearly evenly spaced; several ventral setae.

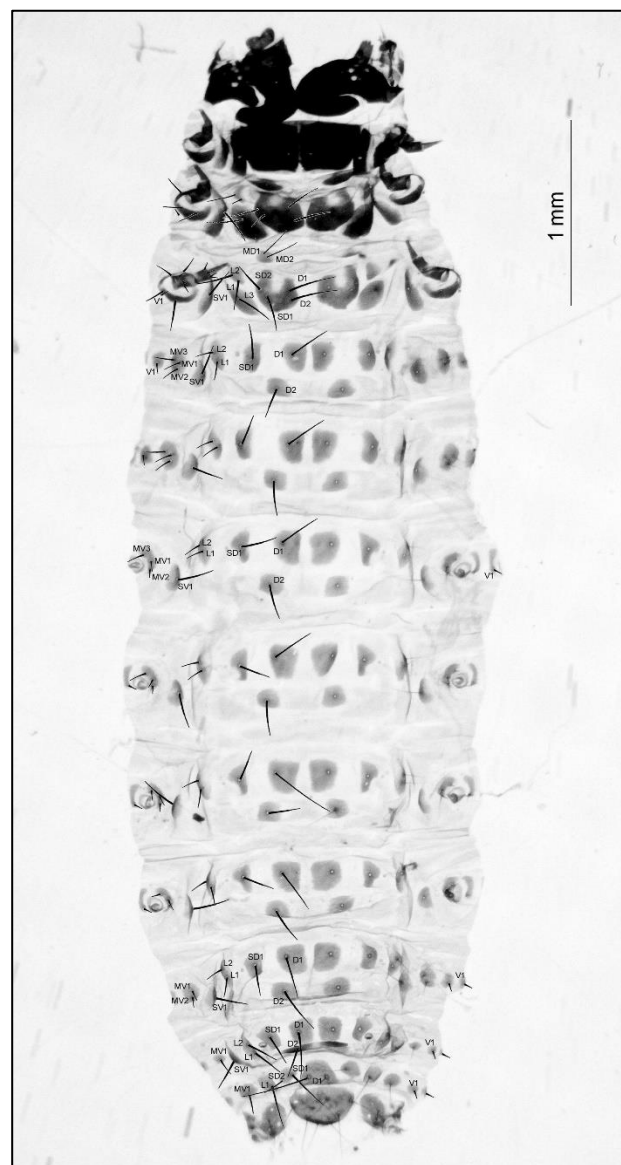


Figure 5 – Integument of *H. nigritalis*.

Pupa (Figs 7–8):

6–7 mm; amber; palpi maxillares distant from maxillae; mandibulae quite large, nearly triangular; palpi labiales

open; proboscis longer than forelegs, slightly shorter than middle legs; at the end of the abdomen broad ventro-lateral protrusions; end of abdomen bell-shaped, with two pairs of strong, straight, rather long bristles.



Figure 6 – 10th abdominal segment of *E. lacustrata*.



Figure 7 – Pupa of *H. nigritalis* in substrate at Cabbage Tree Road (2017, photo D. Pryce).

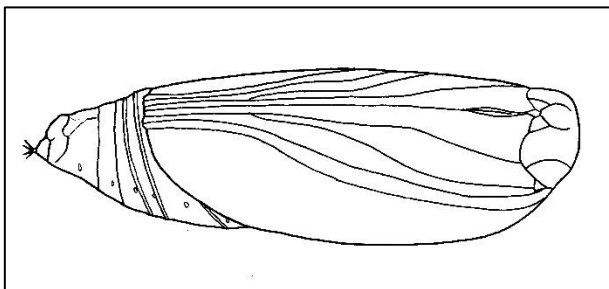


Figure 8 – Pupa of *H. nigritalis*, ventro-lateral view.

With exception of the more distinct end of the abdomen with the two pairs of strong bristles the pupa fits well with the characters of pupae of Scopariinae, given by Patočka (2001).

Remarks

Larvae of *E. lacustrata* (Figs 9, 10) and *S. ambigualis* are

(Fig. 11) very similar to one another and differ mainly in the form of the prothoracic shield and the prespiracular and subventral pinacula. The differences between *H. nigritalis* and the two European Scopariinae are much more obvious (Table 1).

