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Redescription of *Asphondylia sphaera* Monzen (Diptera, Cecidomyiidae), with Notes on its Bionomics

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Introduction

At least 10 species of the genus *Asphondylia* H. Loew²⁾ have been known to occur in Japan⁸⁻¹¹⁾, and about 200 nominal species have been recognized in the world¹⁾. They are morphologically quite similar, and species identifications are mainly based on host data, and partly on biological information, setal counts and measurements of specimens¹⁾.

The original description of the ligustrum fruit midge, *Asphondylia sphaera* Monzen³⁾ was based on adult midges reared from fruit galls on *Ligustrum obtusifolium* Sieb. et Zucc. Recently, this species was also reared from fruit galls on *Ligustrum japonicum* Thunb.¹⁰⁾. In the original description, details of chaetotaxy, immature stages and bionomics of the species were not given. To fill some of these gaps in description and to contribute to future studies on the Japanese asphondyliid gall midges, *A. sphaera* is redescribed here, in the light of recent taxonomic study. A neotype is designated and notes on the bionomics of this species are presented.

Materials and Methods

The fruit galls of *Ligustrum* species were collected mainly from Kagoshima prefecture and partly from other localities in Honshu, Shikoku, Kyushu and Okinawa in occasional field investigations during the period between 1969 and 1977. Some of the collected galls were dissected to obtain larval and pupal specimens. The number of larvae or pupae per gall was counted and the developmental stages of the gall midge were also examined. To rear adult midges, the rest of the galls were retained in the laboratory, using a method similar to the one described in Yukawa⁸⁾. The emergence, flying, and other behavioural activities were observed hourly in the laboratory during the emergence period in April and May of 1977. To determine the natural life span, 4 males and 8 females were caged in a glass cylinder (18 × 30 cm) with a small moistened cotton ball and the number of surviving midges was counted hourly. Ovipositing behaviour was observed for females emerging from *L. japonicum* at the census field of Mt. Shiroyama, which is situated in the centre of Kagoshima city. To obtain the growth curve of both the galled and normal fruits, their length and width were measured periodically, based on samples collected from *L. japonicum* at the census field during the period between July 1970 and March 1971.

In preparing microscope slides, the authors adopted the Xylene-Balsam method, and

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drawings were made with the aid of a camera lucida.

Because types of *A. sphaera* could not be found in Monzen's gall midge collection, which is presently in the Entomological Laboratory of Kagoshima University, a neotype came to be designated in the present paper. The specimens, including the neotype, are kept in the collection of the Entomological Laboratory of Kagoshima University.

Asphondylia sphaera Monzen

(Figs. 1 & 2, Tables 1 to 5)

Japanese name: "Ibota-mi-tamabae"

English name: the ligustrum fruit midge

Asphondylia sphaera Monzen³⁾, *Kontyû* 11, 190-191 (1937).

Asphondylia sphaera Monzen: Monzen⁴⁾, Yukawa⁸⁾.

Parasphondylia sphaera Monzen: Shinji⁶⁾.

See Yukawa⁸⁾ for diagnosis of the genus *Asphondylia* and for drawings of typical male genitalia and ovipositor of the genus.

Male: Eye bridge 7 to 8 facets wide medially. Palpus consisting of 1 + 2 segments; second palpal segment (terminal segment) with scattered setae, about 1.6 times as long as first palpal segment (not basal tubercle). Antenna with 2 + 12 segments; scape with dense dorsal and ventral setae; basal enlargement of third and fifth flagellar segments 3.3 to 4.3 and 3.4 to 4.3 times as long as wide, respectively. First tarsal segment of all legs each with an apical protuberance; claw simple on all legs, bent nearly at right angle; empodium nearly as long as claw. Wing about 2.4 times as long as wide; R₅ meeting with costa beyond wing apex. Genitalia showing typical shape of *Asphondylia*; cerci divided into 2 lobes; tegmen rather deeply emarginated dorsally, rather shallowly emarginated ventrally; gonostylus subglobular, apically with a sclerotized and bidentate claw; gonocoxite massive, ventrally extending beyond insertion of gonostylus; aedeagus laterally sclerotized, distally tapering, basally with a rather weakly sclerotized plate-like structure, which is developed into a pair of small lobes caudo-laterally and connected laterally with inner portion of gonocoxite.

