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Asteralobia Gall Midges (Diptera: Cecidomyiidae) on *Aster* Species (Asteraceae) in Japan and the Russian Far East*

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Abstract. Full-grown larvae of *Asteralobia doellingeriae* and *Asteralobia asteris* were redescribed. An unidentified gall midge forming drop-shaped flower galls on *Aster scaber* in Japan was identified as *A. doellingeriae,* which had been known only from the Russian Far East but was newly recorded from Japan. Gall midges causing flower galls on *Aster ageratoides* subsp. *ovatus* and *Aster glehni* var. *hondoensis* in Japan were identified as *Asteralobia* species.

Key words: *Asteralobia doellingeriae, Asteralobia asteris, Aster scaber,* flower gall, identification, redescription.

Introduction

Phylogenetic relationships between certain plant taxa and associated herbivores have been paid special attention by many biologists in order to clarify the coevolutionary and speciation processes of the herbivores (e.g. Scheffer & Wiegmann, 2000; Cook *et al.*, 2002).

The family Asteraceae and associated herbivores are one of the most suitable materials for such evolutionary studies, because Asteraceae is considered to be a monophyletic

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group that has recently radiated throughout the world (e.g. Judd *et al.*, 1999; Wildner *et al.*, 1999; Panero & Funk, 2002).

In the case of gall-forming Cecidomyiidae, for example, about 250 species of the genus *Rhopalomyia* are associated mostly with the genus *Artemisia* and its related genera belonging to the tribe Anthemideae of Asteraceae (e.g. Skuhravá, 1986; Gagné, 1994; Yukawa & Masuda, 1996; R. J. Gagné, in press, A Catalog of the Cecidomyiidae (Diptera) of the World. *Proc. Entomol. Soc. Wash.*), nine species of the genus *Asteromyia* are associated with the tribe Asterae in the Nearctic Region (e.g. Gagné, 1968; Gagné, 1969), and three species of the genus *Asteralobia* are associated with several genera of Asteraceae such as *Aster, Cacaria, Senecio*, and *Solidago* in the Russian Far East (Kovalev, 1964). Among them, we refer to the *Asteralobia* gall midges on *Aster* spp. in this study.

We intend to (1) redescribe the full-grown larvae of two Russian species of *Asteralobia, A. doellingeriae* and *A. asteris*; (2) clarify the taxonomic status of some gall midges associated with *Aster* spp. in Japan; and (3) supplement the host and distributional information of *Asteralobia* gall midges in Japan and the Russian Far East. All results obtained from this study will contribute to future coevolutionary studies of Asteraceae and associated gall midges in the eastern Holarctic Region.

Materials and Methods

Scientific names of host plants

Scientific names of some plant species are differently used in Japan and Russia even though these plants are commonly distributed in both countries. For example, *Aster scaber* Thunb. that has been used in Japan (e.g. Kitamura, 1981; Hotta *et al.*, 1989) is called *Doellingeria scabra* (Thunb.) Nees. in Russia (e.g. Kovalev, 1964; Charkevicz, 1992; Kozhevnikov & Probatova, 2002). In order to avoid confusion in host plant nomenclature, the scientific names of all plant species appearing in this study consistently follow Kitamura (1981).

General information about midge galls on Aster *species in Japan and the Russian Far East*

According to Yukawa & Masuda (1996), 13 sorts of cecidomyiid gall have been recorded from Japan on four *Aster* species, *A. ageratoides* Turcz. subsp. *leiophyllus* (Franch. et Savat.) Kitam. var. *ovalifolius* Kitam., *A. ageratoides* subsp. *ovatus* (Franch. et Savat.) Kitam., *A. glehnii* Fr. Schm. var. *hondoensis* Kitam., *A. scaber,* and *A. tataricus* L. fil. Among them, four sorts of gall are caused by *Lasioptera* species and one by *Dasineura*, while the gall midges responsible for eight other galls have not yet

Table 1. Collection records of *Asteralobia* galls on *Aster* spp. in Primorsky Territory (2002).