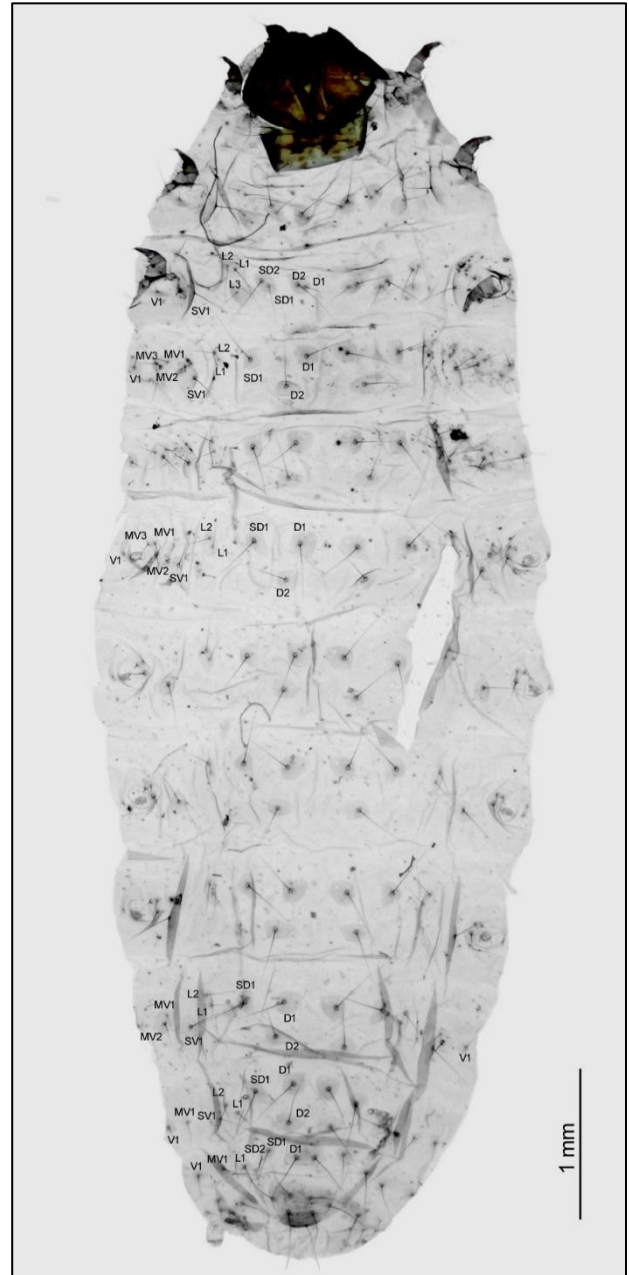


Figure 9 – Integument of larva of *E. lacustrata*.

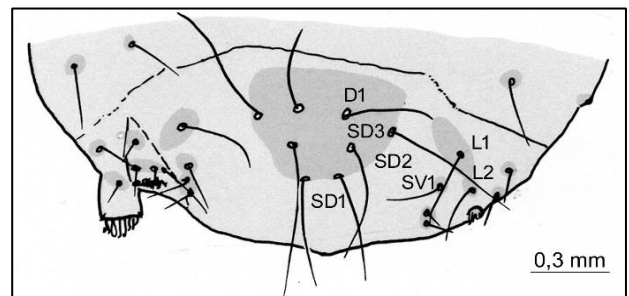


Figure 10 - 10th abdominal segment of *E. lacustrata*.

Notable are the different shape of the prothoracic shield, the extended lateral sclerotisation of the whole spiracular

area and the stronger sclerotisations in the subventral part of the integument and around the bases of the legs. In *H. nigritalis* the dorsal pinacula of A2 and A3 are fused with the subdorsal pinacula and form a broad, semicircular sclerotisation. In *E. lacustrata* and *S. ambigualis* subdorsal and dorsal pinacula are well separated and comparatively small. Furthermore in *E. lacustrata* the sclerotisations at the bases of the legs are less extensive as in *H. nigritalis*.

