

Immature Stages and Life History of a Hazel Leaf-rolling Sawfly, *Pamphilius benesi* (Hymenoptera, Pamphiliidae)

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Abstract Based on the material obtained in Kôshû City, Yamanashi Prefecture, Honshu, observations on the oviposition and results of the rearing experiments of *Pamphilius benesi* Shinohara, 1985, are presented, the life history of this sawfly is outlined, and the immature stages and the larval leaf-rolls are briefly described and illustrated.

Key words: Symphyta, *Corylus sieboldiana* var. *sieboldiana*, Betulaceae.

Introduction

Pamphilius benesi Shinohara, 1985, is a leaf-rolling sawfly occurring in Japan (Hokkaido, Honshu, Shikoku, Kyushu) and South Korea (Shinohara, 1985, 2001; Shinohara *et al.*, 2022). Shinohara and Hara (1997) reported on the host plant and larvae of this species for the first time based on the observations in Hokkaido and Shinohara and Hara (2005) gave a concise account of the larvae and life history with color photographs. These are the only references to the host plant, larvae and life history of *P. benesi*. The larvae of this sawfly are gregarious leaf-rollers on *Corylus sieboldiana* Blume var. *sieboldiana* (Betulaceae).

At the end of May 2022, Kato found a female of *P. benesi* ovipositing on a leaf of *C. sieboldiana* var. *sieboldiana* in Kôshû City, Yamanashi Prefecture, Honshu, and made observations on its oviposition behavior. He also reared the eggs and the larvae until their last feeding instar. Here we report on these observations, which will add

much more details to the currently available, rather fragmentary information based only on Hokkaido material (Shinohara and Hara, 1997, 2005).

Materials and Methods

Rearings were made by Kato in Yokohama City, Kanagawa Prefecture. The temperature and day length of the rearing room were not rigidly controlled. For morphological terminology, we generally follow Viitasaari (2002). Photographs were taken with Canon EOS 8000D or Olympus Stylus TG–4 Tough by Kato. The digital images were processed and arranged with Adobe Photoshop Elements 15 software.

Results and Discussion

Field observations and rearing records. On May 28, 2022, Kato discovered a female of *Pamphilius benesi* ovipositing on a leaf of *Corylus sieboldiana* var. *sieboldiana* in Enzan-kamihagihara (35.710°N, 138.830°E, 1,370 m alt.), Kôshû City, Yamanashi Prefecture. The female was on

