Bull. Natl. Mus. Nat. Sci., Ser. A, 42(1), pp. 49–54, February 22, 2016

Host Plant, Larva and Life History of *Asiemphytus fasciatus* (Hymenoptera: Tenthredinidae) in Japan

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(Received 29 October 2015; accepted 22 December 2015)

Abstract Based on observations and rearing experiments in Nakagawa Town, Tochigi Prefecture, Honshu, in 2015, the host plant and life history of a tenthredinid sawfly, *Asiemphytus fasciatus* (Takeuchi, 1929), are recorded and the larvae are described. The sawfly probably has three generations a year in Nakagawa and the larvae are solitary external feeders on the leaves of *Cornus controversa* (Cornaceae). The mature larva enters rotten wood, not soil, for the prepupal and pupal stages.

Key words: Hymenoptera, Tenthredinidae, *Asiemphytus fasciatus*, host plant, larva, life history, *Cornus controversa,* Japan.

Introduction

Asiemphytus fasciatus (Takeuchi, 1929) (Hymenoptera, Tenthredinidae) is a sawfly widely distributed in Hokkaido, Honshu, Shikoku and Kyushu, Japan (Abe and Togashi, 1989). It is an uncommon species and the host plant and life history were unknown. In 2015, Ibuki was able to rear this sawfly from larvae feeding on *Cornus controversa* Hemsl. ex Prain. (Cornaceae) in Nakagawa Town in Tochigi Prefecture, central Honshu, Japan.

Here we give the rearing records, the first host plant record, and a brief description of the larva. The new host record, *Cornus* for an *Asiemphytus* species, was quite unexpected, because the three other known Japanese species of *Asiemphytus* are all associated with *Deutzia crenata* Siebold et Zucc. (Hydrangeaceae) (Okutani, 1967).

Materials and methods

The material used in this work is kept in the National Museum of Nature and Science, Tsukuba. Four groups of larvae, with the group codes SI150604 (eight larvae), SI150609 (four larvae and the offspring of one of them), SI150707 (one larva) and S15I0920 (one larva) were collected in the field and reared (Fig. 12) in a room at Bambi Farm in Wami (N36°47′ E140°10′, about 240 m alt.), Nakagawa Town, Tochigi Prefecture. The temperature and day length were not controlled in the room, but the light was usually on for about 16 hours a day. All the photographs were taken by Ibuki with a Ricoh GR Digital II camera. The digital images were processed and arranged with Adobe Photoshop Elements 12 software. For the larval morphological terminology, we followed Viitasaari (2002).

Results

Reared specimens examined. 2♀1♂, Koisago, 125 m, N36°47′ E140°08′, Nakagawa Town, larva collected 4. VI. 2015, matured 9. IV., emerged 6. VII., host: *Cornus controversa*, S. Ibuki; 1♀, Oyamada, 210 m, N36°48′ E140°13′,

Nakagawa Town, larva collected 9. VI. 2015, matured 25. IV., emerged 19. VII., host: *Cornus controversa*, S. Ibuki; 2♀1♂, same data but matured 27. IV.–2. VII., emerged 20. VII.; 7♂, same locality, eggs laid 20, 21. VII. 2015, matured 8, 9. VIII., emerged 26. VIII., host: *Cornus controversa*, S. Ibuki; 1♂, same data but emerged 28. VIII.

Host plant. Cornaceae: *Cornus controversa* Hemsl. ex Prain.

Field observations and rearing records. Fig. 12 shows rearing records in Nakagawa Town, Tochigi Prefecture in 2015. On June 4, Ibuki found eight larvae (SI150604) feeding on the leaves of *Cornus controversa* in Koisago. Of these, five reached maturity on June 9 and three on June 11. All larvae went into a piece of rotten wood. Two female and one male adults emerged on July 6 from the larvae that matured on June 9. The others died.

