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Food plant, larval bionomics, and diagnosis of the Alpine Silver-Y, *Syngrapha ottolenguii* (Lepidoptera: Noctuidae)☆

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ABSTRACT

Information on the biology of the alpine moth, *Syngrapha ottolenguii*, is very limited. On the main island of Japan, Honshu, we determined a natural host plant of *S. ottolenguii* to be *Empetrum nigrum* in alpine fields; the larvae showed a characteristic nocturnal feeding behavior on this plant. During daytime, the moths hid in the lower layer of the dense *E. nigrum* shrub. *S. ottolenguii* exhibited a univoltine life cycle with hibernation at the second or third instar larval stage under deep snow, where the temperature stayed stable at 0 °C for about 6 months. They could be reared with a generation time of about 60 days on an artificial diet under 16L–8D at 20 °C. The larva was classified as a monosetose with subventral (SV) setae on the second and third thoracic segments.

Introduction

The Alpine Silver-Y, *Syngrapha ottolenguii* (Dyar) (Fig. 1), is known to be distributed in both Palaearctic and Nearctic regions. It has been reported from China, Russia, and Attu and Atka in the Aleutian Islands of Alaska (Jinbo and Watanabe, 1994; Lafontaine and Poole, 1991). The distribution of the insect, as determined by adult collection survey, is well known in Japan. According to Jinbo (1984), it is widely distributed in Alpine areas. There have been some reports on the adult biology of the species. *S. ottolenguii* and allied *Syngrapha* species are often referred to as "diurnal and nocturnal actors" (Ahola and Silvonen, 2005; Goater et al., 2003; Nishio, 1986; Jinbo, 1984). However, there is no specific information on its food plants and larval bionomics. *Vaccinium uliginosum* has been suggested as a food plant from evidence that the allied circumpolar species, *S. interrogationis*, fed on *Vaccinium* spp. (Sugi, 1982). A higher preference of the crowberry, *Empetrum nigrum*, for hatched larvae is known (Yasuda and Watanabe, 1985).

Some reports have described *E. nigrum* and *Andromeda polifolia* as food plants for the field-collected larvae of *S. ottolenguii* in East Hokkaido (Nakatani *et al*., 1994; Nakatani and Hirama, 1995). However, larvae and adults collected in Kushiro Marsh and on Mt. Atosanupuri in 1999 were later identified not as *S. ottolenguii*, but as *S. interrogationis* (Nakatani, 1999). Consequently, there is no reliable record on the host plants and biology of *S. ottolenguii* in the field. Recently, Kusunoki and Yasuda (2002) described *V. citis-idaea*, *V. uliginosum*, and *E. nigrum* as the food plants of *S. ottolenguii* based on field observations and references. They also listed *Rhododendron aureum*, *V. ovalifolium*, and *Phyllodoce caerulea* as accepted plants from feeding trials. Furthermore, they successfully reared a few adults with these plants in some *ex ovo* trials. Those previous reports provide an incomplete overview of the food plants, ecology, and morphology of this species.

In the present paper, we report the biology of the larvae in Alpine Silver-Y, *S. ottolenguii*, and provide extensive evidence. More specifically, the food plant was confirmed, and some interesting larval feeding behavior was observed. Successive generations of the species were reared on an artificial diet in the laboratory. The larval life history in the natural habitat was described with some reference to the larval morphology, including the diagnosis of setae as the classification key.

Materials and methods

Field investigations

Field observations and recordings were carried out at a typical alpine-vegetational area in Mt. Zao, Yamagata Prefecture (1600–1800 m asl, N38°9', E140°25') on 22–23 August, 18–19 October, 2003, 3–4 and 17–18 July, 7–9 August 2004, 27 February, 15–17 July, 21–22 August, 3 November 2005, and 27–28 May 2006. The site is approximately 500 km south of East Hokkaido, where the above reports (Kusunoki and Yasuda, 2002; Nakatani et al., 1994; Nakatani and Hirama, 1995) were based. The two sites are separated by

☆ We propose the English name Alpine Silver-Y for this species.

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Fig. 1. Image of *Syngrapha ottolenguii*. Right: male; Left: female.

