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Tenthredo babai (Hymenoptera, Tenthredinidae) Feeds on Peony in Japan: First Record of Sawfly Associated with Paeoniaceae

Akihiko Shinohara[1], Shin-ichi Ibuki[2] and Eisuke Katayama[3]

[1] National Museum of Nature and Science,
4–1–1 Amakubo, Tsukuba, Ibaraki 305–0005, Japan
E-mail: shinohar@kahaku.go.jp
[2] Wami 1355–13, Nakagawa, Tochigi 324–0612, Japan
E-mail: banbi-fa@ktd.biglobe.ne.jp
[3] Shimoishigami 1780–57, Otawara, Tochigi 324–0036, Japan
E-mail: eisuke-k0878@ninus.ocn.ne.jp

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Abstract Based on rearing experiments, *Paeonia suffruticosa* Andrews and *Paeonia lactiflora* Pall. [Paeoniaceae] are newly recorded as host plants of *Tenthredo babai* Takeuchi, 1936. This is the first record of Paeoniaceae and the genus *Paeonia* as host plants of sawflies. The life history of *T. babai* is outlined and the larva and previously unknown male adult are briefly described and illustrated.

Key words: new host record, *Paeonia suffruticosa*, *Paeonia lactiflora*.

Introduction

Peonies (Paeoniaceae, *Paeonia* spp.) are common and very popular garden plants in Japan. An injury of this plant by unidentified sawfly larvae was first found in 2013 by E. Katayama in Otawara, and in 2016 by S. Ibuki in Nakagawa, both in Tochigi Prefecture, central Honshu. By rearing the larvae, some adult specimens were obtained and they were determined as *Tenthredo babai* Takeuchi, 1936. This sawfly is known to occur in Hokkaido, Honshu, Sado Island, Shikoku and Kyushu, Japan (Hara and Shinohara, 2018), but the species is rarely collected and the host plants and immature stages were unknown.

Tenthredo Linné, 1758, is the largest sawfly genus with over 1000 species worldwide (Taeger *et al.*, 2018) and 84 species have been recorded from Japan (Shinohara, in press). The host plants and larvae of the Japanese species are poorly known with records only for 18 species available so far (Shinohara and Ibuki, 2018, 2019).

Here we report on the host plants and life history of *T. babai* and briefly describe and illustrate the larva and previously undescribed male adult. *Tenthredo babai* is the first sawfly species to be recorded as feeding on peonies.

Materials and Methods

Rearing was made in Kamiishigami (N36°50′E139°57′, about 230 m alt.), Otawara, by E. Katayama and Wami (N36°47′E140°10′, about 230 m alt.), Nakagawa, by S. Ibuki, both in Tochigi Prefecture. The temperature and day length were not controlled in the rearing room. Adult specimens reared by E. Katayama are kept in his collection and those reared by S. Ibuki are kept in the National Museum of Nature and Science, Tsukuba. All the photographs were taken by S. Ibuki with digital cameras, Casio EX-ZR1000 (Fig. 1) and Canon Power Shot S95