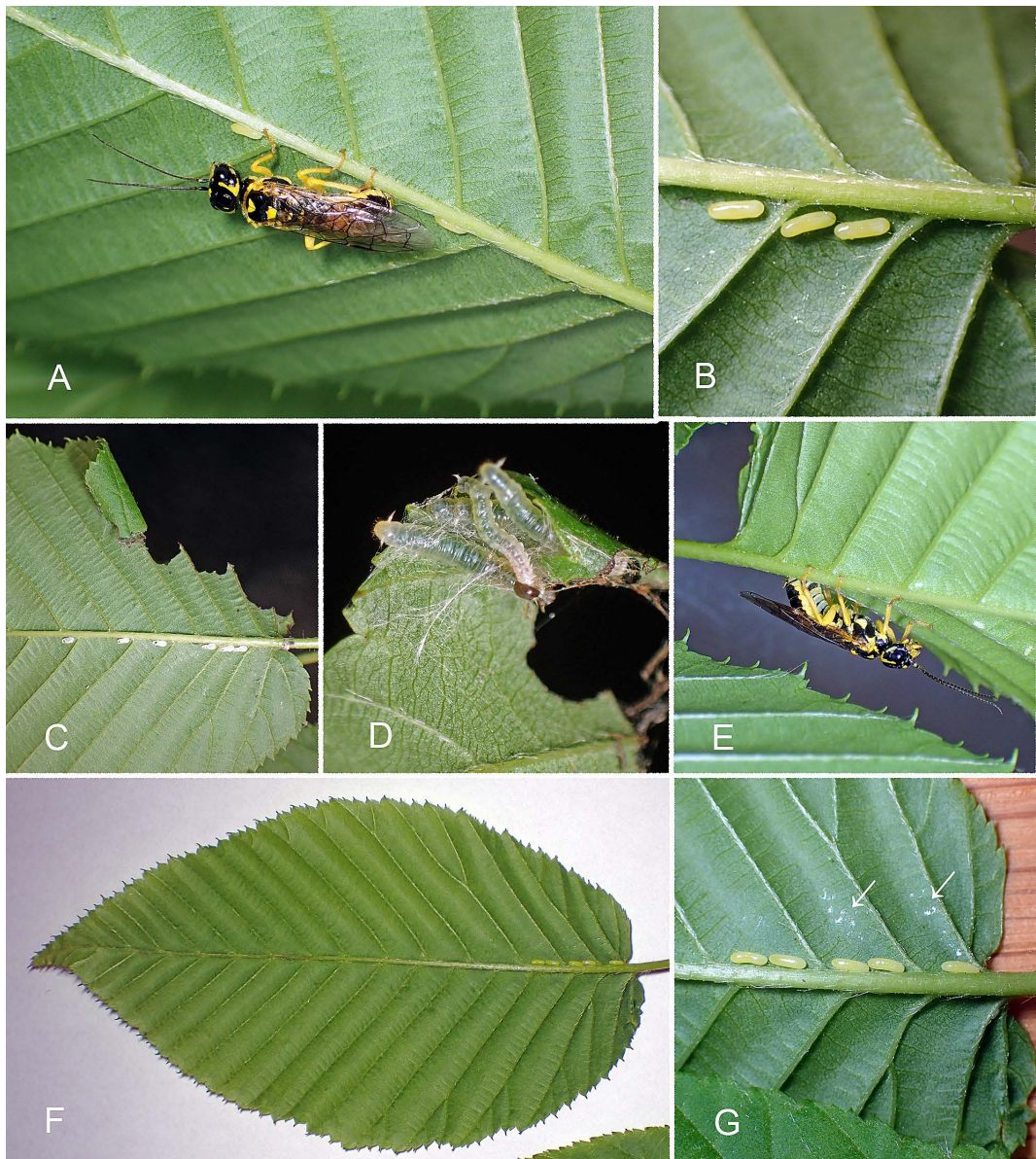


Fig. 1. *Pamphilius benesi*. — A, Ovipositing female on leaf of *Corylus sieboldiana*, Group Ab, May 29; B, three eggs, Group Aa, May 29; C, remains of six eggshells, Group Aa and Ab, and leaf-roll made by young larvae, June 6; D, larvae inside the same leaf-roll, June 6; E, ovipositing female on leaf of *C. sieboldiana*, Group B, May 29; F, leaf with five eggs, Group B, May 29; G, eggs of Group B, possible marks of sticky substance arrowed, May 29. All photographed by Kato.

the underside of a leaf on a branch about 2 meters above the ground in a tree 4 to 5 meters high. The female had already deposited three eggs (Group Aa) which formed a line along the main vein in the basal part of the leaf (Fig. 1B).

The female was captured alive. There were no other eggs on the leaves around.

On May 29, in a container with the host plant, the female deposited five eggs in a line along the main vein of a leaf (Group B, Fig. 1F, G). Then,



Fig. 2. *Pamphilius benesi*. — A, Eggs, remains of eggshell and newly hatched larva beginning to make leaf-roll, Group B, June 5; B, C, early instar larva, June 7; D, E, middle instar larva, June 14; F, late instar larva, June 23; G, H, J, late instar larva, June 21; I, late instar larva, June 28. All photographed by Kato.

the female moved to the leaf with Group Aa and deposited three additional eggs (Group Ab) making a line along the main vein apical to Group Aa (Fig. 1A). Therefore, on this leaf, there are six eggs apparently forming one linear egg group

along the main vein (Fig. 1C), which is actually a composite of Group Aa (basal position, deposited on May 28) and Group Ab (apical position, deposited on May 29).

Three eggs of Group Aa hatched on June 5,

and the larvae made a leaf roll together. Three eggs of Group Ab hatched on June 6. Two larvae went to the leaf roll made by Group Aa and stayed in this roll together, while another one went to the leaf margin and died soon without making a leaf roll. One egg of Group B hatched on June 5, four eggs hatched on June 6, and they made a leaf roll together. The two groups of totally ten larvae were reared in the same container and regrouped into three segregates of two to four individuals soon. During June 7 to 11, four young larvae died. During June 12 to 17, three middle-instar larvae died (two of them fixed in ethanol) and the remaining three late-instar larvae died thereafter, the last one fixed in ethanol on June 29.

