

Distribution, Immature Stages and Life History of a Rose Leaf-rolling Sawfly, *Pamphilius hilaris*, in Japan (Hymenoptera, Pamphiliidae)

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Abstract *Pamphilius hilaris* (Eversmann, 1847) is newly recorded from Ibaraki Prefecture. Collection records of this species in Japan are all from central Honshu (Gunma, Tochigi, Ibaraki, Saitama, Tokyo, Yamanashi and Nagano prefectures), although the host plant, *Rosa multiflora*, is widely distributed and generally common in Japan, except in the Ryukyus. Based mainly on the material newly obtained in Moriya City, Ibaraki Prefecture, and results of rearing experiments, 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, *Rosa multiflora*, Rosaceae.

Introduction

Pamphilius hilaris (Eversmann, 1847) is a leaf-rolling sawfly attached to rose and known to occur in vast areas from Orenburg through Siberia to Kamchatka, Primorye, Sakhalin to Japan (Honshu) (Shinohara and Lee, 2010). The occurrence of this species in Japan was first reported half a century ago with brief notes on its host plant and biology in an obscure local publication in Japanese language (Shinohara, 1971) and part of the content of this paper was later summarized briefly in a more technical paper in English (Shinohara and Okutani, 1983). However, the immature stages of this species have not been described or illustrated. Shinohara (2002) listed collection data of all the specimens then available from Japan.

This lovely sawfly is very difficult to find in the field, but we can rarely see the adults and larvae in numbers around undisturbed bushes of *Rosa multiflora* in the right place and season. I encountered such occasions in Shiki, Saitama

Prefecture in 1968–1970 (Shinohara, 1971) and in Oishi on the northern coast of Lake Kawaguchi, Yamanashi Prefecture in 1977–1978 (Shinohara, 2002). In 2019, I was able to find a wonderful habitat for this species, where numerous *Rosa multiflora* bushes were growing in a sparse forest on a huge riverbed of the Tone River in Ibaraki Prefecture. In late April to early May of that year, I collected a good series of adults. In 2021, I visited the site again and made rearing experiments using the eggs and larvae then obtained.

Here I summarize the current knowledge of the distribution of *P. hilaris* in Japan with additional collection records. I also report on the life history of this species mainly based on the rearing experiments and briefly describe the immature stages and larval leaf-rolls with photographs.

Materials and Methods

All the specimens used in this work are kept in the National Museum of Nature and Science, Tsukuba. Rearings were made in Tsukuba City,

Ibaraki Prefecture, at an altitude of 25 m. The temperature and day length of the rearing room were not rigidly controlled. For morphological terminology, I generally follow Viitasaari (2002a). Examination of anatomy was made with Olympus SZX7 stereo binocular microscope. Photographs were taken with digital cameras, Olympus Stylus TG-4 Tough (Figs. 1A, 2D–H), Olympus Stylus TG-4 Tough with Olympus SZX7 stereo binocular microscope (Fig. 1B–J) and iPhone12 Pro (Fig. 2A–C). The digital images were processed and arranged with Adobe Photoshop Elements® 9 and 15 software.

Results and Discussion

Distribution in Japan. The available collection records of *P. hilaris* in Japan are limited in central Honshu. Shinohara (1971, 2002) and Shinohara and Okutani (1983) published collection records of this species from Gunma, Saitama, Tokyo, Yamanashi and Nagano prefectures. Nakamura (2004) gave the first record of this species from Tochigi Prefecture (see also Katayama and Nakamura, 2018). The following specimens examined represent the first distribution record from Ibaraki Prefecture: 4 ♀45 ♂, Togashira, about 5 m alt., Toride, 23. IV. 2019, A. Shinohara; 3 ♀16 ♂, Koya, about 5 m alt., Moriya, 28. IV. 2019, A. Shinohara; 11 ♂, Koya, about 5 m alt., Moriya, 28. IV. 2019, N. Shinohara; 8 ♀24 ♂, Koya, about 5 m alt., Moriya, 2. V. 2019, A. Shinohara. Fujimaru (2014) showed photographs of a female adult, an egg and a larva of this species, but he did not publish the locality where he found the sawfly.

