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A first ecological description of the lichen-clad larva of *Eublemmistis chlorozonea* Hampson, 1902 (Lepidoptera: Erebidae) from a southern Afrotemperate forest

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Abstract: The unusual habit of the larva of *Eublemmistis chlorozonea* Hampson, 1902 (Lepidoptera: Erebidae) of covering itself in its lichen host is reported and illustrated for the first time. We review the known information on this species and discuss its ecology and distribution.

Key words: Afromontane forest, camouflage, larval ecology, lichen, South Africa
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INTRODUCTION

The genus *Eublemmistis* contains five species from sub-Saharan Africa and one species from Madagascar (Hacker 2019). These species include: *E. chlorozonea* (type species) from southern and eastern Africa; *E. bivirgula* from west, central and east African forests (Berio 1963); *E. aberfoylea* from eastern Zimbabwe in southern Africa; *E. elachistana* from Liberia, West Africa; *E. gola* from Liberia, West Africa; and *E. ramonafana* from Madagascar (Hacker 2019). The early stages and host associations of all *Eublemmistis* species, apart from *E. chlorozonea*, are unknown.

The ecology and life history of *E. chlorozonea* Hampson 1902 (Lepidoptera: Erebidae) has been poorly documented. Platt (1921) listed *Albizia adianthifolia* as a host plant, Kroon (1999) listed "lichens" as host source, and Staude *et al*. (2023) mention that the larvae cover themselves in lichen, but the early stages were neither described nor illustrated by these studies and have remained unpublished to date. The consolidated database for southern African Lepidoptera compiled by the Southern African Lepidoptera Conservation Assessment (SALCA) project (Mecenero *et al*., 2020), and updated by unpublished records by Hermann Staude, lists 105 occurrence records of *E. chlorozonea* for southern Africa (Fig. 1). It appears restricted to Afromontane forests of South Africa from the southern Cape north to the Entabeni forest in Limpopo. It has not been recorded from Zimbabwe where it seems to be replaced by the sister species *E. aberfoylea* Hacker 2019 in the Manica Highlands of Zimbabwe/Mozambique (Fig. 1).

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Eublemmistis chlorozonea is, however, also recorded from Tanzania, Uganda and Ethiopia (Hacker 2019).

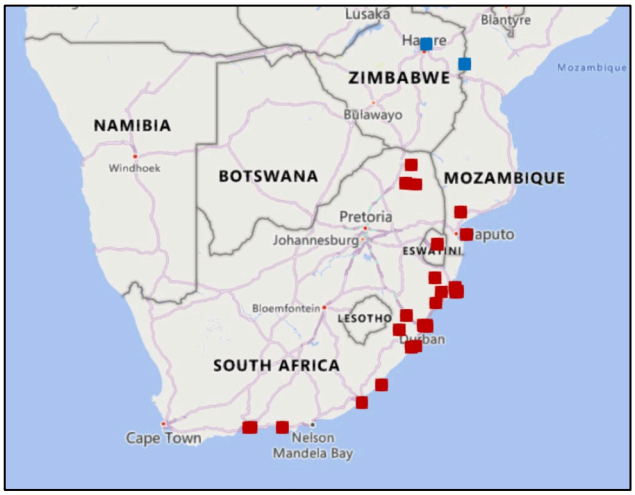

Figure 1 – Adult records of *Eublemmistis* in the southern African region. Red squares: *E. chlorozonea*. Blue squares: *E. aberfoylea*.

On the 25th of August 2021, the first author (RCS) observed an obscure larva in the Saasveld indigenous forest off the George Campus, Western Cape, South Africa (-33.94323; 22.54544). It was well camouflaged on a white lichen patch of a mature, flaky-barked *Afrocarpus falcatus* (Thunb.) (Outeniqua Yellowwood) and was almost invisible. It was a relatively large larva, moving slowly as if disturbed by the wind – much like a piece of lichen would. Since the first observation in August of 2021, 19 additional observations of larvae and pupae across the southern Cape forests were made by RCS (Fig. 2). In November 2022, one adult was successfully reared from a larva, finally connecting the well-described *E. chlorozonea* adult with its cryptic larval form.

This article presents observations made on the life stages, larval host associations, and ecology of *E. chlorozonea*.

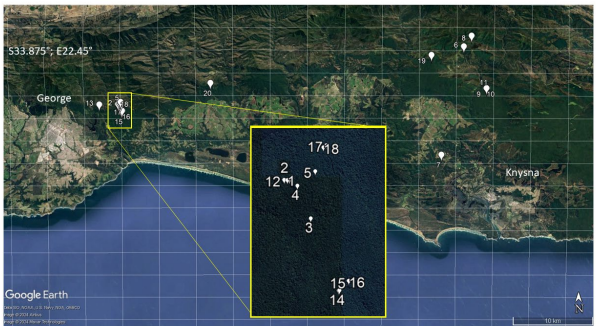

Figure 2 – Distribution of *Eublemmistis chlorozonea* observations over a 24-month period (August 2021–August 2023) in the southern Cape, South Africa (Google Earth 2023). George can be seen to the western part of the map and Knysna to the south-eastern part. Observation 20, near the Woodville big tree, was made by the last author (HSS) on the 26th of December 2013. On the insert are observations 1, 2, 3, 4, 5, 12, 14, 15, 16, 17, and 18 from Saasveld forest.