Date	Locality	Location	Altitude (m)	Host	Gall*
Sept. 13	Shkotovo	N 43° 17', E 132° 21'	0	*A. scaber*	D & S
	Smolyaninovo	N 43° 11', E 132° 41'	20	*A. scaber*	D & S
				A. tataricus	S
Sept. 14	Mt. Litovka	N 43° 06', E 132° 48'	425-1250	*A. scaber*	D
	Mt. Sestra	N 42° 49', E 133° 00'	105	*A. scaber*	D & S
Sept. 15	Bay Tryohozerye	N 42° 45', E 133° 13'	30	*A. scaber*	D & S
Sept. 18	Dukhovskoye	N 44° 36', E 131° 24'	290	*A. scaber*	S

*Abbreviations of gall are as follows: D: Drop-shaped flower galls caused by *Asteralobia doellingeriae*; S: Subglobular flower galls caused by *Asteralobia asteris*.

been identified.

In the Russian Far East, Kovalev (1964) described two *Aster*-associated gall midges, *Asteralobia doellingeriae* Kovalev and *Asteralobia asteris* Kovalev. The former forms drop-shaped flower galls on *A. scaber* and the latter is responsible for subglobular flower galls on *A. scaber* and *A. tataricus*.

Collection of galls and preservation of gall midge specimens

In this study, we examined 75% ethanol stored specimens of cecidomyiid larvae that had been collected from flower galls on *Aster* spp. by JY and his colleagues from Honshu, Japan in the 1970s and 1980s.

In addition, MT, VNK, and AEK searched for flower galls caused by *Asteralobia* gall midges on *Aster* spp. in Primorsky Territory of the Russian Far East in September, 2002. Detailed collection data in the Russian Far East is shown in Table 1. All galls collected in the Russian Far East were dissected under a binocular microscope and the full-grown larvae were picked out of the galls and divided into two groups. One group was stored in 75% ethanol to make slide-mounted specimens for morphological studies and another in 99.5% acetone for future DNA analysis.

Morphological studies and terminology

Some of the ethanol-stored specimens were mounted on slides for microscopic study in Canada balsam using the techniques outlined in Gagné (1989). Drawings were made with the aid of a camera lucida.

Larval morphological terminology follows usage in Möhn (1955; originally written in German) that were translated into English in Yukawa (1971).

Results and Remarks

Redescription of* Asteralobia *gall midges on* Aster *spp.

Asteralobia doellingeriae Kovalev

(Fig. 1A-C)

***Asteralobia doellingeriae* Kovalev, 1964: 422.**

Male: See Kovalev (1964).

Female: See Kovalev (1964).

Full-grown larva: Yellow in body color. Body length 2.6 to 2.9 mm. Second antennal segment short, conical, about 18μm, 2.5 times as long as basal width; cervical papillae without seta. Number and position of spiracles normal; 6 dorsal papillae present on thoracic and first to seventh abdominal segments, each with a seta; 2 dorsal papillae present between spiracles of eighth abdominal segment, each with a seta; usually 3 pleural papillae present each side, each with a seta; 8 terminal papillae present, 2 of them each with a little pigmented large conical seta, and other 6 papillae each with a setiform seta.

Sternal spatula about 160μm in length, distally emarginated, forming a pair of triangular lobes; 3 inner lateral papillae present, 2 of them each with a seta on all thoracic segments, 3 outer lateral papillae present, 2 of them with a seta on all thoracic segments; sternal papillae without seta on all thoracic segments; inner pleural papilla without seta on prothoracic segment and with a seta on meso- and metathoracic segments; 4 anterior ventral papillae without seta; 2 posterior ventral papillae each with a seta; 4 ventral papillae of eighth abdominal segment each without seta; 4 anal papillae each without seta. Anal split linear.

Pupa: See Kovalev (1964).

Host plant: *A. scaber*.

Specimens examined: 6 full-grown larvae (on slides), galls collected from Mt. Iouzen, Kanazawa City, Ishikawa Pref., Honshu, Japan, J. Yukawa leg.; 6 full-grown larvae (on slides), galls collected from Shkotovo, Primorsky Territory, the Russian Far East, Sep. 13, 2002, M. Tokuda, V. N. Kuznetsov & A. E. Kozhevnikov leg.

