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New Host Plant Records and Life History Notes on *Spinarge flavicostalis* (Hymenoptera: Argidae) in Japan

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Abstract *Betula maximowicziana* Regel, *B. grossa* Siebold et Zucc., and *B. corylifolia* Regel et Maxim. (Betulaceae), are newly recorded host plants of *Spinarge flavicostalis* Hara and Shinohara, 2006. The larva is briefly described and the life history is discussed based on field observations and rearing records.

Key words: Hymenoptera, Argidae, *Spinarge flavicostalis*, host plants, *Betula*, life history.

Introduction

Spinarge flavicostalis Hara and Shinohara, 2006, is a rare species of the sawfly family Argidae known to occur in Hokkaido and Honshu, Japan. Hara and Shinohara (2006) briefly reported on the rearing of this species from a group of 12 gregarious larvae feeding on *Betula ermanii* Cham. (Betulaceae) found in Shintoku, Hokkaido in July, 1992. They noted that this species probably had one generation a year, because two females emerged from these larvae in August, 1993. They also gave a very short characterization of the middle instar and final instar larvae.

In 2005–2012, larvae of *S. flavicostalis* were found on three different species of *Betula* in three different localities in Hokkaido and in Niigata and Nagano prefectures, central Honshu. In Nagano Prefecture, H. Kojima managed to rear the species from eggs or larvae to adults in 2007–2008 and 2012–2013. Here we report on these discoveries and observations. This species may possibly be bivoltine in lower mountains in Honshu.

Materials and Methods

The material used in this work is kept in the National Museum of Nature and Science, Tsukuba. Rearings by H. Kojima were in a room at Kitanagaike in Nagano City, Nagano Prefecture at an altitude of 335 m. All the photographs were taken by H. Kojima with digital cameras Nikon D70 and Nikon Coolpix S5100, except for Fig. 1J, which was offered to us by S. Matsuki. The digital images were processed and arranged with Adobe Photoshop Elements® 2.0 software. For the larval morphological terminology, we follow Viitasaari (2002).

Results

Observations and rearing records

1. On July 20, 2005, two groups of late instar larvae were found feeding on *Betula maximowicziana* Regel in Koshunai at an altitude of about 70 m, Bibai, Hokkaido by S. Matsuki

(Figs. 1J; 2B). One group was represented by six larvae and another group by four larvae. No attempt was made to rear the larvae.

2. HK070829 (Fig. 2C): On August 29, 2007, a group of larvae were found feeding on *Betula grossa* Siebold et Zucc. in southwestern Tsunan at an altitude of about 640 m, Niigata Prefecture by Y. Koyama. The larvae were sent to H. Kojima who reared the larvae. Because of the shortage of fresh leaves of *B. grossa*, Kojima gave the larvae fresh leaves of *B. corylifolia* Regel et Maxim., *B. ermanii, B. platyphylla* Sukaczev var. *japonica* (Miq.) H. Hara and *Alnus firma* Siebold et Zucc. f. *hirtella* (Franch. et Sav.) H. Ohba. All the larvae fed on the leaves of *B. corylifolia* and no other plants. A total of ten larvae grew to the final instar and seven cocooned on September 7–10, while the remaining three died without spinning cocoons (Table 1). One male adult each emerged on October 18, 2007 and June 7, 11 and 18, 2008, respectively; others did not survive.