METHODS AND MATERIALS

Observations by RCS of the larvae and pupae were made on an ad-hoc basis during the field data collection for another project on insect pollinators in southern Afrotemperate forests spanning the period 2021-2023 (SANParks permit SWAR-RC/2021-06). During field excursions, randomly selected trees with lichen-clad bark were visually inspected from 0 m – 2 m above the forest floor, with notes only made when individuals of *E. chlorozonea* were present. Notes were not made of trees containing lichen but with no visible individuals of *E. chlorozonea*. Notes taken included the date, the life stage, the tree species (only if we were able to accurately identify the tree species), and the coordinates of the locality. Larvae were taken into captivity for observations by HSS (rearing experiments 22HSS54 & 22HSS55). Larvae were fed various lichens of different types of unknown species on bark taken from the habitat.

RESULTS

Early Stages: There were no discernible patterns with regard to season and phenology. Larval forms were observed from late-May to mid-October, whereas cocoons were observed in February, May, July and September (Table 1). *Eublemmistis chlorozonea* seems to primarily utilise indigenous forest but RCS found a cocoon ca. 120 meters from the indigenous forest edge, in transformed forest vegetation with mature trees of the invasive alien Acacia mearnsii. Observations were made on a variety of host tree species, mostly *Afrocarpus falcatus* and *Pterocelastrus tricuspidatus*. Rather than species of tree, it appears as if the presence of several types of lichen determines larval presence (Fig. 3).

The larva of *E. chlorozonea* is a semi-looper with only two sets of prolegs, apart from the anal claspers. It covers itself with lichen fragments (Fig. 4) and forms a cocoon, that hangs on a thin thread from the tree bark, and which is covered in white lichen (Fig. 5). After an undetermined period of time, the adult emerges from an orange-brown pupa (Fig. 6). Often, post-emergence, the remaining cocoon is seen pressed up against the bark, not hanging in the air as it does pre-emergence, still containing the split open pupa.

Figure 3 – Larvae typically restrict themselves to the lichen-clad parts of various tree species: *Podocarpus latifolius* (left) and *Curtisia dentata* (right).

Figure 4 – Examples of a larva partially covered by lichen fragments (left), and one completely covered (right).

Figure 5 – Cocoons found dangling from the bark of trees, attached by a silky, lichen covered thread.

Figure 6 – Pupa and remaining cocoon post-emergence of adult moth that was reared in captivity.

The colour of the lichen covering the larvae depends on the colour of lichen the individual larva is observed on. These colours include white, off-white, dull green-white, and dull peach-white. In captivity, larvae accepted and fed on all colours and types of lichen presented. For example, on the

7th of October 2022, a larva was collected from the Saasveld forest and placed in a glass tank with pieces of bark containing white lichen and kept moist via lightly misting with water once a week. A pupa was formed on the 31st of October 2022, and the cocoon was found dangling vertically on the side of a flowerpot that was placed in the tank. On the 24th of November 2022, an adult emerged.

The same lichen that the larva feeds on is used as camouflage. This enables it to blend in perfectly within its habitat, as there is no difference in colour or texture with their surroundings. Often the only giveaway is movement, which resembles a bit of lichen in the breeze unless they're feeding or building their disguise. The process of covering themselves in lichen, as observed by the second author (SB), is slow and meticulous. They use their mandibles to scrape off bits of lichen and transfer it in chunks onto their bodies. As silk is used in attaching their cocoons to bark, we presume that silk is also mixed with lichen to make it adhere to their bodies. By bending their bodies backwards, they can easily reach and cover their whole length.

Adult: The forewing measures 8–10 mm in length, and the sexes are similar in size. The wings are white ground colour and variable mustard to green shading, with zigzag lines on the forewings with two distinct black cell spots, which are merged into one in some specimens (Fig. 7). Adults have a characteristic resting posture with wings folded over the body and substrate while resting (Fig. 7). They are nocturnal and attracted to light sources but can be seen resting in the undergrowth of the forest by day where they are easily disturbed.

Figure 7 – Adult male in typical resting posture (left) and a set specimen (right).