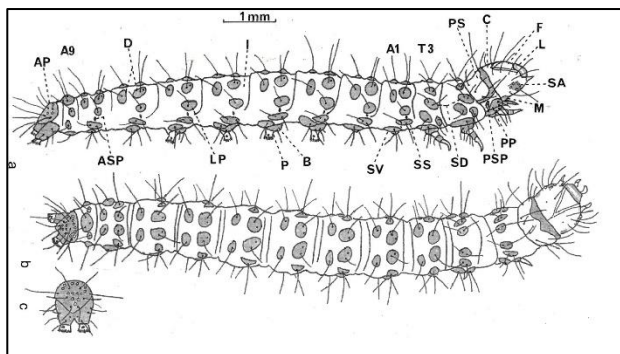


Figure 11 – Larva of *S. ambigualis*; a – lateral, b – dorsal, c – caudal [after Smith 2004; reproduced from Entomologist's Gazette 55 (2004) with kind permission].

On the other abdominal segments, the sclerotisation of the anterior dorsal pinacula is more extended than in the European species. The lateral pinacula are different in shape on A3–6. In contrast to the distinct size and shape of several pinacula, the number and arrangement of setae is very similar in *H. nigritalis*, *E. lacustrata* and *S. ambigualis*.

Judging from the size, shape and arrangement of pinacula, a distant position of the St Helenian species of Scopariinae from the Europeans seems to be justified and therefore the separate genus *Helenoscoparia* is confirmed by our study of the larva.

From the description of the subfamily given by Hasenfuss (1960) we confirm that in *H. nigritalis* AF2 is located below P2; P1 is closer to P1 (on the other side of the body) than P2 to P2; stemmata 4, 6 and 5 are positioned in a right angle; A3 is closer to stemma 2 than to stemma 1. AF1 to AF2 is about the same distance as AF1 to F1. The right or acute angle formed by O1–O3 was not found, either in the illustration in Hasenfuss (1960: Fig. 181) or on the larva of *H. nigritalis*.

Prothorax: XD2, SD1 and SD2 form a right angle as described in Hasenfuss (1960) and SD1 is further from SD2 than from XD2. SV1 is macroscopic, and the distance between D1 and D1 (on the opposite side) is shorter than between D2 and D2. L2 is dorsocaudal from L1 and on A8 the line from D1 to SV1 passes in front of the stigma, and the line from SV1 to L2 passes behind the stigma. On A1 and A2 there are three MV-setae. On A9 setae L1 and SV1 are absent; SD2 is very fine and D1 is dorsocranial to it; setae D1 are on a single pinaculum and the distance D1–D1 is shorter than D1–SD2. Concerning the position of the ventrolateral setae of A10, further studies on more material of *H. nigritalis* are necessary. With regard to the size of the stigma and the length of the setae D1, D2, L1 and L2, *H. nigritalis* fits Hasenfuss's (1960) description of *Scoparia*.

Biology and ecology of the larva

Larvae of *H. nigritalis* have been found in several different micro-habitats. We assume that it accepts a broad range of habitats, if sufficiently damp. The larva was first observed in the thin layer of soil and humus between the lower surface of the lichen *Parmotrema reticulatum* (Taylor) M. Choisy on big rocks (Fig. 12) in the zone of the former cloud forests, now mainly covered with introduced ferns and vascular plants, especially New Zealand Flax (*Phormium tenax* J.R. & G. Forst).



Figure 12 – Larva of *H. nigritalis* under lichens at a rock at Cabbage Tree Road near Taylor's (2018, photo D. Pryce).



Figure 13 – Larva of *H. nigritalis* at the underside of a *Eucalyptus* leaf, Burnt Rock (2019, photo L. Fowler).



Figure 14 – *H. nigritalis* larva in a silky tunnel in the soil at Burnt Rock, with particle of moss (2019, photo L. Fowler).

On 3rd Nov. 2019, a second habitat was discovered on the surface of soil in the shade of *Eucalyptus* trees and under fallen dead leaves of *Eucalyptus* around a house at Burnt Rock at 500 m. a.s.l. (Fig. 13).

Larvae were also found next to a chicken coop. Webbing partially covered areas with *Bryum argenteum* Hedw. and *Ceratodon purpureus* (Hedw.) Brid. On 30th Nov. 2019, larvae were traced in webbing over moss (*Bryum dichotomum* Hedw. and *B. argenteum*) growing from a leaking water tank (Fig. 14) at Burnt Rock.