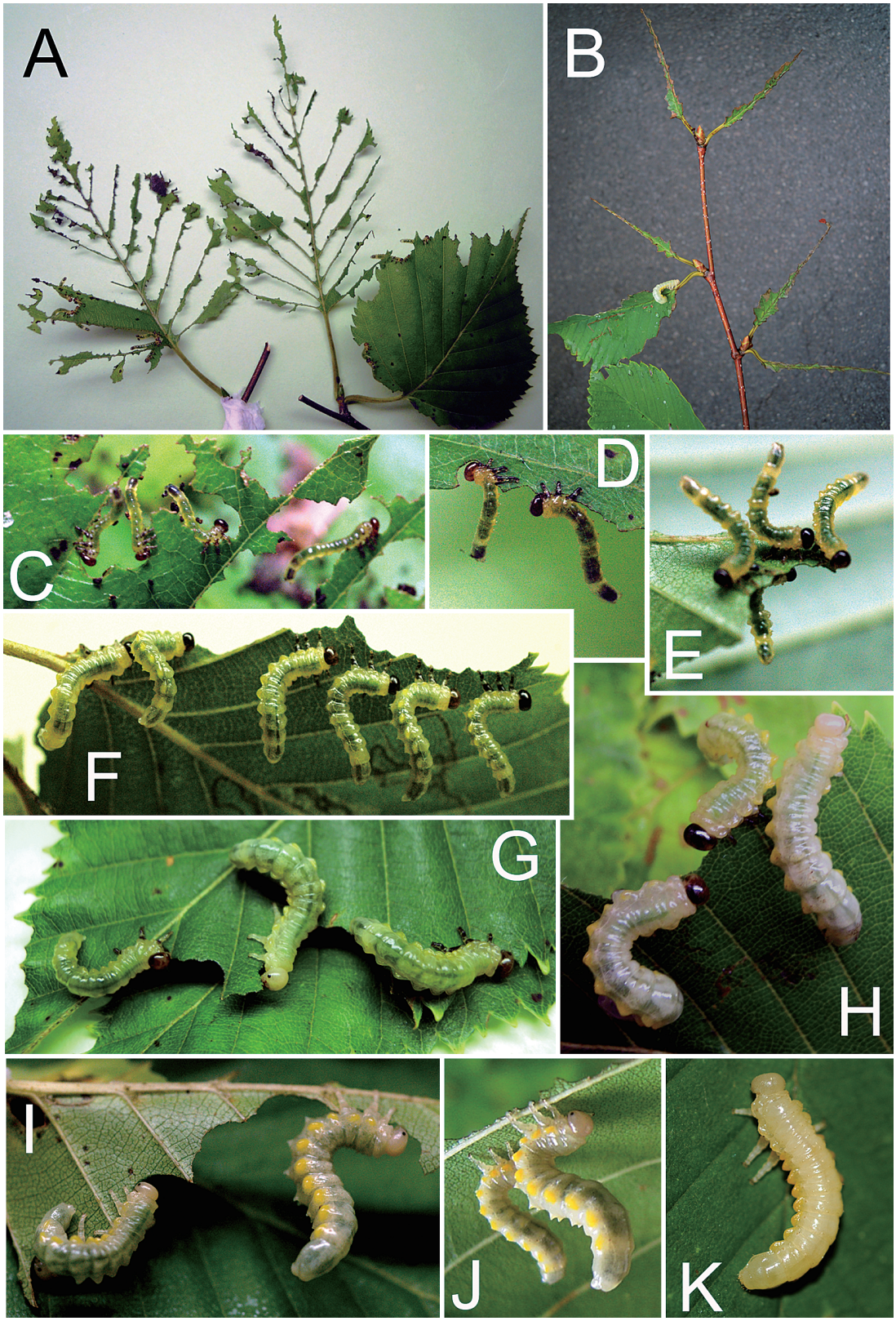
3. HK120718 (Fig. 2D): On July 18, 2012, one female was collected from a leaf of *B. ermanii* near Mt. Kasadake at an altitude of about 1,880 m, Yamanouchi-machi, Nagano Prefecture by H. Kojima. The female, kept alive with a small branch of *B. ermanii* in a plastic bag, deposited a total of 16 eggs on July 19. Table 2 summarizes the rearing record. All the eggs hatched on July 29 and the larvae fed gregariously on the leaves (Fig. 1A). Eleven larvae matured on August 12–19 and each cocooned on the next day. One male adult emerged on May 22, 2013 from the larva cocooned on August 17, 2012, while the others were found dead when examined in August, 2013.

4. HK120815 (Fig. 2E): On August 15, 2012, one almost mature larva was collected on a branch of *B. corylifolia* near Mt. Kasadake at an altitude of about 1,870 m, Yamanouchi-machi, Nagano Prefecture by H. Kojima. The leaves of the branch had been heavily infested (Fig. 1B), suggesting that the larva was the last feeding individual in its group. The larva cocooned on August 18 and was found dead in August, 2013.