DISCUSSION

The use of lichen in larval camouflage is not unique to *E. chlorozonea*. A similar strategy is employed by *Enispa prolectus* (Erebidae) and other members of the *Enispa* genus, a widely occurring genus in the Indo-Australian tropics and subtropics (Sugi *et al.* 1987; Pellinen 2017). Wilson & Methven (1997) noted a lichen camouflage strategy similar to *E. chlorozonea* by the neuropteran *Leucochrysa pavida* from southern Illinois, United States. In this species, the lichen fragments, collected from tree surfaces, form a packet of debris, which are also used to form the cocoon during pupation (Wilson & Methven 1997). The larvae of *L. pavida* has dorsal setae on which the lichen fragments are placed. *Leucochrysa pavida* uses its pincered jaws to break off small pieces of lichen and rolls these into small balls (Wilson & Methven 1997). Research suggests preference for certain species of lichen (Wilson & Methven 1997). Of interest is that *L. pavida* is predatory during its larval phase, whereas *E. chlorozonea* was observed actively feeding on lichen.

The species of lichen harvested and utilized by *L. pavida* include *Lecanora strobilina*, *Myelochroa aurulenta*, and a species of *Lepraria*. In Afrotemperate forests, lichen research is still in its infancy for the most part, making it extremely difficult to identify local lichens to species. For example, the genus *Lecanora* has received little attention and needs revision (Fryday 2015); although it is certainly present in the southern Cape forests. A species of *Lepraria* was observed as a common lichen host on which *E. chlorozonea* was found. It seems likely, based on our experiments, that *E. chlorozonea* does not specialise on a particular species of lichen but will feed on several lichen species. Its distribution, rather than restricted by host species, seems to be restricted to Afromontane forest habitats because these remain moist for most of the year. Lichens in other southern African habitats are dormant (dry) for long periods and it is probable that the larvae of *E. chlorozonea* are not able to survive such extended periods of desiccation. Platt (1920) listed the tree *Albizia adianthifolia* as a larval host plant of *E. chlorozonea*, but it seems likely that this larva (or pupa) was found on the trunk of the tree where it fed on lichens found on that tree rather than on the foliage of the tree itself.

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Table 1 – Summary of 20 observations of *Eublemmistis chlorozonea* between 2021 and 2023, including one adult observation from 2013, made in the southern Cape region (See Fig. 2).

Date	Obser-vation	Tree species	Pupa/larva/ adult	Latitude	Longitude	Area
25/08/2021	1	*Afrocarpus falcatus*	Larva	-33.94323	22.54544	Saasveld Forest, George
25/08/2021	2	*Pterocelastrus tricuspidatus*	Larva	-33.94324	22.545624	Saasveld Forest, George
13/10/2021	3	*Afrocarpus falcatus*	Larva	-33.94607	22.54754	Saasveld Forest, George
07/10/2021	4	*Afrocarpus falcatus*	Larva	-33.94367	22.54636	Saasveld Forest, George
28/07/2022	5	*Rapanea melanophloeos*	Larva	-33.9426	22.54793	Saasveld Forest, George
02/09/2022	6	*Pterocelastrus tricuspidatus*	Cocoon	-33.87931	23.00921	Mountain Forest patch, Millwood, Knysna
15/09/2022	7	*Acacia mearnsii*	Cocoon	-33.9995	22.98022	Invaded forest edge, Westford, Knysna
20/09/2022	8	Unknown	Cocoon/ open pupa	-33.8677	23.01907	Mountain Forest patch, Millwood, Knysna
27/09/2022	9	*Ocotea bullata*	Larva	-33.92550	23.04014	Lelievlei Forest, Knysna
27/09/2022	10	*Pterocelastrus tricuspidatus*	Larva	-33.92547	23.04014	Lelievlei Forest, Knysna
27/09/2022	11	*Pterocelastrus tricuspidatus*	Larva	-33.92551	23.04012	Lelievlei Forest, Knysna
09/02/2023	12	Unknown	Cocoon	-33.94321	22.54516	Saasveld Forest, George
16/05/2023	13	Unknown	Cocoon	-33.94361	22.52038	Semi-invaded riparian forest, George Campus
24/05/2023	14	Unknown	Cocoon	-33.95129	22.55003	Saasveld Forest, George
26/05/2023	15	*Curtisia dentata*	Larva	-33.95127	22.55009	Saasveld Forest, George

04/07/2023	16	*Afrocarpus falcatus*	Larva	-33.950594	22.550892	Saasveld Forest, George
04/07/2023	17	*Rapanea melanophloeos*	Larva	-33.940666	22.548925	Saasveld Forest, George
04/07/2023	18	*Pterocelastrus tricuspidatus*	Larva	-33.940822	22.548637	Saasveld Forest, George
19/07/2023	19	*Ilex mitis*	Cocoon	-33.888674	22.966224	Jubilee Creek, Millwood Forest, Rheenendal
26/12/2013	20	Unknown	Adult	-33.919910	22.669900	Woodville Forest, Hoekwil