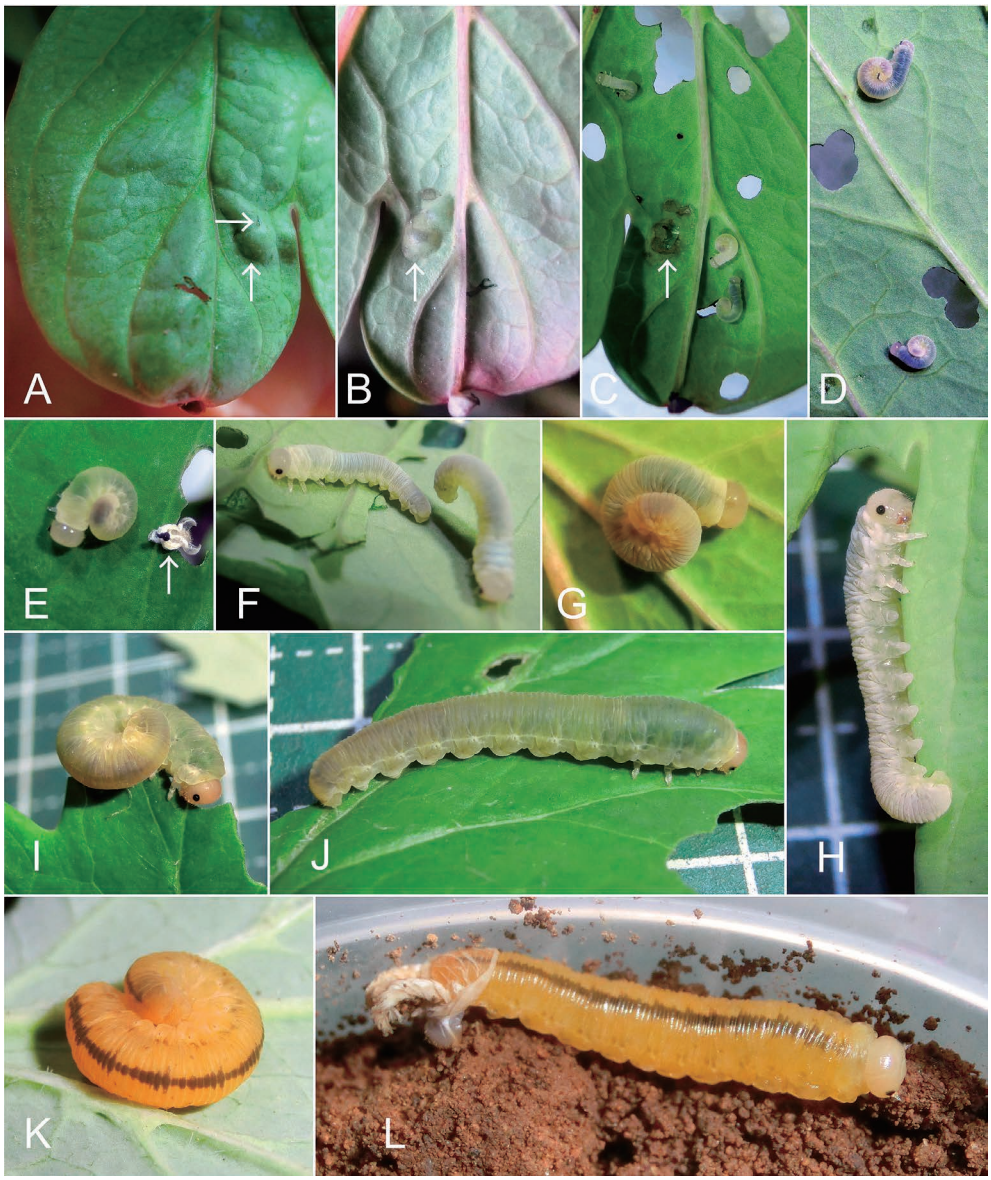

Fig. 1. *Tenthredo babai*, oviposited leaves and larvae, photographed in Wami, Nakagawa, by S. Ibuki in 2018. A, Leaf of *Paeonia suffruticosa*, oviposited by *Tenthredo babai*, upper surface (upper arrow: trace of oviposition; lower arrow: swollen part containing group of eggs inside), April 28; B, same leaf, lower surface, April 27; C, same leaf, lower surface, with 1st instar larvae (arrow: emergence holes of larvae), May 7; D, 1st instar larvae, May 7; E, 2nd instar larva just after first molting (arrow: cast skin nearby), May 8; F, 2nd instar larvae, May 10; G, 3rd instar larva, May 14; H, 3rd instar larva, late stage, May 17; I, 4th instar larva, May 20; J, 4th instar larva, May 21; K, 4th instar larva, late stage, May 26; L, mature larva just finishing last extra molting, May 26.

(Fig. 2). The digital images were processed and arranged with Adobe Photoshop Elements 9 and 15 software. We follow Viitasaari (2002) for morphological terminology and Yonekura and Kajita (2019) for plant names.