Description of the larva

Male with five instars and female with six instars. *First instar* (Fig. 1C): Head dark amber brown to blackish brown; trunk pale greenish; subspiracular lobes brownish; thoracic legs mostly blackish. *Second to fourth instars* (Fig. 1D–F): Similar to first instar but head usually blackish and trunk pale yellowish. *Fifth instar* (*female*) (Fig. 1G, H): Head blackish brown, dorsal and lateral parts black; trunk creamy white, often with greenish tint, with subspiracular lobes yellow; thoracic legs mostly blackish. *Final instar* (*fifth instar in male and sixth instar in female*) (Fig. 1G–J): Length 13–16 mm in male, 18–22 mm in female. Head creamy white; trunk whitish, with subspiracular lobes yellow; thoracic legs whitish. When mature, whitish parts becoming more yellowish (Fig. 1K). Antenna small and conical; clypeus with two pairs of setae; labrum with two pairs of setae; mandible with six setae on outer surface; maxillary palp with four palpomeres; palpifer with five or six setae; labial palp with three palpomeres; first to ninth abdominal segments each with three annulets; prolegs on second to sixth and tenth seg-

Fig. 1. *Spinarge flavicostalis*. —A, Leaves of *Betula ermanii* infested by second instar larvae, Nagano, August 3, 2012; B, infested leaves of *B. corylifolia* with one almost mature larva, HK120815, Mt. Kasadake, August 15, 2012; C–I, offspring of a female collected at Mt. Kasadake, HK120718, reared indoors in Nagano with *B. ermanii*; C, first instar larvae, July 31, 2012; D, second instar larvae, August 3, 2012; E, third instar larvae, August 5, 2012; F, fourth instar larvae, August 7, 2012; G, fourth instar larva (left), fifth instar larva, male (middle), and fifth instar larva, female (right), August 9, 2012; H, fifth instar larvae, female (left two) and fifth instar larva, male (right), August 11, 2012; I, fifth instar larva, male (left) and sixth instar larva, female (right), August 14, 2012; J, last instar larvae feeding on *B. maximowicziana,* Bibai, July 20, 2005; K, mature larva on a leaf of *B. corylifolia*, HK070829, September 7, 2007. Photographed by H. Kojima (A–I, K) and S. Matsuki (J).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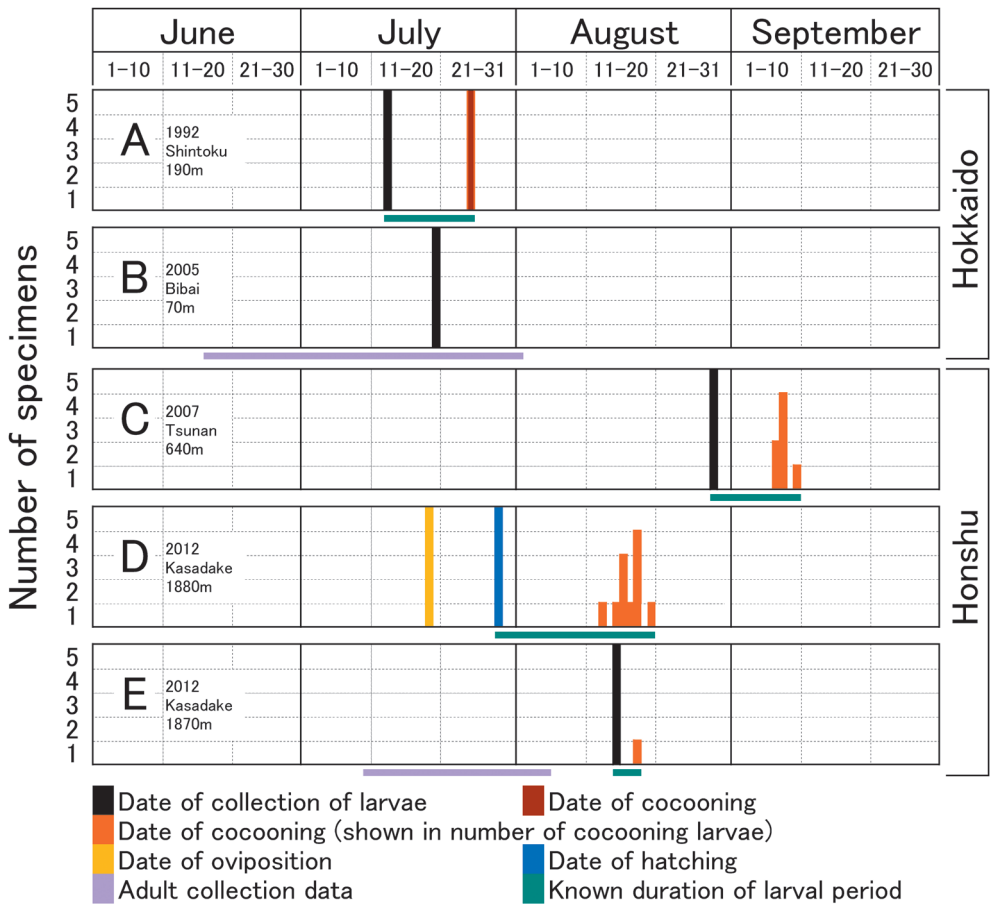