Oviposition (Fig. 1A, E). The eggs were deposited in a group of five to ten (Shinohara and Hara, 1997; present work) along the main vein and lateral vein (Shinohara and Hara, 1997, 2005) or forming a line closely beside the main vein (present work, Fig. 1C, F) on the undersurface of the basal part of the leaf. The female deposited eggs always directing her head towards apex of the leaf (Fig. 1A, E). During the oviposition, no distinct behavior of painting or covering the eggs by sticky substance was observed, but the deposited eggs may have been covered with such substance, which apparently remained also on the leaf surface nearby (Fig. 1G, arrowed).

Egg (Fig. 1B, G). Length about 2.5 mm, long oval, yellowish white. The incubation period was six or seven days.

Larva. Early instar (Figs. 1D, 2A–C): Length about 4 mm, head blackish brown, antenna creamy white; trunk creamy white. **Middle instar** (Fig. 2D, E): Length 10–13 mm; head capsule black; mouth parts whitish, partly blackish; antenna creamy white; trunk semi-translucent, whitish; thoracic segment 1, lateral parts of trunk and subanal appendage creamy white, most of dorsal prothoracic shield and cervical sclerite black; suranal hook blackish. **Last instar** (Fig. 2F–J): Length about 15 mm (up to 18 mm, Shinohara and Hara, 2005); similar to middle instar; blackish mark on dorsal prothoracic shield (Fig.

2G, J) often reduced or missing (Fig. 2F, I).

Larval leaf-roll (Fig. 1C). The larval leaf-roll was made always on the underside of the leaf. It was a simple leaf-roll and normal for the genus, with both ends open and no frass kept inside. All the larvae from the same egg group lived together in the same leaf-roll.

Host plant. Betulaceae: *Corylus sieboldiana* Blume var. *sieboldiana* (Shinohara and Hara, 1997; present work).

General life history. *Pamphilius benesi* is doubtless univoltine as in other *Pamphilius* species. The adults occur mainly in late April to June on mountains of Honshu, Shikoku and Kyushu and in June in Hokkaido (Shinohara, 1985, 1988, 2001; Shinohara and Hara, 1997). The female lays eggs in a line along the main or lateral vein (fig. 1A in Shinohara and Hara, 1997; Fig. 1B, C, F, G) and the hatched larvae make a simple leaf-roll, in which they stay together. The oviposition and the leaf-roll are always on the underside of the leaf. The egg period is six or seven days. The larval period is not definitely known, but one larva lived for 23 or 24 days in our observation (the egg hatched on June 5 or 6 and the larva was fixed in ethanol on June 29). Shinohara and Hara (1997) noted that the individuals caught as young larvae spent up to 24 days until maturation. Because our larva mentioned above was apparently close to maturity when fixed on June 29, we estimate the whole larval period to be 25 or 26 days.

Comparison with related species. *Pamphilius benesi* is the only known species of Pamphiliidae feeding on *Corylus* in Japan. It is one of the four species of *Pamphilius* associated with *Corylus* in the world. The European *P. fumipennis* (Curtis, 1931) (also on *Alnus*) and *P. marginatus* (Serville, 1823) (also on *Carpinus*) and the North American *P. middlekauffi* Shinohara and Smith, 1983 (also on *Cornus*) are the other three species. Unlike *P. benesi*, these three species are solitary leaf-rollers (Stritt, 1935, 1937; Middlekauff, 1964).

Among the Japanese *Pamphilius* species, *P. alnicola* Ermolenko, 1973, has much in common

with *P. benesi* in adult morphology, COI and NaK sequences, oviposition method and larval gregariousness (Shinohara and Hara, 1993; Shinohara *et al.*, 2022). The larvae of *P. alnicola* are gregarious leaf-rollers on *Alnus hirsuta* Turcz. (Betulaceae) (Shinohara and Hara, 1993). Besides the difference in host plants, the larvae of the two species may be separated by the color of the terminal abdominal segment; *P. alnicola* has black spots on the segment both dorsally and ventrally (Shinohara and Hara, 1993, 2005), whereas *P. benesi* has no black spots on the segment (Fig. 2A–E, H–J).

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