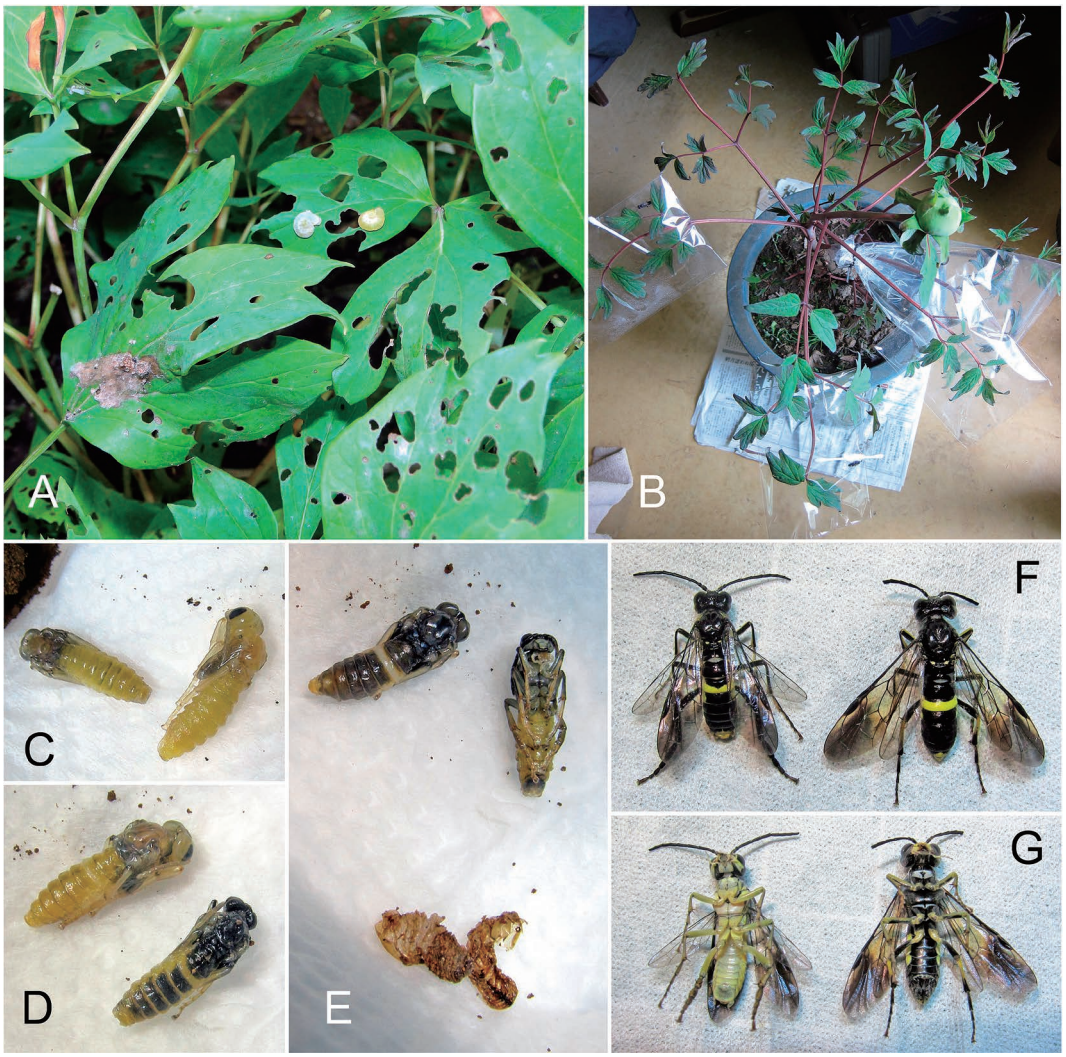

Fig. 2. *Tenthredo babai*, photographed in Wami, Nakagawa, by S. Ibuki. A, Leaves of *Paeonia suffruticosa*, damaged by larvae of *Tenthredo babai* (two larvae visible), June 13, 2017; B, oviposition experiment, a pot of *Paeonia suffruticosa*, with plastic bags each containing one emerged female inside, April 18, 2018; C, pupae dug out from soil, April 21, 2017; D, same, April 22, 2017; E, same, several hours later, with cast skins; F, emerged adults, left male and right female, dorsal view, 20 April, 2018; G, same, ventral view.