This species occurs in central Honshu from lowlands to mountains over 1000 meters high (Shinohara, 2002). The adults are active in late April to early May in lowlands and in late May at higher altitudes. It is interesting that *P. hilaris* has been found only in limited areas in central Honshu, whereas the host plant *R. multiflora* is widely distributed and common in Japan.

Field observations, rearing records and outline of life history. Shinohara (1971) was the

first to record *P. hilaris* from Japan and was the first to report on the life history and immature stages of this species. He collected 11 female and one male adults of this species on the foliage of *R. multiflora* in a school campus in Shiki (about 14 m alt., 35°49'N 139°34'E), Saitama Prefecture, during the period of April 20 to May 18, 1968 to 1970. He also found young larvae (about 8 mm long and creamy white with black head) feeding on *R. multiflora* on May 19, 1970. They matured and went into the soil on June 13 and one female and one male emerged on April 17, 1971 (Shinohara and Okutani, 1983).

In 2019, I found numerous adults of *P. hilaris* around *R. multiflora* bushes growing on the riverbed of the Tone River in Toride City and Moriya City, Ibaraki Prefecture (see collection records above). On May 3, 2021, I visited Moriya City again and collected four eggs, one each on one leaflet (Fig. 1A), on rose bushes in Koya (about 5 m alt., 35°55'N 139°59'E). The four eggs hatched on May 5. The molts were not observed, and thus the number of instars is unknown. One larva each matured on June 7 and 9, respectively, while two others died before maturity. On May 15, I visited the site, collected several leaf-rolls containing early and middle instar larvae and reared them. Eight larvae matured on June 5 to 9. At the same site, I collected seven additional leaf-rolls of late instar larvae (Fig. 2E–H) on May 23 and 29, 2021. Four larvae matured on June 2, one larva on June 3 and two larvae on June 4.

Based on the observations noted above, the general life cycle of this species in the lowland of central Honshu may be summarized as follows: There is one generation a year. The adults are in flight from mid April to early(–mid) May. The feeding larvae are found in early May to early(–mid) June. The larval feeding stage lasts about 33–35 days. The larvae mature in early to mid June and enter the soil, where they stay until next spring. At higher altitudes (e.g., Lake Kawaguchi, about 900 m alt., Yamanashi Prefecture), the adults appear in late May (Shinohara, 2002) and the larval feeding period is estimated to be in