Table 1. *Asphondylia sphaera* Monzen: fronto-clypeal and thoracic setal counts, and measurements of wing length and width

Host plant		<i>L. obtusifolium</i>		<i>L. japonicum</i>	
Locality		Yorii, Saitama		Shiroyama, Kagoshima	
No. of specimens examined		12♂♂	13♀♀	8♂♂	10♀♀
		mean ± s.d.	(range)	mean ± s.d.	(range)
Fronto-clypeal setae	♂	36.50 ± 3.32	(31 - 42)	32.13 ± 3.06	(26 - 37)
	♀	40.88 ± 2.89	(38 - 48)	36.43 ± 5.47	(30 - 46)
Mesopleural setae	♂	32.13 ± 4.68	(26 - 40)	28.92 ± 4.87	(22 - 40)
	♀	38.30 ± 5.69	(27 - 45)	32.92 ± 5.27	(23 - 39)
Pteropleural setae	♂	30.25 ± 2.95	(27 - 36)	26.50 ± 2.60	(21 - 30)
	♀	35.20 ± 3.22	(29 - 41)	28.92 ± 4.78	(18 - 35)
Wing length (mm)	♂	2.82 ± 0.10	(2.67 - 2.92)	2.71 ± 0.13	(2.41 - 2.86)
	♀	3.55 ± 0.11	(3.37 - 3.68)	3.26 ± 0.27	(2.60 - 3.49)
Wing width (mm)	♂	1.20 ± 0.05	(1.14 - 1.27)	1.15 ± 0.08	(1.02 - 1.27)
	♀	1.53 ± 0.06	(1.40 - 1.59)	1.34 ± 0.12	(1.08 - 1.46)

Table 2. *Asphondylia sphaera* Monzen: measurements of the third and fifth flagellar segments and legs of males

Host plant		<i>L. obtusifolium</i>		<i>L. japonicum</i>	
Locality		Yorii, Saitama		Shiroyama, Kagoshima	
No. of specimens examined		8 ♂♂		12 ♂♂	
		mean ± s.d.	(range)	mean ± s.d.	(range)
3rd flag. seg.	ds*(μm)	18 ± 2	(15 – 23)	16 ± 1	(15 – 18)
	be	188 ± 5	(183 – 198)	176 ± 9	(163 – 195)
	w	46 ± 2	(45 – 50)	48 ± 2	(45 – 50)
5th flag. seg.	ds (μm)	16 ± 1	(15 – 18)	14 ± 1	(13 – 15)
	be	182 ± 8	(173 – 193)	175 ± 11	(155 – 193)
	w	46 ± 2	(43 – 48)	46 ± 2	(45 – 53)
Fore leg	Fe (mm)	1.31 ± 0.07	(1.18 – 1.40)	1.28 ± 0.07	(1.13 – 1.38)
	Ti	1.30 ± 0.05	(1.20 – 1.35)	1.26 ± 0.07	(1.13 – 1.35)
	T ₂	1.21 ± 0.04	(1.15 – 1.25)	1.13 ± 0.06	(1.05 – 1.23)
	T ₃	0.55 ± 0.04	(0.50 – 0.60)	0.52 ± 0.04	(0.45 – 0.58)
	T ₄	0.37 ± 0.02	(0.33 – 0.38)	0.33 ± 0.02	(0.30 – 0.35)
	T ₅	0.17 ± 0.01	(0.15 – 0.18)	0.17 ± 0.01	(0.15 – 0.18)
Mid leg	Fe (mm)	1.01 ± 0.05	(0.95 – 1.08)	1.02 ± 0.05	(0.93 – 1.10)
	Ti	1.09 ± 0.06	(1.00 – 1.15)	1.06 ± 0.09	(0.90 – 1.18)
	T ₂	0.78 ± 0.03	(0.73 – 0.83)	0.78 ± 0.05	(0.70 – 0.85)
	T ₃	0.45 ± 0.03	(0.40 – 0.48)	0.43 ± 0.04	(0.38 – 0.48)
	T ₄	0.30 ± 0.02	(0.28 – 0.33)	0.29 ± 0.02	(0.25 – 0.33)
	T ₅	0.15 ± 0.01	(0.13 – 0.15)	0.16 ± 0.01	(0.15 – 0.18)
Hind leg	Fe (mm)	1.30 ± 0.06	(1.18 – 1.40)	1.30 ± 0.08	(1.18 – 1.40)
	Ti	1.34 ± 0.06	(1.25 – 1.40)	1.32 ± 0.08	(1.20 – 1.45)
	T ₂	0.99 ± 0.06	(0.90 – 1.05)	0.95 ± 0.05	(0.88 – 1.03)
	T ₃	0.60 ± 0.04	(0.53 – 0.65)	0.55 ± 0.04	(0.48 – 0.60)
	T ₄	0.40 ± 0.03	(0.38 – 0.45)	0.37 ± 0.03	(0.33 – 0.40)
	T ₅	0.18 ± 0.02	(0.15 – 0.20)	0.18 ± 0.02	(0.15 – 0.20)