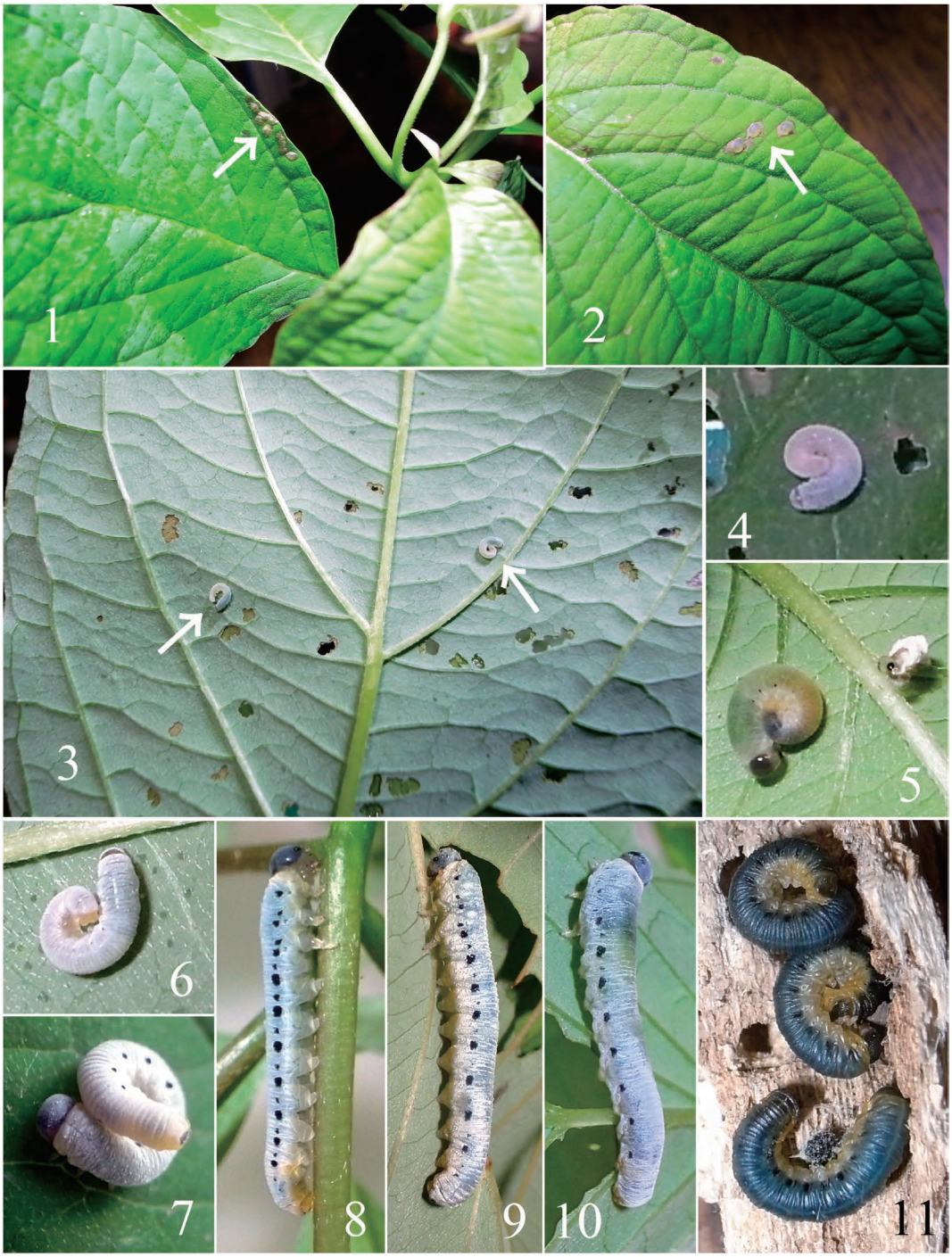
On June 9, Ibuki found four larvae (SI150609) feeding on the host plant in Oyamada. Of these, one each matured on June 25, 27, and July 1 and 2. They all entered a piece of rotten wood. One female adult emerged on July 19 from the larva that matured on June 25, and two female and one male adults emerged on July 20 from the larvae that matured on June 27 and July 1 and 2. One of the female adults that emerged on July 20 laid 15 eggs into three leaves (one egg, three eggs, and 11 eggs, respectively) on July 20 to 21 and they all hatched on July 25 to 26 (the offspring of SI150609). All the larvae matured and entered rotten wood on August 8 to 9. The rearing container was not examined until August 26, when seven male adults were found in the container; a few were alive but others were dead, suggesting that the emergence occurred about a week before August 26. An additional two males emerged on August 28, and one male on September 19. The remaining five individuals did not emerge before October 25 and probably died.

On July 7, Ibuki found a larva (SI150707) feeding on *Cornus controversa* in Wami. It matured on July 13 and was preserved in ethanol.

On September 20, Ibuki found a larva (SI150920) feeding on *Cornus controversa* in Wami. It reached maturity on October 2, but the larva was kept in a container only with soil, where the larva stayed on the surface of the soil and never entered the soil. On October 5, a piece of rotten wood was put in the container and the larva immediately entered the rotten wood.