Results

Rearing records and field observations (Table 1)**.** The first encounter with *T. babai* was in June 2013, when E. Katayama found some sawfly larvae feeding on *Paeonia suffruticosa* in Shimoishigami, Otawara, Tochigi Prefecture, but no attempt was made to rear them. On June 14, 2014, E. Katayama found seven or eight middle-instar larvae on *P. suffruticosa* at the same site and reared them. From this series, a total of five adults (three females and two males) emerged on April 21 to 25, 2015, and E. Katayama identified them with *T. babai*. On the same plant at the same locality, E. Katayama collected eight young larvae on May 18, 2015. Six of the eight larvae were found on a leaf with a swelling containing the remains of six egg shells grouped together

Table 1. Rearing records of *Tenthredo babai* in 2013–2018. See text for more details.

Larva found	Locality	Number	Matured	Adult emergence	Remarks
June, 2013	Shimoishigami, N36°51′E139°58′, 228 m alt.				EK, not reared
June 14, 2014	Shimoishigami, N36°51′E139°58′, 228 m alt.	7 or 8	not recorded	April 21–25, 2015 (3 ♀, 2 ♂)	reared and adults identified by EK
May 18, 2015	Shimoishigami, N36°51′E139°58′, 228 m alt.	8	June 29–July 6	April 19–23, 2016 (2 ♀, 2 ♂)	reared by EK
June 14, 2016	Wami, N36°46′E140°10′, 144 m alt.	8	June 22–July 2	April 20–27, 2017 (1 ♀, 4 ♂)	reared by SI
May 16, 2017	Wami, N36°46′E140°10′, 144 m alt.	8	June 7–10	April 10–19, 2018 (4 ♀, 1 ♂)	reared by SI
June 6, 2017	Wami, N36°46′E140°10′, 144 m alt.	22	June 21–29	none	reared by SI
June 13, 2017	Bato, N36°44′E140°10′, 114 m alt.	4	June 18–21	none	reared by SI
June 23, 2017	Bato, N36°44′E140°10′, 114 m alt.	12	June 24–July 1	none	reared by SI

EK: E. Katayama, SI: S. Ibuki

inside (similar to the one shown in Fig. 1A). A trace of oviposition was found on the upper surface of the swelling (e.g. Fig. 1A), while the larvae apparently hatched from the lower surface (e.g. Fig. 1C). The larvae matured during the period from June 29 to July 6 and four adults (two females and two males) emerged on April 19 to 23, 2016.

On June 14, 2016, S. Ibuki found eight larvae feeding on *P. suffruticosa* in Wami, Nakagawa, Tochigi Prefecture. They reached maturity and entered the soil on June 22 to July 2 and five adults (one female and four males) emerged on April 20 to 27, 2017. Two of the pupae were dug out from the soil on April 21 (Fig. 2C) and became adults on the next day (Fig. 2D, E). Each of the pupae was in an earthen cell in the soil. On May 16, 2017, S. Ibuki found eight larvae on *P. suffruticosa* in Wami and they matured and entered the soil on June 7 to 10. Five adult sawflies (four females and one male) emerged on April 10–19, 2018 (Fig. 2F, G). At the same site, S. Ibuki also found 22 larvae on June 6, 2017. They matured and went into the soil on 21 to 29 June, but no adults emerged in the next spring. In Bato, Nakagawa, S. Ibuki collected four larvae on June 13 and 12 larvae on June 23, 2017, all from the leaves of *P. suffruticosa*. The former four larvae matured on June 18 to 21 and the latter 12 larvae on June 24 to July 1, but no adults emerged in 2018. During the 2017 experiments, leaves of *Paeonia lactiflora* were also used for diets and the larvae equally fed on both *Paeonia* species.

S. Ibuki conducted an oviposition experiment using four females which emerged on April 10–17, 2018 (Fig. 2B). One of the females, which emerged on April 15, successfully laid eggs (oviposition date unrecorded but during the period of April 16–27) and eight larvae hatched on May 3 to 5. Because the female did not copulate, the larvae were all males. A group of eight eggs were inserted in the tissue of the leaf from the upper surface forming an inconspicuous swelling as shown in Fig. 1A with a trace of oviposition (cut by the saw) on the surface. The hatched larvae came out from the under surface of the leaf, leaving recognizable emergence holes (Fig. 1C). Observations were made on the two larvae which hatched on May 3. The larvae had four instars (Fig. 1C–K) in the feeding stage, with molts on May 8, 14 and 17. The two larvae matured (ceased feeding and had an extra molt, Fig. 1K, L) and went into the soil on May 25 to 26. No emergence of adults in 2019.