*ds: distal stem, be: basal enlargement, w: width of basal enlargement.

Female: Flagellar segments successively shortened distally; terminal segment subglobular; basal enlargement of third and fifth flagellar segments 4.0 to 5.0 and 3.6 to 5.2 times as long as wide, respectively. Wing about 2.4 times as long as wide. Seventh abdominal segment with a chitinized ventral sclerite. Ovipositor protractile, slender, aciculate, basally with a bilobed dorsal pouch. Otherwise practically as in male.

Mature larva: Second antennal segment short, conical, about 10.6 μm , 1.5 times as long as basal width. Number and position of spiracles normal; 4 of 6 dorsal papillae each with a seta; 3 pleural papillae present on each side, each with a seta; 2 dorsal papillae of eighth abdominal segment each with a seta; 2 of 6 terminal papillae somewhat cone-shaped, remaining 4 terminal papillae each with a short seta. Sternal spatula 250 to 325 μm , distally with 4 lobes which are normally pointed apically (Fig. 1A); length of outer lobes 25 to 50 μm ; length of inner lobes 22.5 to 40 μm , width between tips of 2 outer lobes 55 to 70 μm ; 3 inner and 2 outer lateral papillae all with setae; 2 anterior ventral papillae and 2 posterior ventral papillae each with a seta; 2 ventral papillae of eighth abdominal segment each with a seta; anal papillae without seta.

Pupa: Apical spine long, 280 to 330 μm , acutely pointed, with finely denticulate inner margin (Fig. 1B); apical papillae with setae which are 45 to 65 μm long; an upper frontal

Table 3. *Asphondylia sphaera* Monzen: measurements of the third and fifth flagellar segments and legs of females