Distribution: The Russian Far East, Japan (Honshu): **new rec.**

Remarks: *Asteralobia doellingeriae* is the type species of the genus. The larva exhibits typical morphological features of the genus *Schizomyia* such as the existence of three inner and three outer lateral papillae and eight terminal papillae. Therefore, future detailed examination of adult and pupal morphological studies will synonymize *Asteralobia* with *Schizomyia* although Kovalev (1964) distinguish *Asteralobia* from

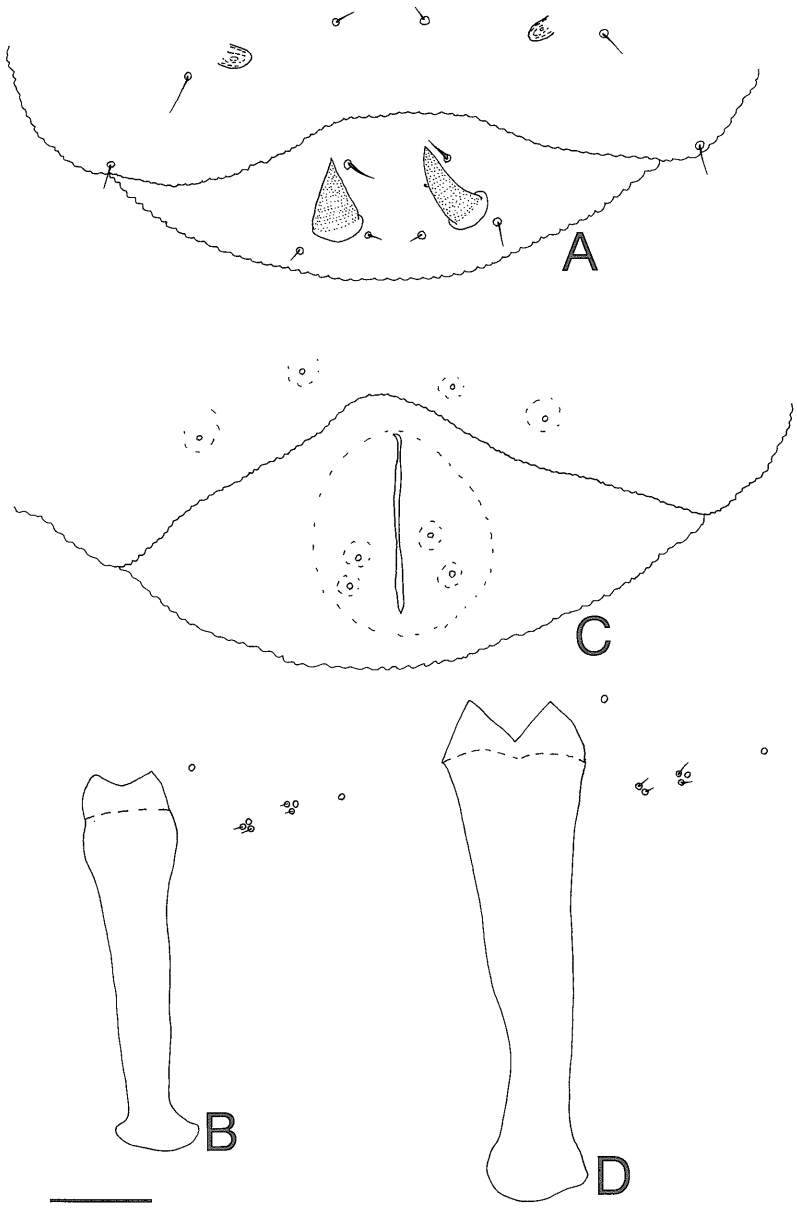

Fig. 1. A-C: *Asteralobia doellingeriae*, A: eighth and ninth abdominal segments of full-grown larva in dorsal view; B: sternal spatula of full-grown larva and associated papillae; C: eighth and ninth abdominal segments of full-grown larva in ventral view; D: *Asteralobia asteris*, sternal spatula of full-grown larva and associated papillae. Scale: 0.10mm.

Schizomy only by shallowly constricted male flagellomeres.

Lasioptera gibaushi Shinji, 1939 has been considered to produce drop-shaped galls on flowers of *Aster scaber* (= *Doellingeria scabra*) in Japan (e.g. Shinji, 1939; Shinji, 1944; Skuhravá, 1986; Yukawa & Masuda, 1996). However, the full-grown larvae inhabiting the galls do not have characteristics of the genus *Lasioptera*, but are morphologically very similar to those of *A. doellingeriae*. In addition, we compared in 2002 the structure of galls caused by *A. doellingeriae* in the Russian Far East with the drop-shaped galls in Japan and reached the conclusion that the two sorts of gall are structurally identical. Therefore, we identified the midge larvae that are responsible for the drop-shaped galls in Japan not as *L. gibaushi* but as *A. doellingeriae*.