Figure 15 – Webbing of *H. nigritalis* in moss at a water tank at Burnt Rock (2019, photo L. Fowler).

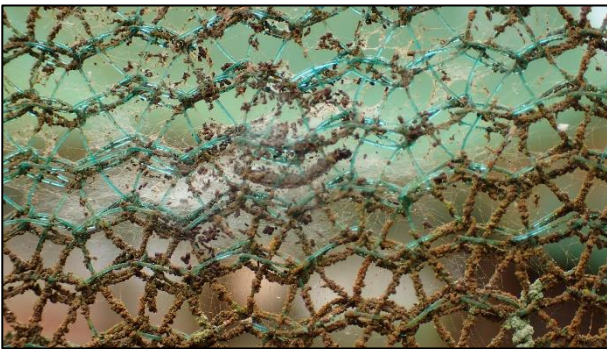


Figure 16 – Shade web of chicken coop with trace of frass of *H. nigritalis* larva (2020; photo L. Fowler).

Subsequently, larvae have been observed by the second author amongst mosses in different types of forest. In the Eastern part of the island there are semi-arid habitats with sparse vegetation where larvae seem to prefer the soil surface under plants or in places where water is dropping from the leaves [L.F.'s observations at Horse Point (Fig. 15), and Isaac, Fowler & Stevens 2018]. In all places the larvae were found moving in thin silky tunnels in webbing. When the webbing was turned over, the caterpillars often clung to the web (Fig. 16). A few larvae crawled away and hid in silky holes in the soil crust.

The larvae from Cabbage Tree Road were fed with *P. reticulatum* and pupated successfully and hatched, although the moths were comparatively small. Larvae were only seen at night at Cabbage Tree Road, but everywhere else larvae were also active by day. Besides the lichen, the larvae were also seen feeding on several species of moss, including those mentioned above (Fig. 14). On a shade net covering a chicken coop at Burnt Rock, larvae were found to feed on (probably) algae and protonema stages of mosses (Fig. 16).

Pupae were found at Cabbage Tree Road in the substrate where larvae were living (Fig. 7). Because the moths

hatched during transport in sealed bags, further research is necessary to determine the duration of pupation.

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Table 1 – Comparison of larval characters of *H. nigrifalis*, *S. ambigualis* and *E. lacustrata*.

Segment	Character	<i>Helenoscoparia nigrifalis</i>	<i>Scoparia ambigualis</i> (after Smith 2004)	<i>Eudonia lacustrata</i>
prothoracal segment	prothoracic shield	size, opacity, dark brown, trapezoid	large, shiny, semi-translucent, dark brown, rather rectangular	large, translucent, yellowish brown, trapezoid
		with smooth outline	anterior edge with a dark, shallow rounded 'W' outline	anterior edge with straight outline
		not such a border	dark sepia border around anterior and lateral edges	not such a border
	setae	six macroscopic setae on anterior edge and six in postmedian region	six macroscopic setae on anterior edge and six in posterior region	six macroscopic setae on anterior edge and six in posterior region
	pinacula	pair of broad, elongate pinacula posterior to prothoracic shield	dark sepia prespiracular pinaculum and subventral pinaculum, each with two setae	yellowish brown prespiracular subventral pinaculum, each with two setae
		lateral with a broad, shield-like sclerotisation around spiraculum, subventral pinaculum very broad, each with two setae	prespiracular and subventral pinacula very close	prespiracular and subventral pinacula further apart (about one diameter of a pinaculum)
	bases of legs	broad semilunar sclerotisation at bases of legs	[not described]	broad, but weak shape sclerotisation at bases of legs
	femur	dark brown	[not described]	yellowish brown
	tibia	dark brown		yellowish brown
	claw	pale	[not described]	slightly more sclerotised than integument
thoracic segments 2 & 3	dorsal pinacula	two pairs of dorsal pinnacula, anterior very small, posterior very large, semicircular, anastomosed with the subdorsal pinaculum	pair of large dorsal pinacula, separated by a distance roughly equal to the diameter of a pinaculum	pair of medium dorsal pinacula, separated by a distance about 1.5 times diameter of a pinaculum
	subdorsal pinacula	[see above]	adjacent to each dorsal pinaculum there is a large subdorsal pinaculum	adjacent to each dorsal pinaculum there is a subdorsal pinaculum of similar size
	lateral pinacula	two lateral pinacula, posterior larger than anterior	two large lateral pinacula	two medium sized lateral pinacula
	subventral pinaculum	one elongate subventral pinaculum	elongate subventral pinaculum	elongate subventral pinaculum
	setae	anteriodorsal pinaculum with two setae, posteriodorsal pinaculum with four setae	two setae on dorsal pinacula and anterior of lateral pinaculum	two setae on dorsal and subdorsal pinacula and anterior of lateral pinaculum
		one seta on subventral and posterior to lateral pinaculum	one seta on subventral and posterior to lateral pinaculum	one seta on subventral and posterior to lateral pinaculum
	ventral pinacula	base of legs with circular pinaculum	ventrally a pair of unisetose pinacula	ventrally a pair of unisetose pinacula
	femur	concolorous with pinacula	concolorous with integument	concolorous with pinacula
	tibia	concolorous with pinacula	concolorous with pinacula	concolorous with pinacula
	tarsus	concolorous with pinacula	a little paler than integument, with grey marks on base	concolorous with pinacula
setae on leg	probably up to 8 setae on each leg	about 8 setae on each leg	not examined	