Host plant		<i>L. obtusifolium</i>		<i>L. japonicum</i>	
Locality		Yorii, Saitama		Shiroyama, Kagoshima	
No. of specimens examined		10 ♀♀		10 ♀♀	
		mean ± s.d.	(range)	mean ± s.d.	(range)
3rd flag. seg.	ds*(μm)	17 ± 2	(15 - 20)	15 ± 1	(13 - 15)
	be	208 ± 6	(198 - 215)	118 ± 16	(140 - 193)
	w	44 ± 1	(43 - 45)	42 ± 3	(35 - 45)
5th flag. seg.	ds (μm)	16 ± 1	(15 - 18)	14 ± 2	(10 - 18)
	be	198 ± 8	(185 - 210)	169 ± 16	(145 - 185)
	w	41 ± 1	(40 - 43)	40 ± 3	(35 - 43)
Fore leg	Fe (mm)	1.63 ± 0.07	(1.53 - 1.75)	1.52 ± 0.14	(1.20 - 1.70)
	Ti	1.65 ± 0.09	(1.48 - 1.75)	1.46 ± 0.13	(1.13 - 1.60)
	T ₂	1.52 ± 0.05	(1.40 - 1.58)	1.34 ± 0.09	(1.13 - 1.45)
	T ₃	0.65 ± 0.04	(0.60 - 0.70)	0.58 ± 0.05	(0.50 - 0.65)
	T ₄	0.43 ± 0.03	(0.38 - 0.45)	0.38 ± 0.03	(0.33 - 0.40)
	T ₅	0.24 ± 0.02	(0.18 - 0.25)	0.21 ± 0.02	(0.18 - 0.25)
Mid leg	Fe (mm)	1.15 ± 0.04	(1.08 - 1.23)	1.04 ± 0.10	(0.78 - 1.15)
	Ti	1.35 ± 0.08	(1.23 - 1.45)	1.20 ± 0.13	(0.88 - 1.35)
	T ₂	0.76 ± 0.03	(0.70 - 0.83)	0.71 ± 0.07	(0.58 - 0.78)
	T ₃	0.36 ± 0.02	(0.33 - 0.38)	0.33 ± 0.03	(0.28 - 0.35)
	T ₄	0.26 ± 0.02	(0.23 - 0.28)	0.23 ± 0.03	(0.18 - 0.25)
	T ₅	0.18 ± 0.02	(0.13 - 0.20)	0.16 ± 0.02	(0.13 - 0.20)
Hind leg	Fe (mm)	1.51 ± 0.09	(1.35 - 1.58)	1.38 ± 0.15	(1.13 - 1.53)
	Ti	1.65 ± 0.09	(1.50 - 1.78)	1.48 ± 0.15	(1.15 - 1.68)
	T ₂	0.91 ± 0.11	(0.63 - 1.03)	0.88 ± 0.08	(0.75 - 0.98)
	T ₃	0.44 ± 0.04	(0.35 - 0.48)	0.41 ± 0.03	(0.35 - 0.45)
	T ₄	0.30 ± 0.02	(0.25 - 0.33)	0.28 ± 0.02	(0.25 - 0.30)
	T ₅	0.19 ± 0.01	(0.18 - 0.20)	0.18 ± 0.02	(0.15 - 0.20)
Ovipositor	(mm)	1.22 ± 0.03	(1.20 - 1.28)	1.15 ± 0.06	(1.03 - 1.20)

*ds: distal stem, be: basal enlargement, w: width of basal enlargement.

spine present, strongly sclerotized; 3 lower frontal spines present, strongly sclerotized (Fig. 1B); usually 1 of 2 lower facial papillae and 1 of 3 lateral facial papillae each with a seta; prothoracic horn rather short, 85 to 105 μm long; short spiracular tubercles present on first to eighth abdominal segments; each abdominal segment, except first one, dorsally with several transverse rows of spines which are successively longer and more regularly arranged posteriorly; usually 4 of 8 dorsal papillae each with a seta.

Host plant: *Ligustrum obtusifolium* Sieb. et Zucc. "Ibota-no-ki", *Ligustrum japonicum* Thunb. "Nezumi-mochi", *Ligustrum ovalifolium* Hassk. "Ôba-ibota" new host rec.