Blakiston's Line, which divides the fauna of Honshu and Hokkaido islands. Additional and comparative observation on Honshu Island sites was performed at Mt. Ontake (2400–2800 m asl) and Mt. Komagatake (2700–2800 m asl), Nagano Prefecture, about 400 km southwest of Mt. Zao, in August 2005. To discover the larval food plant, we first checked a wide variety of candidate plants, especially *Vaccinium* spp., based on the information described for *Syngrapha interrogationis* (Sugi, 1982; Nakatani et al., 1994 Nakatani and Hirama, 1995; Yasuda and Watanabe, 1985). However, after discovering that *Empetrum nigrum* was the food plant on Mt. Zao in July 2004, we focused mainly on *E. nigrum*.

We observed larval behavior during the day and at night using a white LED or handheld fluorescent lamp. When found, the larvae were photographed immediately using a digital camera in order to record the larval instar, situation, date, and time.

Table 1
Detection records of *S. ottolenguii* larvae in field based on digital photograph time stamp

Date	Time	Day/ night	Instar	Weather	State of larvae	Note
2004						
03 July	14	Day	4	–	Hyperactive	Parasitized
03 July	21	Night	5	–	Active	Feeding on Em* from Vc**
04 July	11	Day	5	Fine	Static	On stem of Em
04 July	12	Day	4	Fine	Static	On stem of Em
18 July	–	Day	5	Drizzle/foggy	Active	Feeding on Em
2005						
15 July	22	Night	5	Cloudy	Active	Feeding on Em
15 July	22	Night	5	Cloudy	Active	Feeding on Em
15 July	23	Night	5	Cloudy	Active	Feeding on Em
16 July	2	Night	5	Cloudy	Active	Feeding on Em
16 July	2	Night	5	Cloudy	Active	Feeding on Em
16 July	13	Day	5	Foggy	Active	Feeding on Em
17 July	21	Night	5	Foggy	Active	Feeding on Em
17 July	0	Night	5	Foggy	Active	On *Cyperaceae* sp.
2006						
27 May 12	12	Day	3	Fine/cloudy	Static	On stem of Em
27 May 12	12	Day	3	Fine/cloudy	Static	On stem of Em
27 May 12	12	Day	3	Fine/cloudy	Static	On stem of Em
27 May 13	13	Day	3	Fine/cloudy	Static	On stem of Em
27 May 13	13	Day	3	Fine/cloudy	Static	On stem of Em
27 May 13	13	Day	3	Fine/cloudy	–	Held by ant
27 May 13	13	Day	3	Fine/cloudy	Static	On upper stem of Em
27 May 14	14	Day	2	Fine/cloudy	Static	On stem of Em
28 May 14	14	Day	4	Foggy/drizzle	Active	Feeding on Em
28 May 14	14	Day	3	Foggy/drizzle	Static	On upper stem of Em
28 May 14	14	Day	3	Foggy/drizzle	Static	On upper stem of Em

Em*: *Empetrum nigrum* Vc**: *V. citis-idaea*.

To determine the temperatures of larval overwintering sites, sensors of a digital thermal logger (Thermo Recorder RT-12 Espec Mic Corp.) were set up at 10 cm beneath the surface of *E. nigrum* dwarf shrubs and on the underside of a branch in an alpine pine crown about 50 cm above the ground.

Laboratory rearing on artificial diet

The first-generation materials for *ex ovo* rearing were obtained from Mt. Zao as adults or larvae. Adults were fed on 10% sugar and 1% yeast extract solution in water, and young branches of *E. nigrum* were provided for oviposition substrate. Oviposited eggs were moved to a plastic rearing dish (9 cm diameter and 1 cm depth), and a commercial diet, "Insecta LFS" (Nihon Nosan Kogyo, Ltd.), was supplied to hatched larvae. The diet was originally developed for rearing silkworms, but is suitable for many Plusiinae larvae. To assess the potential stimulative effect of the host plant on the onset of larval feeding on the artificial diet, the dried leaf-powder of *E. nigrum* was mixed at about 5% directly into the artificial diet and provided to the hatched larvae. The patty-like diet was attached at 5- to 8-mm thick under the lids because the larvae liked to rest under the substrate. The bottom was lined with filter paper. Approximately 100 larvae of the first instar stage were reared in rearing dishes in the condition of 16L–8D and 20±2 °C. When the larvae reached the third or fourth instar, appropriate numbers were transferred to larger dishes.

Fig. 2. Final instar larva feeding on *Empetrum nigrum* from a shoot of *Vaccinium citis-idaea* at night (21:55, 3 July 2004) (Photo by N. Ichikawa).