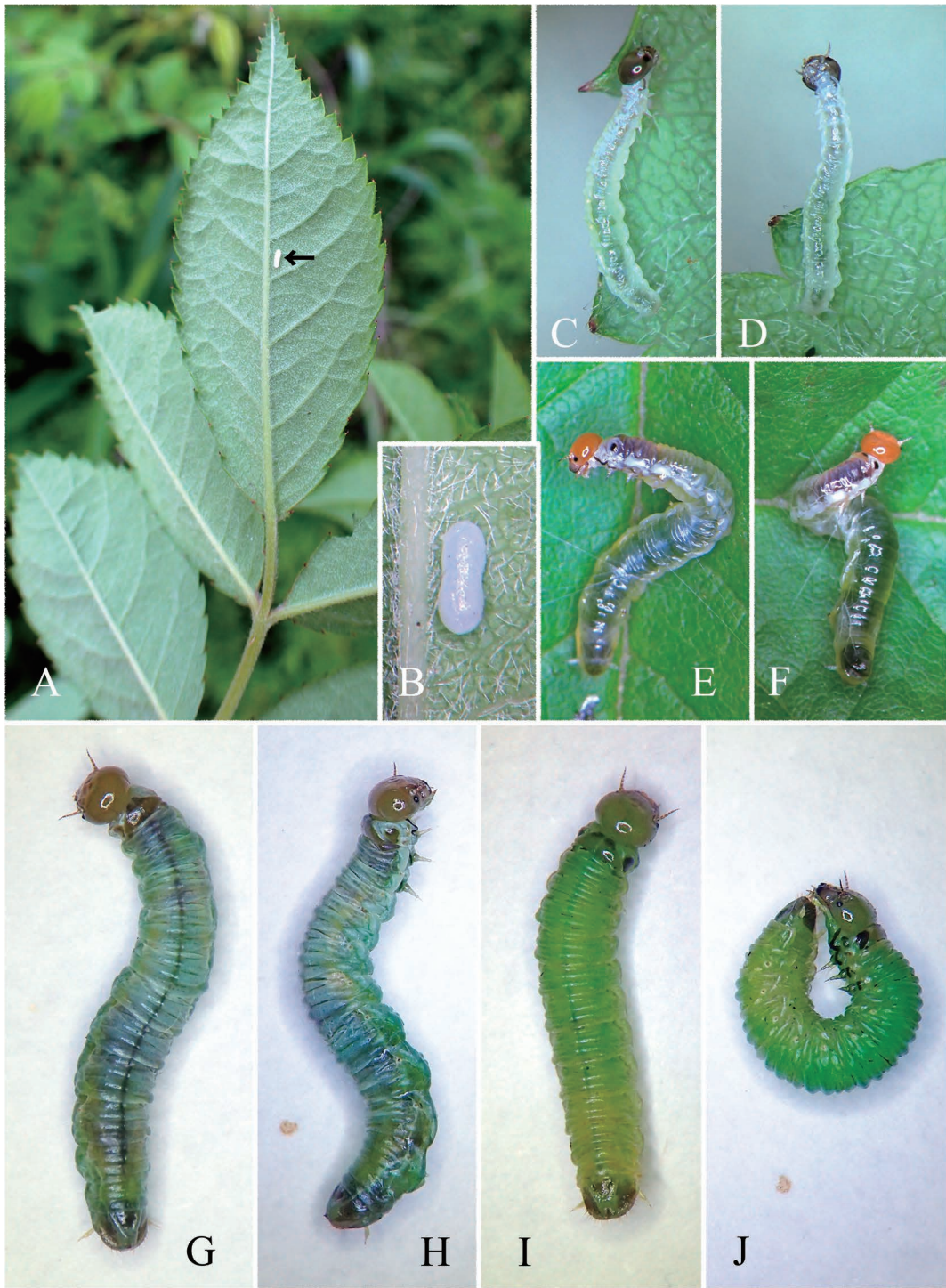


Fig. 1. *Pamphilius hilaris*. Egg on a leaflet of *Rosa multiflora* (A–B) and larvae (C–J), 2021.—A, Koya, Moriya City, Ibaraki Prefecture, May 3 (egg arrowed); B, another egg, same data; C, D, early instar, about 5 mm long, May 6; E, F, middle instar, about 13 mm long, May 19; G, H, late instar, about 17 mm long, June 4; I, J, mature larva, about 16 mm long, June 4.