Gall: The galled fruits are not distinguishable from normal ones in appearance until the middle of September. Thereafter, differences between them become clear because the normal fruits develop more rapidly than the galled fruits (Fig. 2), changing colour from green to blackish purple. In addition, the normal fruits usually fall down to the ground during the winter. The galled fruits remain on the tree without changing colour, and develop gradually and somewhat irregularly through the winter and spring. Fully matured galls are mostly green tinged with a blackish purple, and are distinctly smaller than normal fruits (major and minor axes of the galls are about 9.5 mm and 4.3 mm on average). Usually

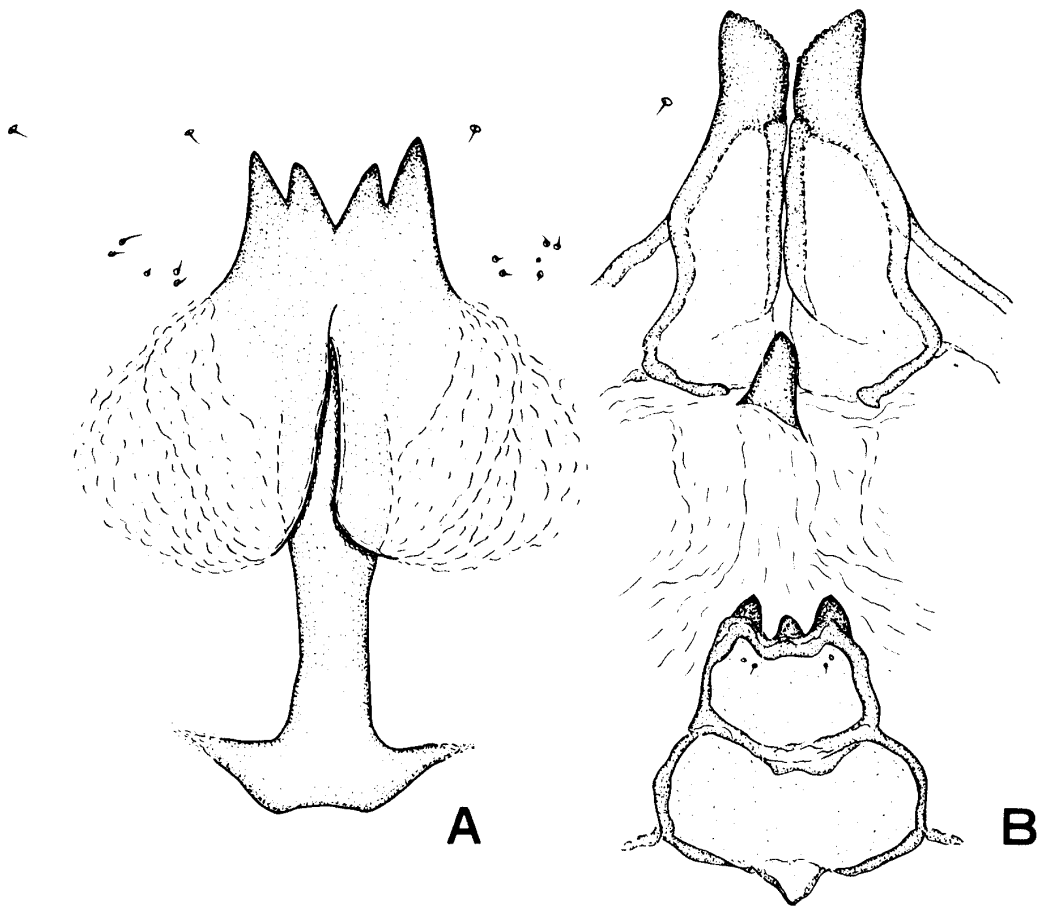


Fig. 1. *Asphondylia sphaera* Monzen. A: Sternal spatula of larva, B: Apical spine and frontal spines of pupa.