Fig. 2. Summary of available data on the life history of *S. flavicostalis*. — See text for explanation.

ments, those on second to sixth elongate; tenth tergum in dorsal view rounded apically; trunk glabrous, with only a few setae along posterior margin of each segment; suranal and subanal lobes posteriorly setose. *Cocoon*: Pale brown. Length 8.6–11.8 mm in male, 12.5–13.7 mm in female (Tables 1, 2). Elongate oval, double walled; outer wall netted; inner wall parchment like.

Discussion

Comparative comments

The larva of *S. flavicostalis* is gregarious and quite peculiar in coloration. In all instars, except in the final one, the head is black, dark amber brown or blackish brown, the thoracic legs are mostly blackish, and the trunk is pale green, becoming whitish in later instars, with only the subspiracular lobes brownish in early instars and yellowish in later instars. The final instar larva is entirely whitish, with only the subspiracular lobes yellow. Most *Arge* and *Spinarge* larvae, particularly in early and middle instars, have scattered minute dark spots on the trunk (e.g., in *A. pullata*, fig. 1 in Hara and Shinohara, 2008b), but such spots are absent in all instars of this species.

Spinarge flavicostalis is very closely related to *S. metallica* (Klug, 1834) occurring in Europe to the Russian Far East and Korea (Hara and Shinohara, 2006). Judging from the literature (Saarinen, 1946; Schedl and Altenhofer, 2013), the two species are very similar to each other also in

Table 1. Rearing records of *S. flavicostalis* from larvae collected in Tsunan, Niigata Prefecture, on August 29, 2007.

No.	Cocooned	Length of final instar larva	Emerged (all males)	Length × width of cocoon
1	7 September	13 mm	dead	9.3 × 4.5 mm
2	7 September	13 mm	18 October 2007	8.6 × 4.9 mm
3	8 September	13 mm	dead	9.4 × 4.8 mm
4	8 September	13 mm	11 June 2008	9.2 × 4.8 mm
5	8 September	15 mm	dead	9.9 × 5.5 mm
6	8 September	15 mm	18 June 2008	9.4 × 5.1 mm
7	10 September	14 mm	7 June 2008	Cocoon lost
8	11 September*	14 mm	dead	—
9	13 September*	15 mm	dead	—
10	13 September*	14 mm	dead	—

*: Matured but cocooning failed.

the larval stage and we are not able to separate the larvae of the two species. Conde (1937) gave a brief description of a young larva of "*A. metallica*", but the larva may belong to a different species, as Lorenz and Kraus (1957) pointed out, because it has a reddish-yellow head with blackish stripes and a whitish-yellow trunk with black setiferous swellings and black marks near the bases of legs and on the anal segment.

Three other species of argine sawflies are known to feed on *Betula* in Japan. The larvae of *Arge solowiyofka* (Matsumura, 1911) and *A. aenea* Hara and Shinohara, 2008, are more or less cryptic and solitary in late instars (Hara *et al.*, 2007; Hara and Shinohara, 2008a). The late instar larvae of these two species are pale green. The head has a dark marking, the trunk is relatively dull, sparsely setose and often has rather inconspicuous small dark spots scattered all over, and the subspiracular lobes are yellowish white. The larva of *A. pullata* (Zaddach, 1859) is gregarious and quite aposematic. The head and the thoracic legs are black and the pale greenish or yellowish trunk is covered with small black spots, the black areas with slight brownish metallic luster in the final stage (Hara and Shinohara, 2008b).