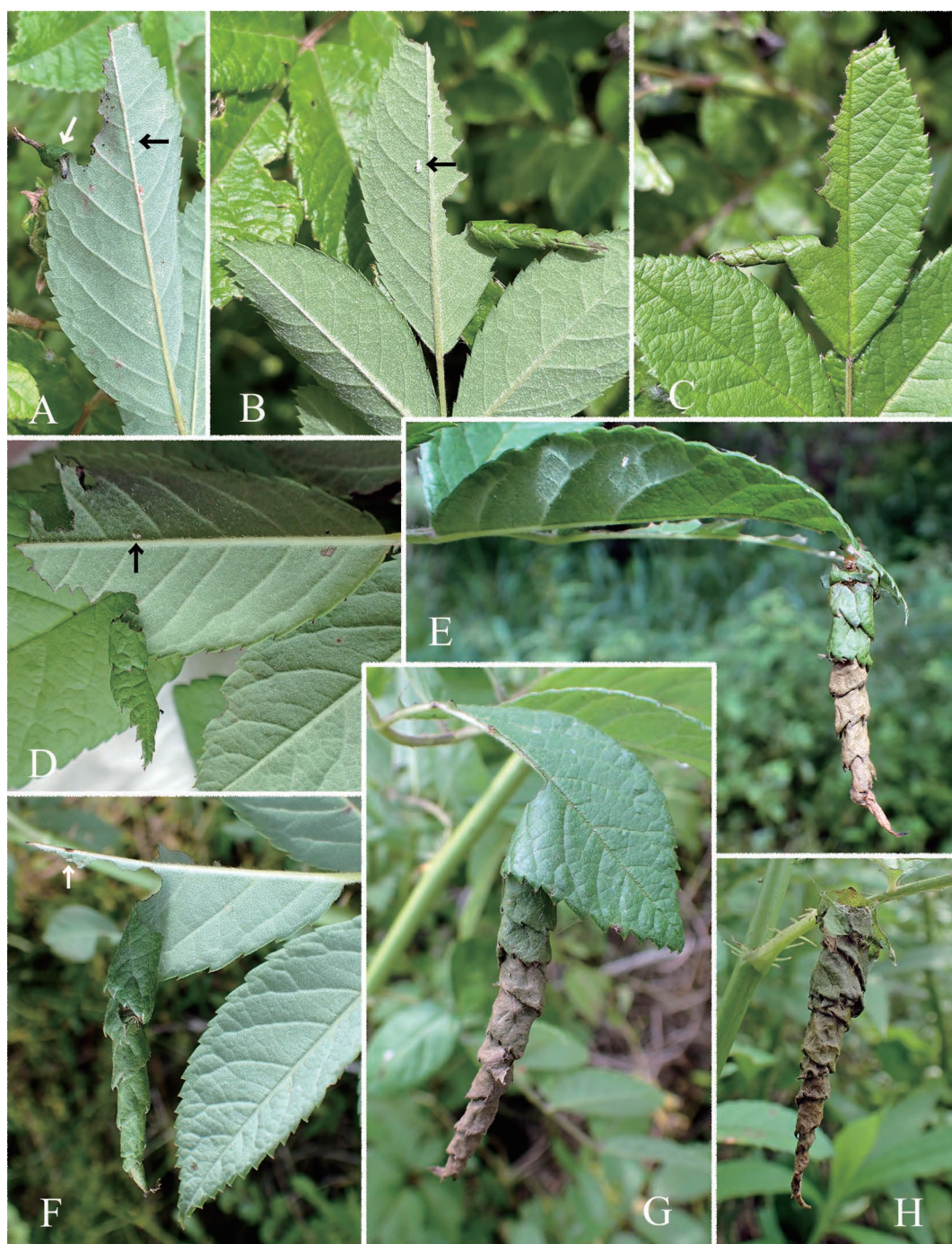


Fig. 2. *Pamphilius hilaris*. Larval leaf-rolls on leaflets of *Rosa multiflora*, Koya, Moriya City, Ibaraki Prefecture, 2021, early instar (A), middle instar (B–D), late instar (E–H).—A–C, May 15; D, May 10; E, G, H, May 29; F, May 23. White arrow in A showing small larval leaf-roll and black arrows in A, B, D and white arrow in F showing remains of egg shells.

June to July.

Egg (Fig. 1A–B). Creamy white, without distinct covering of sticky substance. Deposited near the midvein on the undersurface of the leaflet, one egg per leaflet.