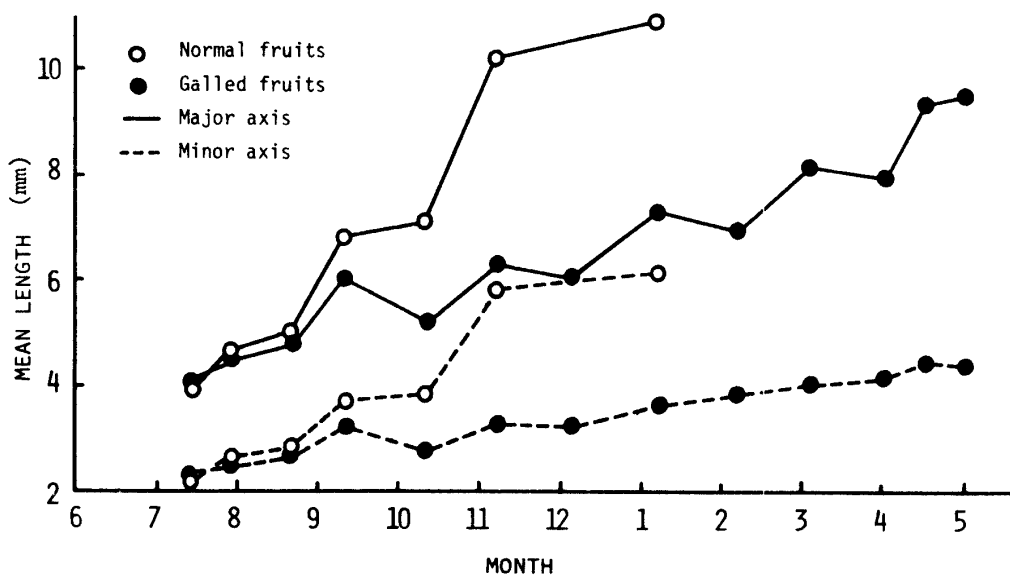


Fig. 2. Growth of normal and galled fruits of *Ligustrum japonicum* Thunb. (1970-1971, at Kagoshima).

1, rarely 2 or 3 larvae inhabit each gall. [Japanese name of the gall: "Ibota-mi-okure" Shinji⁶⁾; "Ibota-mi-fushi" Monzen⁴⁾].

Behaviour: As a rule, the males emerge between 12:00 and 15:00 hr. Most females emerge between 12:00 and 18:00 hr, and the rest of them between 18:00 and 24:00 hr. The actual emergence takes 20 to 30 minutes. After emergence, the males rest for 1 to 2 hours, sitting on the underside of the galls out of which they have emerged, and then they fly off for swarming. The females rest in the same situation as that of the males for several hours. During this time, they extend and retract their ovipositors repeatedly, waiting for the males. Judging from the emergence and resting time of both the sexes, mating probably occurs around midnight. Perhaps 1 or 2 hours after matings, the females fly off to oviposit. They lay their eggs into flower buds of the host plant. It takes about 20 seconds on average to lay an egg. Oviposition continues at least until noon on the day after emergence. The laboratory experiments roughly indicated that the average life span of the males and unmated females might be 20 hrs. and 32 hrs., respectively.

Life cycle: This species is normally univoltine. The emergence of adults in the field usually starts in the third week of April and continues until the middle of May in southern Kyushu. The egg stage lasts for 7 to 10 days. The first instar larvae pass through the summer, autumn and winter in the galls. Exceptionally, a very few of the first instar larvae develop into the second or into further stages, even to adults, in summer. Their future development or contribution to the next generation is, however, unknown at present. Normally overwintered first instar larvae moult to the second instar in the middle of March, and to the third instar around the end of March. Pupation takes place in early to late April. The pupal stage lasts for about 2 weeks.