Segment	Character	<i>Helioscoparia nigrifalis</i>	<i>Scoparia ambigua</i> (after Smith 2004)	<i>Eudonia lacustrata</i>
1st abdominal segment	dorsal pinacula	two pairs of large dorsal pinacula, anterior more trapezoid and slightly larger, much closer together than posterior pair; posterior pair more rectangular	two pairs of large dorsal pinacula, anterior pair larger and closer together than the posterior pair	two pairs of large dorsal pinacula, anterior pair larger and closer together than the posterior pair
	lateral pinaculum	large, unisetose, caudally narrowed at A3–A6	flanks with a large, unisetose lateral pinaculum	flanks with a medium sized, unisetose lateral pinaculum
	subspiracular pinaculum	elongate	elongate	elongate
	subventral pinaculum	unisetose, elongate	unisetose, elongate	unisetose, elongate
abdominal segments 1–5	dorsal pinacula	posterior pair of dorsal pinacula further apart than the diameter of one of the pinacula	posterior pair of dorsal pinacula further apart than the diameter of one of the pinacula	posterior pair of dorsal pinacula apart no more than twice the diameter of one of the pinacula
9th abdominal segment	dorsal pinaculum	single large dorsal pinaculum with two setae	single large dorsal pinaculum with two setae and a central black spot anterior of them	single large dorsal pinaculum with two setae
	lateral pinaculum	ovoid, bisetose	ovoid, unisetose	round, unisetose
	subspiracular and subventral pinacula	subspiracular and subventral pinacula unisetose	subspiracular and subventral pinacula unisetose	subspiracular and subventral pinacula unisetose
abdominal segments 1, 2, 7, 8, 9		with a pinaculum resembling that at base of a proleg; on A1 and A2 with three setae, on A 7 with two setae, on A8, A9 one seta	with a pinaculum resembling that at base of a proleg; on A1 and A2 with three setae, on A 7 with two setae, on A8, A9 one seta	with a pinaculum resembling that at base of a proleg; on A1 and A2 with three setae, on A 7 with two setae, on A8, A9 one seta
10th abdominal segment	shape, colouration	large, nearly ovoid, slightly more strongly coloured than pinacula	large, coloured as pinacula	large, nearly ovoid, slightly more strongly coloured than pinacula
	setae	three transverse rows of setae present, anterior row with four, the other rows with two setae; distal sclerotisation with five setae, sclerotised areas at base of anal proleg with two setae each	three transverse rows of setae present, anterior row with four, the other rows with two setae	three transverse rows of setae present, anterior row with four, the other rows with two setae; lateral eight setae with more strongly sclerotised integument around their bases
	special sclerotisations	lateral and towards the anal proleg more strongly sclerotised; proximal sclerotisation at base of anal proleg composed of two more strongly sclerotised areas	in front of anterior setae a row of six reddish brown marks with a further mark posterior to each terminal mark; between second and third row of setae a triangular pattern of three reddish brown marks, broadest posteriorly	no other marks at or anterior to abdominal plate