Although *L. gibaushi* was inadequately described in Shinji (1939), it is apparently not identical with *A. doellingeriae* because, for example, the former has 21 antennal segments according to Shinji (1944). Therefore, it is highly probable that in the original description, Shinji (1939) recorded the gall caused by *A. doellingeriae* erroneously as that by *L. gibaushi*. Because he did not refer to type or any other specimens examined, it is now difficult to determine what sort of gall is produced by the gall midge with the name of *L. gibaushi*.

Asteralobia asteris Kovalev

(Figs. 2D & 3)

***Asteralobia asteris* Kovalev, 1964: 425.**

Male: See Kovalev (1964).

Female: See Kovalev (1964).

Full-grown larva: Yellow in body color. Body length about 3.0 mm. Second antennal segment short, conical, about 16μm, 2.5 times as long as basal width; cervical papillae without seta. Number and position of spiracles normal; 6 dorsal papillae present, each with a seta; eighth abdominal segment with 2 dorsal papillae, each of which is situated on a low hemispherical swelling, each papilla with a seta; an additional swollen area present between dorsal papillae on eighth abdominal segment as in Fig. 2A; 3 pleural papillae present on each side, each with a seta; 4 terminal papillae visible, 2 of them each with a little pigmented large conical seta, other 2 each with a setiform seta, remaining 4 inconspicuous.

Sternal spatula 260μm in length, distally incised by a U-shaped emargination, forming a pair of triangular lobes; 2 inner lateral papillae present, each with a seta on all thoracic segments, 3 outer lateral papillae present, two of them with a seta on all thoracic segments; sternal papillae without seta on all thoracic segments; inner pleural

papillae without seta on prothorax and with a seta on meso- and metathorax; 4 anterior ventral papillae without seta; 2 posterior ventral papillae each with a seta; 4 ventral papillae of eighth abdominal segment without seta; 4 anal papillae without seta. Anal split not linear, but wavy.

Pupa: See Kovalev (1964).

Host plants: *A. scaber* and *A. tataricus*.

Specimens examined: **[Host: *A. tataricus*]** 4 full-grown larvae (on slides), galls collected from Smolyaninovo, Primorsky Territory, the Russian Far East, Sep. 13, 2002, M. Tokuda, V. N. Kuznetsov & A. E. Kozhevnikov leg.; **[Host: *A. scaber*]** 6 full-grown larvae (on slides), galls collected from Smolyaninovo, Primorsky Territory, the Russian Far East, Sep. 13, 2002, M. Tokuda, V. N. Kuznetsov & A. E. Kozhevnikov leg.