Larva (male)**.** *First and second instars* (Fig. 1C–F): Head translucent pale creamy white, shiny, with ocularium and stemmatum black; trunk translucent opaque white. *Third instar* (Fig. 1G, H): Similar to first and second instars; trunk covered with thin whitish wax layer. *Fourth instar* (Fig. 1I–K): About 20–25 mm. Head very

pale brown, weakly shiny, covered with inconspicuous brownish pubescence; ocularium, stemmatum and apex of mandible black; trunk translucent opaque greenish white, covered with very thin whitish wax layer. Later in the instar, whole insect bearing dark yellowish tint, with blackish brown dorsal line all through trunk and paired rather obscure dark brown lateral spots on each segment. Solitary, curling abdomen at rest, in all feeding instars. *Mature larva* (Fig. 1L): About 18–20 mm. Similar to later stage of fourth instar, but whole insect smooth and shiny, without wax layer.

Male adult (hitherto undescribed)**.** Length 10–12 mm. Black with following parts yellowish white: malar space to lower half of gena, clypeus, most of mouth parts, including labrum and most of mandible, narrow dorsal and lateral posterior margins, lateral ventral part, and spot in dorsal median part of pronotum, ventral part of cervical sclerite, anterior part of tegula, most of mesepisternum, dorsal half of mesepimeron, entire metepisternum, dorsal margin of metepimeron, all legs except for entire dorsal surfaces, lateral margin of each abdominal tergum, most of tergum 3, narrow posterior margins of terga 4 and 8, entire tergum 9, and entire abdominal sterna. Wings as in female. Antenna longer and more slender and hind tarsus much thicker than in female.

Host plants. Paeoniaceae: *Paeonia suffruticosa* Andrews, *Paeonia lactiflora* Pall. (new record). Known only from these cultivated plants. The larval infestation was observed on both plants in the gardens in Nakagawa, Tochigi Prefecture.

Discussion

General life history

The rearing records and field observations given above indicate that *T. babai* has a univoltine life cycle as in other *Tenthredo* species (Shinohara and Ibuki, 2018, 2019). In the low mountainous regions in central Honshu, such as Otawara (ca 230 m alt.) and Nakagawa (ca. 110–150 m alt.), Tochigi Prefecture, the adults emerge in late April and the larvae are found in May to June. The larvae mature and enter the soil in June to early July. In the *ex ovo* rearing of the male in Nakagawa in 2018, the egg period was not definitely recorded but somewhere between six to 19 days and the total larval feeding period was 22 or 23 days. There were four instars (three molts) in the feeding stage (first instar five days, second instar six days, third instar three days and fourth instar eight or nine days), and the mature larva had an additional molt before entering the soil. The mature larva makes an earthen cell underground where they hibernate and pupate.

Recognition of the larva and adult of T. babai

Until the late stage of the last feeding instar (fourth instar), the larva of this species has no distinctive features (Fig. 1C–J) and is difficult to distinguish from the other similar-looking sawfly larvae, besides based on the host plant. The fourth instar larva, when it comes close to maturation, has a characteristic dark yellow body with a blackish brown dorsal stripe on the trunk (Fig. 1 K). This peculiar color pattern will easily separate it from the known sawfly larvae.

The adult female of *T. babai* (Fig. 2F, G, right) is a rather robust, dorsally mostly black sawfly, with apically dark forewings and pale yellow abdominal tergum three. The antenna is black, rather short and slightly thickened subapically, the thorax is entirely black, the pectus has no apically pointed swelling laterally, and the forewing has a rather obscurely delimited infuscated area covering apical 2/5 (except for anterior parts of the cells 2R1 and 3R1). The stigma is black and the hind tibia is yellow basally and black apically. The abdomen has the propodeum entirely black and the tergum three is mostly pale yellow. It resembles the female of *T. ussuriensis* (Mocsáry, 1909) but the latter has the forewing with a strongly infuscated area extending from base to apex, the stigma is brown, the hind tibia is brown, becoming blackish apically, and the propodeum is yellow posteromedially. *Tenthredo ussuriensis* usually has the posterior margin of

the pronotum and the mesoscutellum marked with pale yellow.