Larva. *Early instar* (Fig. 1C–D): About 5–8 mm long, head, including most of mouthparts and antenna black; trunk creamy white, only cervical sclerite black. *Middle instar* (Fig. 1E–F): About 12–13 mm long, head capsule pale reddish brown; mouth parts mostly pale gray; antenna dark gray, inter-antennomere areas white; trunk semi-translucent, thoracic segment 1 and lateral parts of trunk creamy white, paired spots in anterior part of dorsal prothoracic shield, large spot on lateral prothoracic field, cervical sclerite, line dorsal to coxa of each thoracic leg black; apical two segments of thoracic legs, apex of subanal appendage and suranal hook blackish. *Late instar* (Fig. 1G–H): About 15–17 mm long, head capsule, most of mouth parts and antenna pale olive brown; trunk sordid greenish white, prothoracic shields pale olive brown, often marked with black; cervical sclerite and sometimes line dorsal to coxa of each thoracic leg black; thoracic legs creamy white, coxae sordid greenish white; subanal appendage creamy white, apex blackish; suranal hook black. *Mature larva (prepupa)* (Fig. 1I–J): About 16 mm long, head capsule pale olive green; mandible and antenna light brown; trunk vivid pale green; prothoracic shields concolorous to head capsule, with anterior part of dorsal shield and most of lateral shield blackish; cervical sclerite and elongate mark dorsal to coxa of each thoracic leg black; thoracic legs pale green, coxae slightly darker; suranal plate with three sunken areas and most of subanal plate blackish; subanal appendage creamy white, apex blackish; suranal hook black.

Larval leaf-roll (Fig. 2). The larval leaf-rolls are made always on the underside of the leaflet. Usually, one roll is found per leaflet and one larva in one leaf roll. The leaf-roll is a specialized, tight, screw-like tube, with the apex closed (type b of Viitasaari, 2002b). The late instar

larva, after consuming one original leaflet, moves onto another leaflet carrying the hanging screw-like abode (Fig. 2E, H). The frass is kept inside the abode.

Host plant. Rosaceae: *Rosa multiflora* Thunb. Not found on *Rosa luciae* Rochebr. et Franch. ex Crép., which often coexist with *R. multiflora* in the field (Shinohara, 1971; present work).

Pamphiliid sawflies associated with *Rosa*. Larvae of six world species of Pamphiliidae, all belonging to the genus *Pamphilius*, are known to feed on *Rosa* spp. They are *P. balteatus* (Fallén, 1808) and *P. stramineipes* (Hartig, 1837), both widely spread in the Palaearctic region, *P. inanitus* (Villers, 1789) from Europe, *P. palliceps* Shinohara and Xiao, 2006 from eastern China, and *P. pacificus* (Norton, 1869) from western North America, besides *P. hilaris*. Of these, the former three species occurring in Europe were fully discussed by Viitasaari (2002b), who gave a key to separate the species using the characters of the larvae and larval abodes. Two species occurring in Japan, *P. stramineipes* and *P. balteatus*, were further discussed by Hara (1993) and Shinohara and Hara (2005, 2006) based on Japanese material. Shinohara and Wei (2016) gave a note on the biology of *P. palliceps* with photographs of the larvae and the infested host plant. Middlekauff (1964) recorded his observation on the adult emergence, eggs and young larvae of *P. pacificus*.

Among the six species, *P. inanitus* and *P. hilaris* are peculiar in making a specialized, tight, screw-like larval leaf-roll (Fig. 2; type b of Viitasaari, 2002b), unlike a simple, loose larval leaf-roll or abode of the other species (e.g., fig. 3 in Hara, 1993, for *P. stramineipes*, fig. 1 in Shinohara and Hara, 2006, for *P. balteatus* and fig. 8 in Shinohara and Wei, 2016, for *P. palliceps*). The late instar larva of *P. hilaris* may differ from that of *P. inanitus* in that the parietal region and frons are uniformly pale olive brown without dark brown marks and the thoracic legs are entirely creamy white, not distally brown (Fig. 1G–H). *Pamphilius inanitus* has the parietal region spotted with dark brown, the frons usually

having two large and three small brown flecks and the thoracic legs distally brown (Lorenz and Kraus, 1957; Viitasaari, 2002b; Taeger *et al.*, 2018).

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