Host plants

The larva of this species was known to feed on *Betula ermanii* (Hara and Shinohara, 2006). Our rearing records have shown that three additional species of *Betula*, *B. maximowicziana*, *B. grossa*, and *B. corylifolia*, also serve as host plants of *S. flavicostalis*. In our experiment, where *B. corylifolia*, *B. ermanii, B. platyphylla* and *Alnus firma* were given to the larvae found afield on *B. grossa*, only *B. corylifolia* was selected and the larvae grew and matured feeding on this plant (HK070829, see "Observations and Rearing Records" above). This may suggest that the larvae of *S. flavicostalis* prefer *B. corylifolia* to *B. ermanii* when both plants are available.

Life history

Spinarge flavicostalis is a rare species with adult collection records from mid-June to early August in Hokkaido (6♀ 6♂) and from early July to early August in Honshu (7♀ 3♂) (purple horizontal lines in Fig. 2; see Hara and Shinohara, 2006, and observations given above for collection data). Hara and Shinohara (2006) mentioned that this species probably had one generation a year, because two female adults emerged in August, 1993 from the larvae found in July, 1992 in Shintoku, Hokkaido (Fig. 2A).

As noted above, the larvae of this species were found afield on July 13 and 20 in Hokkaido and on August 15 and 29 in Honshu (Fig. 2A–C, E). The larvae found on July 13, 1992, cocooned on July 25 (Fig. 2A), those found on August 15, 2012, cocooned on August 18 (HK120815) (Fig. 2E), and those found on August 29, 2007, cocooned on September 7–10 (HK070829) (Fig.

Table 2. Rearing records of *S. flavicostalis* from 16 eggs deposited on July 19, 2012, by a female collected on Mt. Kasadake, Nagano Prefecture.

No.	July			August																				Length of final instar larva	Length × width of cocoon
	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	
1	**1**	1	1	**2**	2	**3**	3	3	**4**	4	4	**5**	5	5	**M**	**C**									16 mm	11.5 × 5.7 mm
2	**1**	1	1	**2**	2	**3**	3	3	**4**	4	4	**5**	5	**6**	6	6	6	6	6	**M**	**C**				22 mm	13.7 × 6.2 mm
3	**1**	1	1	1	**2**	2	**3**	3	3	**4**	4	4	**5**	5	5	**6**	6	6	6	6	**M**	m	**D**		22 mm	—
4	**1**	1	1	1	**2**	2	**3**	3	3	**4**	4	**5**	5	5	5	5	**M**	**C**							15 mm	10.1 × 5.6 mm
5	**1**	1	1	1	**2**	2	**3**	3	3	**4**	4	4	**5**	**6**	6	6	6	6	6	**M**	**C**				22 mm	13.3 × 6.3 mm
6	**1**	1	1	1	**2**	2	**3**	3	3	**4**	4	4	4	**5**	5	5	5	5	**M**	**C**					16 mm	11.8 × 5.8 mm
7	**1**	1	1	1	**2**	2	**3**	3	3	**4**	4	4	4	**5**	5	**6**	6	6	6	6	6	**M**	**C**		20 mm	12.5 × 6.2 mm
8	**1**	1	1	1	**2**	2	**3**	3	3	3	**4**	4	4	**5**	5	5	5	**6**	6	6	6	6	6	**D**	—	—
9	**1**	1	1	1	**2**	2	**3**	3	**D**																—	—
10	**1**	1	1	**2**	2	2	**3**	3	**4**	4	4	**5**	5	5	5	5	5	**M**	**C**						15 mm	10.4 × 5.0 mm
11	**1**	1	1	**2**	2	2	**3**	3	**4**	4	4	**5**	5	5	5	5	5	**M**	**C**						15 mm	11.1 × 5.6 mm
12	**1**	1	1	**2**	2	2	**3**	3	**4**	4	4	**5**	5	5	5	5	5	**M**	**C**						15 mm	11.1 × 6.0 mm
13	**1**	1	1	**2**	2	2	**3**	3	**4**	4	4	**5**	5	**6**	6	6	6	**M**	m	m	m	m	**D**		20 mm	—
14	**1**	1	1	**2**	2	2	**3**	3	**4**	4	4	**5**	5	**6**	6	6	6	6	6	**M**	**C**				22 mm	13.2 × 6.9 mm
15	**1**	1	1	**2**	2	2	**3**	3	**4**	4	4	4	**5**	5	**6**	6	6	6	**M**	m	m	m	**D**		18 mm	—
16	**1**	1	1	**2**	2	**3**	3	3	3	**4**	4	4	4	**5**	5	5	5	5	5	**M**	**C**				15 mm	10.3 × 5.9 mm