Table 4. Sex ratio of *Asphondylia sphaera* Monzen

Host plant	Locality	Year	♂ (%)	♀ (%)	Total
<i>L. obtusifolium</i>	Yorii, Saitama	1977	8 (29.6)	19 (70.4)	27
<i>L. japonicum</i>	Shiroyama, Kagoshima	1969-1973	20 (37.7)	33 (62.3)	53
<i>L. japonicum</i>	Shiroyama, Kagoshima	1977	28 (38.9)	44 (61.1)	72

Sex ratio: This species has a sex ratio in which females are markedly more numerous than males (Table 4).

Number of ovarian eggs: 252 ± 56.6 (10 females were dissected; host plant: *L. japonicum*).

Parasites: At least, 2 braconids and 1 eurytomiid have been reared from the galls, but have not been identified.

Slide-mounted specimens examined: Neotype, ♂, gall collected from Yorii, Saitama pref., 25. V. 1977, T. Nanbu leg., emerged on 27. V. 1977, host: *L. obtusifolium*, Cecid. No. C401. Other specimens examined during the course of this study are summarized in Table 5.

Distribution: Japan (Honshu, Shikoku, Kyushu and Okinawa; including Tsushima, Iki, Gotô, Yakushima and Izu Is.).

Remarks: There are small differences in the average numbers of setal counts between the midges reared from two different host species of *Ligustrum* (Table 1). It is, however, difficult to separate them as two distinct species, because the ranges of setal counts overlap in most cases (Table 1) and there are no marked differences between them in basic measure-

Table 5. List of slide-mounted specimens examined

♂	♀	L	P	Locality	Coll. date of galls	Leg.	Emerg. date	Host*	Cecid. No.
8**	10	2	-	Yorii, Saitama pref.	25.V.1977	T.Nanbu	25-30.V.1977	OB	C401-20
2	-	-	2	Hirakawa, Kagoshima city	13.III.1973	K.Ôhara	3.IV.1973	OB	C421-24
-	1	-	-	Ishiki, Kagoshima city	12.IV.1973	J.Yukawa	23.IV.1973	OB	C425
-	2	-	-	Iso, Kagoshima city	1.V.1969	A.Mori	2-8.V.1969	JA	B3701-02
-	-	8	-	Shiroyama, Kagoshima city	1.IV.1971	J.Yukawa	---	JA	B3703-10
8	7	-	12	Shiroyama, Kagoshima city	5.IV.1973	J.Yukawa	17.IV-15.V.1973	JA	B3711-37
4	6	-	-	Shiroyama, Kagoshima city	25-29.IV.1977	K.Miyamoto	26.IV-20.V.1977	JA	B3738-47
-	-	3	-	Kôrimoto, Kagoshima city	26.XII.1977	K.Miyamoto	---	JA	B3748-50
4	5	-	4	Wakayama-jô, Wakayama city	13-14.IV.1975	K.Yamagishi	4-12.V.1975	JA	B3751-63
1	2	-	3	Okada, Izu-Ôshima	5.I.1978	T.Sunose	28.II.1978	OV	D5101-06

*OB: *L. obtusifolium*, JA: *L. japonicum*, OV: *L. ovalifolium*.

**Includes neotype Cecid. No. C401.

ments (Tables 2 & 3). In addition, they are quite similar in their life histories and patterns of gall formation. The midges reared from *L. ovalifolium* were also considered to be identical with *A. sphaera*, though only a few specimens could be examined.

This univoltine species is biologically distinguishable from its relatives in Japan: *Asphondylia baca* Monzen³⁾ is responsible for fruit galls on *Ampelopsis brevipedunculata* (Maxim.) Trautv., and produces at least 2 generations a year; the soy bean pod gall midge, *Asphondylia* sp. is bi- or multi-voltine⁷⁾ and has a relatively wide host range in Leguminosae^{5,7)}.

Summary

The ligustrum fruit midge, *Asphondylia sphaera* Monzen is redescribed together with a designation of neotype. Its host plant range, gall, behaviour, life cycle, sex ratio, parasites and geographical distribution are also mentioned. This species is univoltine and is biologically distinguishable from its relatives in Japan.

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