Both in Koisago and Oyamada, the larvae were found on lower branches of young trees growing along small streams in rather dark forests. Eggs were laid into the leaf tissue of the host plant, usually in a small group (Figs. 1, 2). The larva fed on the leaf solitarily and often assumed a coiled resting position (Figs. 3–7). The young larva stayed on the underside of the leaf and fed on the surface cuticle of the leaf (Fig. 3). On maturity (Fig. 11), the larva entered rotten wood and stayed in a cavity inside the rotten wood without making a cocoon.

Description of the larvae. First and 2nd instars (Figs. 3, 4): translucent creamy white; head with pale bluish-gray tint posteriorly. Third instar (Figs. 5, 6): similar to 1st/2nd instars, but head more extensively darkened and median abdominal segments each with very small black spot in supraspiracular region. Fourth instar (Fig. 7): similar to 3rd instar, but dorsum of head mostly pale bluish gray and black spot on each abdominal segment larger. Last feeding instar (probably fifth) (Figs. 8–10): about 15 mm long; head dark bluish gray with ventral part dark olive gray; trunk creamy white, with dark bluish tint inside dorsally and often slightly orange tint ventrally; paired spots (large anterior one and small posterior one) on supraspiracular region of mesothorax, metathorax and 1st to 8th abdominal segments and small spot near anterior margin of 9th abdominal segment black. For each feeding instar, entirely covered with wax and consequently appearing whitish, except just after molting (Figs. 5, 8). Prepupa (Fig. 11) similar to last feeding instar, but ground color dark bluish gray dorsally, dark creamy white along spiracular region, and dirty pale orange ventrally and on prothorax, without wax covering.



Figs. 1–11. *Asiemphytus fasciatus*, immature stages, all photographs taken by S. Ibuki in Nakagawa in 2015.—1, 2, Small group of eggs (arrowed) deposited in the leaf tissue of *Cornus controversa*, July 23; 3, first instar larvae (arrowed) on an infested leaf, July 26 (probably hatched on July 25); 4, second instar larva, July 29; 5, probably third instar larva with a cast skin, July 31; 6, probably third instar larva, July 31; 7, probably fourth instar larva, August 5; 8, last instar larva, Koisago, June 4; 9, last instar larva, Oyamada, June 26; 10, last instar larva, Koisago, June 4; 11, mature larvae, August 8.

Discussion

Life History

The field observations and rearing records given above indicate that *Asiemphytus fasciatus* probably has three generations a year in Nakagawa Town. The occurrence of the larvae in June (SI150604 and SI150609 in Fig. 12) implies that their parent adults were active and oviposited in May to early June, and these adults probably belonged to the first emergence for the year. The second emergence of the adults occurred in July (dark blue in Fig. 12) and the third emergence in late August to September (offspring of SI150609 in Fig. 12). The larvae of the last generation matured in October (SI150920) and most probably went into prolonged diapause until the next spring.

In the case where one full generation was observed in July to August (offspring of SI150609, Fig. 12, all unfertilized male eggs), the incubation period was only five days, the larval feeding period was about 14 days and the prepupal plus pupal period was 18 to 20 days (one exceptional case 42 days). This is probably the shortest developing period because the season was during the warmest part of summer. In other cases observed in June to July (SI150604, SI150609, Fig. 12), the larval feeding period was longer than 23 days at least in one individual and the prepupal plus pupal period ranged from 18 to 27 days.

Tomizawa (1934) studied the life history of *Asiemphytus deutziae* (Takeuchi, 1929), which feeds on *Deutzia crenata*. This species has two generations a year in Tokyo, with the adult emergences in mid-April and mid-September. The female deposits an average of three or four eggs per leaf. The incubation period is about 10 days. On maturing, the larva enters a dead stem and there pupates after a long prepupal stage. *Asiemphytus deutziae* differs from *A. fasciatus* in having only two generations a year (no summer generation) but they both utilize dead stems or wood, not soil, for diapausing and pupating sites. The use of dead stems or wood for spending the dormant stage is known only for species of Selandriinae and some Allantinae and Blennocampinae (Okutani, 1957).