The previously undescribed male of *T. babai* has a similar color pattern to the female in dorsal view, but it is mostly pale yellow in ventral view (Fig. F, G). The entirely black dorsum of the head, thorax and abdomen, except for the mostly pale yellow tergum three of the abdomen, and the apically blackish forewing will distinguish the male of *T. babai* from the known males of Japanese congeners.

This species belongs to the subgenus *Temuledo* Zhelochovtsev, 1988, because of the absence of conspicuous frontal crest and presence of elongated mouth parts and truncated posterior margin of the subgenital plate.

Host plants

Paeoniaceae is a small family of eudicots and no sawflies were known to feed on this group of plants. The larvae of *T. babai* have been found only on two cultivated plants, *Paeonia suffruticosa* and *P. lactiflora*, which are now quite commonly planted in gardens in Japan but were originally introduced from the Asian continent by man. So far as is known, *T. babai* is endemic to Japan (Hara and Shinohara, 2018). *Tenthredo babai* should also feed on two Japanese indigenous *Paeonia* species, *P. japonica* (Makino) Miyabe et Takeda or *P. obovata* Maxim (Kadota, 2016).

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References

Hara, H. and A. Shinohara 2018. Taxonomic notes and new distribution and host plant records for sawflies and woodwasps (Hymenoptera, Symphyta) of Japan IV. Bulletin of the National Museum of Nature and Science, Series A, 44: 93–113.

Kadota, Y. 2016. Paeoniaceae. In Ohashi, H., Y. Kadota, J. Murata and K. Yonekura (eds.): Wild Flowers of Japan, Vol. 2, Poaceae-Urticaceae, pp. 181–182. Heibonsha, Tokyo. (In Japanese.)

Linné, C. 1758. Systema Naturae, per regna tria naturae secundum classes, ordines, genera, species cum characteribus, differentiis, synonymis, locis. Editio Decima Reformata. Vol. 1. 824 pp. Laurentius Salvius, Holmiae.

Mocsáry, A. 1909. Chalastogastra nova in collectione Musei nationalis Hungarici. Annales historico-naturales Musei Nationalis Hungarici, Budapest, 7: 1–39.

Shinohara, A. in press. Genus *Tenthredo* Linné, 1758. In Editorial Committee of Catalogue of the Insects of Japan (ed.): Catalogue of the Insects of Japan, Volume 9 Hymenoptera (Part 1 Symphyta), pp. 112–123. Entomological Society of Japan, Tokyo. (In Japanese.)

Shinohara, A. and S. Ibuki 2018. Host plant and life history of bamboo-feeding sawfly, *Tenthredo nigropicta* (Hymenoptera, Tenthredinidae) in Japan. Bulletin of the National Museum of Nature and Science, Series A, 44: 51–55.

Shinohara, A. and S. Ibuki 2019. Host plants and larvae of three sawfly species of the genus *Tenthredo* (Hymenoptera, Tenthredinidae) in Japan. Bulletin of the National Museum of Nature and Science, Series A, 45: 107–112.

Taeger, A., A. D. Liston, M. Prous, E. K. Groll, T. Gehroldt and S. M. Blank 2018. ECatSym–Electronic World Catalog of Symphyta (Insecta, Hymenoptera). Program version 5.0 (19 Dec 2018), data version 40 (23 Sep 2018). Senckenberg Deutsches Entomologisches Institut (SDEI), Müncheberg. https://sdei.de/ecatsym/ (Last access August 14, 2019.)

Takeuchi, K. 1936. Some sawflies from Sado Island. Tenthredo, 1: 150–164.

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

Yonekura, K. and T. Kajita 2019. BG Plants Wamei-Gakumei Index (YList). http://ylist.info/index.html (In Japanese; last access May 15, 2019.)

Zhelochovtsev, A. N. 1988. Symphyta. In Medvedev, G. C. (ed.): Opredelitel' Nasekomykh Evropeyskoy Chasti SSSR, Tom III, Pereponchatokrylye, Shestaja Chast', pp. 7–234. Nauka, Leningrad. (In Russian; English translation, 1994, Keys to the Insects of the European Part of the USSR, Vol. III, Hymenoptera, Part VI, Symphyta, pp. 1–387, E. J. Brill, Leiden, New York, Köln.)