1–6: Larval instars (bold letters showing date of hatching or molts). M: Matured. m: Mature larva. C: Cocooned. D: Dead.

2C). In one case where the rearing was made from eggs in 2012 (HK120718), eleven larvae matured on August 13–19 (Fig. 2D). None of these became adults within the same year, except for one male which emerged on October 18, 2007 from the larvae cocooned on September 7–10, 2007. From the same series of larvae, three males emerged on June 7–18, 2008 (Table 1).

This apparent polymodal emergence of the adults, where one male emerged within the same year as cocooning and three others emerged in the next year, may be an abnormal case due to artificial rearing condition. However, if this is just a normal case of polymodal emergence, this species may possibly be multivoltine at least in the lower altitudes in Honshu. In Tsunan (altitude about 640 m), Niigata Prefecture, the larvae were found on August 29, 2007, and they matured on September 7–10 (HK070829; Fig. 2C). It is quite possible that there was actually another generation probably in July as in the Hokkaido population. We need more information to ascertain the voltinism of this sawfly.

A total of eleven larvae cocooned from the eggs deposited by one female collected afield in 2012 (Table 2). Of these, four had five molts (six instars) while the other seven had four molts (five instars). The fifth instar of the individual having totally six instars is similar to the fourth instar whereas the final instars (fifth or sixth) are quite similar in both types of development (Fig. 1G–I). Only one adult, a male, emerged from the larva which matured at the fifth instar. Though no adults emerged from the larvae which had six instars, we believe that the individuals having five instars are the males and those having six instars are the females.

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References

Conde, O. 1937. Ostbaltische Tenthredinoidea III, nebst Bemerkungen zu einigen anderen paläarkitischen Arten. Korrespondenzblatt des Naturforscher-Vereins zu Riga, 62: 103–112.

Hara, H., H. Kojima and A. Shinohara 2007. *Arge solowiyofka* (Hymenoptera, Argidae) feeding on *Betula ermanii*, newly recorded from Japan. Japanese Journal of Systematic Entomology, 13: 85–89.

Hara, H. and A. Shinohara 2006. The sawfly genus *Spinarge* (Hymenoptera, Argidae). Bulletin of the National Science Museum, Tokyo, Ser. A, 32: 61–94.

Hara, H. and A. Shinohara 2008a. The species-group of *Arge aenea* (Insecta, Hymenoptera, Argidae). Bulletin of the National Museum of Nature and Science, Ser. A, 34: 77–94.

Hara, H. and A. Shinohara 2008b. Taxonomy, distribution and life history of *Betula*-feeding sawfly, *Arge pullata* (Hymenoptera, Argidae). Bulletin of the National Museum of Nature and Science, Ser. A, 34: 141–155.

Lorenz, H. and M. Kraus 1957. Die Larvalsystematik der Blattwespen (Tenthredinoidea und Megalodontoidea). *Abhandlungen zur Larvalsystematik der Insekten*, (1): 1–339.

Saarinen, A. 1946. Tenthredinologische Mitteilungen, 1–2. *Suomen Hyönteistieteellinen Aikakauskirja*, 12: 57–61.

Schedl, W. and E. Altenhofer 2013. Zur Morphologie, Biologie und Verbreitung von *Spinarge metallica* (Klug 1834) in Österreich (Hymenoptera: Argidae). *Linzer Biologische Beiträge*, 45: 663–669.

Viitasaari, M. 2002. The suborder Symphyta of the Hymenoptera. In: Viitasaari, M. (ed.), Sawflies 1 (Hymenoptera, Symphyta), pp. 11–174. Tremex Press, Helsinki.