Host Plant

Host plants of the species of *Asiemphytus* Malaise, 1947, were known for only three Japanese species, *A. albilabris* (Takeuchi, 1929), *A. deutziae* and *A. vexator* (Smith, 1874), and all are associated with *Deutzia crenata* (Hydrangeaceae)

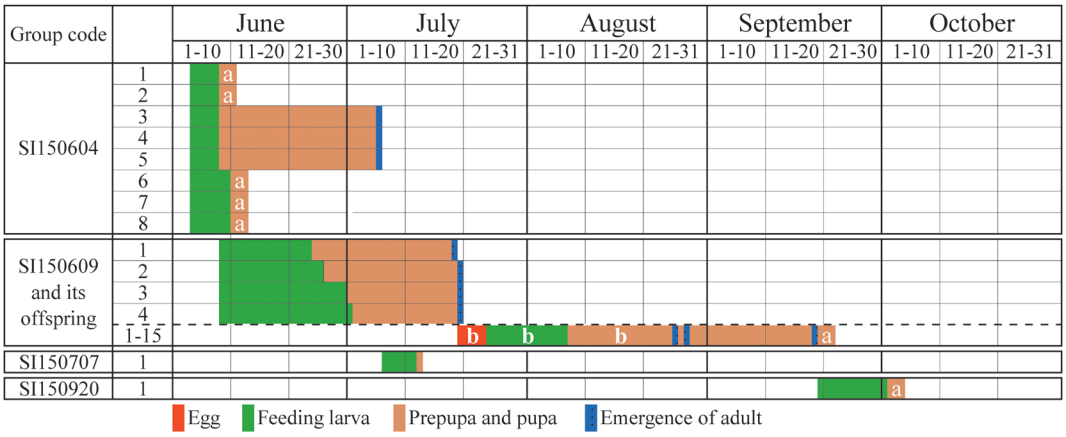


Fig. 12. Rearing records of *Asiemphytus fasciatus* in Nakagawa from June to October, 2015. Each individual in the four groups is shown separately, except for the offspring of SI150609 (15 individuals, which grew almost simultaneously until maturation). a: Matured and entered rotten wood but died or did not emerge before October 25. b: Combined data of 15 individuals. See text for more details and explanation.

(Takeuchi, 1929; Okutani, 1967). Our discovery of the association of *A. fasciatus* with *Cornus controversa* is the first host plant record of *Cornus* and Cornaceae for an *Asiemphytus* species. The families Hydrangeaceae and Cornaceae both belong to the order Cornales and are phylogenetically fairly closely related (Xiang *et al.*, 2011).

Asiemphytus is represented by 10 species distributed in Primorsky Kray, Japan, China, and Vietnam (Taeger *et al.*, 2010). Malaise (1947) proposed the genus for the East Asian species originally described in *Macremphytus* MacGillivray, 1908, which currently contains five North American and one Chinese species (Taeger *et al.*, 2010). These two genera have much in common, and it is interesting that four species of *Macremphytus* from North America, *M. lovetti* MacGillivray, 1923, *M. semicornis* (Say, 1836), *M. tarsatus* (Say, 1836) and *M. testaceus* (Norton, 1861), feed on *Cornus*, which is the only plant genus recorded as hosts of *Macremphytus* (Smith, 1979). A close one-to-one host plant relationship between tenthredinid sawfly species groups/genera and plant genera/families certainly exists. Examples include a tenthredinine genus *Conaspidia* Konow, 1898 and Araliaceae (the *sikkimensis* group and *Aralia* and the *scutellaris* group and *Kalopanax*) (Shinohara and Ibuki, 2011) and an allantine genus *Emphytopsis* Wei and Nie, 1998 and *Stewartia* (Theaceae) (Shinohara *et al.*, 2014). The relationship of *Macremphytus* with *Cornus* is another example. The association of *Asiemphytus* both with *Deutzia* and *Cornus* appears irregular and it may suggest a heterogeneous nature of the genus itself. Accumulation of further data on the host plants and clarification of phylogenetic relationships of the species of *Asiemphytus* and *Macremphytus* are needed for understanding the evolution of these sawflies which may possibly be connected with host preference shift.

In Japan, another allantine sawfly, *Togashia horii* (Togashi, 1962), is known to feed on *Cornus controversa*. It is a much larger species, whose eggs are deposited in large groups (lines) along the lateral veins on a leaf (Togashi, 1976). Togashi's figure 2 shows long lines of eggs deposited along (on both lateral sides of) nine lateral veins on one leaf (thus 18 lines of eggs), suggesting that a great number of larvae will feed gregariously. In *A. fasciatus*, the eggs are laid in a small group, not lined up along the veins, and the larvae are solitary (Figs. 1–3).

Acknowledgements

We thank David R. Smith, United States Department of Agriculture, Washington, D. C., for his careful review of the manuscript. This study was partly supported by JSPS KAKENHI Grant No. 25440223.

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