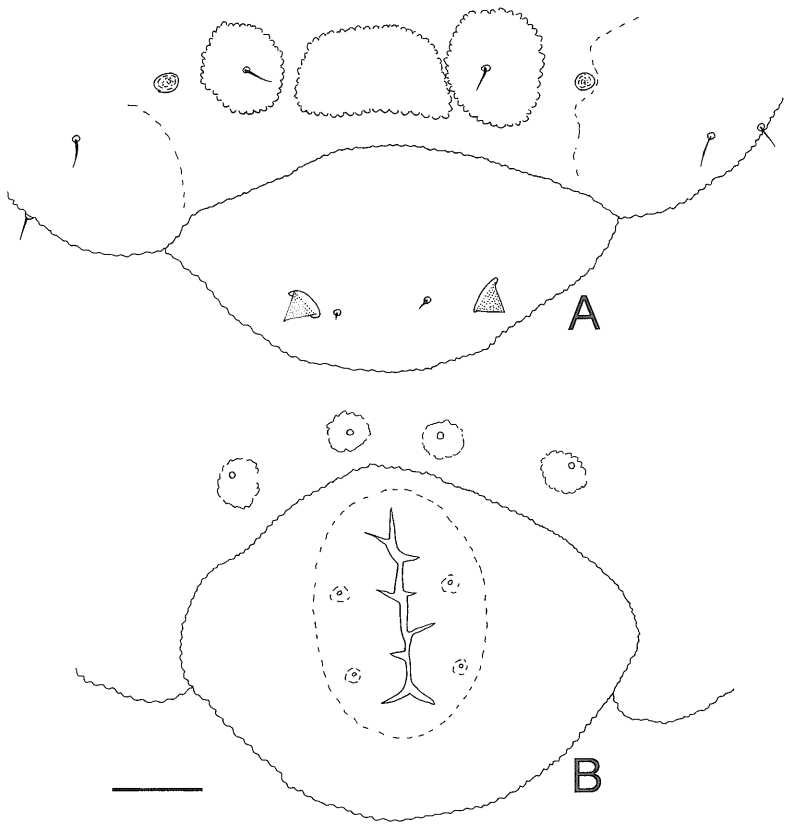

Fig. 2. *Asteralobia asteris,* A: eighth and ninth abdominal segments of full-grown larva in dorsal view; B: eighth and ninth abdominal segments of full-grown larva in ventral view. Scale: 0.10mm.

Table 2. List of gall midges associated with *Aster* spp. in Japan (modified from Yukawa & Masuda, 1996 based on the results of this study).

Host plant species	Galled organ	Shape of gall	Gall midge species ※
Aster ageratoides subsup. *leiophyllus* var. *ovalifolius*	Bud	Cluster-shaped gall	Unidentified
Aster ageratoides subsp. *ovatus*	Bud	Cluster-shaped gall	Unidentified
	Flower	Drop-shaped gall	***Asteralobia* sp.**
Aster glehnii var. *hondoensis*	Stem	Irregular swelling	Unidentified
	Leaf	Pit gall	Unidentified
	Flower	Subglobular gall	***Asteralobia* sp.**
Aster scaber	Stem	Irregular swelling	*Lasioptera astericola*
	Stem & leaf	Cluster-shaped gall	*Dasineura asteriae*
	Leaf edge	Subglobular gall	Unidentified
	Leaf	Conical gall	*Lasioptera* sp.
	Flower	Subglobular gall	Unidentified
	Flower	Drop-shaped gall	***Asteralobia doellingeriae***
Aster tataricus	Stem	Spindle-shaped gall	*Lasioptera euphobiae*

※Taxonomic status of gall midges indicated by gothic letters is newly proposed in this study.

Distribution: The Russian Far East.

Remarks: The larva of *A. asteris* is distinguishable from that of *A. doellingeriae* by the number of inner lateral papillae and terminal papillae, the existence of swollen portion on dorsal surface of eighth abdominal segment, and the shape of anal split.

The galls caused by *A. asteris* are similar to those produced by an unidentified gall midge on flowers of *A. scaber* in Japan (Yukawa & Masuda, 1996). We could not examine specimens of the unidentified gall midges, but the gall shapes of both species indicated that the Japanese gall midge might be identical with *A. asteris* or its close relative.

Other gall midges causing flower galls on* Aster *species in Japan

In this study, we also examined morphological features of larval specimens collected from flower galls on *A. ageratoides* subsp. *ovatus* and *A. glehni* var. *hondoensis* in Japan. As a result, the gall midges on the two plant species could not be clearly distinguished from *A. asteris*. Although they are considered to be identical with or closely related to *A. asteris*, further comparative studies of adult and pupal morphology are needed to identify these species. Thus, in this study, we tentatively deal with these

gall midges as unidentified species of the genus *Asteralobia*. As a consequence, the taxonomic status of *Aster* associated gall midges in Japan is revised as in Table 2.

Specimens examined: **[Host: *A. ageratoides* subsp. *ovatus*]** 4 full-grown larvae (on slides), galls collected from Mt. Iouzen, Kanazawa City, Ishikawa Pref., Honshu, Japan, Oct. 17, 1978, H. Ikenaga leg.; **[Host: *A. glehni* var. *hondoensis*]** 4 full-grown larvae (on slides), galls collected from Maruyama, Ojiya City, Niigata Pref., Honshu, Japan, Oct. 12, 1981, K. Yamagishi leg.

Asteralobia *on other Asteraceae than the genus* Aster *in Japan*

In Japan, subglobular flower galls similar to those by *A. asteris* are known to occur also on such asteraceous genera as *Eupatrium*, *Senecio*, and *Solidago* (Yukawa & Masuda, 1996). According to preliminary DNA analysis of these gall midges (M. Tokuda & J. Yukawa, unpublished data), they are rather closely related to *A. asteris*. Future detailed and comprehensive studies will reveal the taxonomic status and evolutionary processes of these species.

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