

## A Taxonomic Study of *Asarum* sect. *Asiasarum* (Aristolochiaceae) in Japan

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Three species and one variety of *Asarum* sect. *Asiasarum* have hitherto been known in Japan. They are reclassified into seven species including three new species: *A. maruyamae*, *A. tohokuense*, and *A. mikuniense*. Most of the taxonomic studies on the section gave weight to the characters of leaves, calyx lobes, and the number of stamens and pistils. However, this study is based on the following characters to distinguish the species: color pattern in the adaxial surface of calyx tube, the shape of calyx tubes, the width of calyx tube throat, the shape of calyx lobe, and the number and height of ridges on inner surface of calyx tubes. The distribution range of the seven species are geographically segregated. *Asarum sieboldii* is distributed in central and western Honshu, as well as Korea and central to southern China; *A. misandrum* in Kyushu, the Aso Mountains as well as southern Korea; *A. heterotropoides* var. *heterotropoides* in northern Honshu, Hokkaido, southern Sakhalin and Kuriles; *A. tohokuense* in central and northern Honshu; *A. mikuniense* in central Honshu; *A. maruyamae* in western Honshu; *A. dimidiatum* in western Honshu, Shikoku and Kyushu.

**Key words:** *Asarum* sect. *Asiasarum*, distribution, Japan, new species.

*Asarum* L. consists of about 80 species of rhizomatous herbs distributed in eastern Asia, Europe and North America (Kelly 2001). Based on cladistic analyses of morphological data and internal transcribed spacer (ITS) sequences of nuclear ribosomal DNA (Kelly 1997, 1998), Kelly (1998) proposed an infrageneric classification system of *Asarum*. The genus is divided into two subgenera, subgenus *Asarum* and subgenus *Heterotropa* (Morr. & Decne.) O. C. Schmidt, and subgenus *Heterotropa* into two sections: sect. *Asiasarum* (F. Maek.) Araki

and sect. *Heterotropa* (Morr. & Decne) A. Braun (Kelly 1998).

*Asarum* sect. *Asiasarum* comprises six species and three varieties and occurs in northeastern Asia; Japan, China, Korea and eastern Russia (Maekawa 1936b, Cheng and Yang 1983, Yamaki et al. 1996, Watanabe 1996, Oh et al. 1997, Lee and Lee 2000). In Japan, totally four taxa (three species and one variety) have been recorded so far: *Asarum sieboldii* Miq., *A. heterotropoides* F. Schmidt var. *heterotropoides* and var. *mandshuricum* (Maxim.) Kitag., and *A.*

*dimidiatum* F. Maek. (Maekawa 1956, Ohwi 1965, Satake and Momiyama 1982, Hatusima 1993). Most of the precedent taxonomic studies of the section gave weight to the characters of leaves, calyx lobes, and number of stamens and pistils.

Yamaji et al. (2007) revealed that eight distinct forms were recognized based on morphological examinations. In this study, each form was recognized based on a multivariate analysis of various floral characters and examination of new floral characters together with those used in the previous works. First, two color patterns in the inner surface of calyx tube were found (form D and L). Form D is dark purple, on the other hand, form L is dark purple proximally, ivory white, yellowish green, light purple, or their intermediate in the middle part, dark purple or rarely ivory white at the throat. Form D is further divided by the cell number of trichomes on the inner surface of calyx tube and adaxial surface of calyx lobes; form D1 has single-cell trichomes; forms D2 and D4 have three-cell trichomes; form D3 has seven to ten-cell trichomes. Forms D2 and D4 are further divided by the number of stamens and pistils; form D2 has the regular number of them in the sect. *Asiasarum*: 12 stamens and six pistils while form D4 has half of them: six and three, respectively. Form L is further divided by the shape of the calyx tube. Form L4 has a round, elliptical, urceolate calyx tube; its length is about a half of the external diameter. On the other hand, forms L1, L2, and L3 have round urceolate calyx tube; its length is more than a half of the external diameter. Forms L1, L2, and L3 are identified by the width of calyx tube throat. Forms L1 and L3 have narrow throat, less than a half in diameter to external diameter, on the other hand, form L2 have wide throat, more than a half in diameter to external diameter. Forms L1 and L3 are identified by the size and shape of calyx lobes; form L1 has smaller, triangular calyx

lobes; form L3 has larger, pentagonoid calyx lobes. These forms were also supposed to be different in pollen, and chemical component characters (Nakamura 1986, Nakamura and Nagasawa 1987, Nakamura et al. 1979, 1982, 1987).

The aim of this study is to clarify the taxonomic position of the eight forms. For this purpose, we examined specimens deposited in herbaria, and compared with the taxa hitherto described in Japan and the other areas. Consequently we revised the taxonomy of *Asarum* sect. *Asiasarum* of Japan.

### Identification of herbarium specimens

About 500 fertile specimens in the herbaria: KYO, MAK, TI, THS, and TUS including about 100 specimens collected by the authors were also examined (see each description of the following taxonomic treatment). Through the comparison among fresh, fixed, and pressed and dried flowers from the populations examined in Yamaji et al. (2007), we found that pressed flowers in herbarium specimens were enough to identify each form recognized in this study except for difficulties of discrimination between forms D1 and D2 (Fig. 1). A considerable number of specimens keep their floral color pattern as well as the number of ridges of the inner surface of the calyx tube, calyx lobe shape/condition, and length/inclination of pistil protuberances. Moreover, from the total size/shape of flower, and basal width of calyx lobe, the size/shape of the calyx tube including calyx tube throat width were able to be anticipated.

However, we found specimens with unstable number of stamens and pistils, 6–12 and 3–6, respectively (e. g., H. Yamaji 8006, TUS 284589, THS 72985). These specimens belong to forms D1, D2, and D4. For such plants, Nakamura et al. (1982) showed that the number of stamens and pistils were unstable, and varied 6–12 and 3–6, respectively in a restricted area of central Kyushu. As the

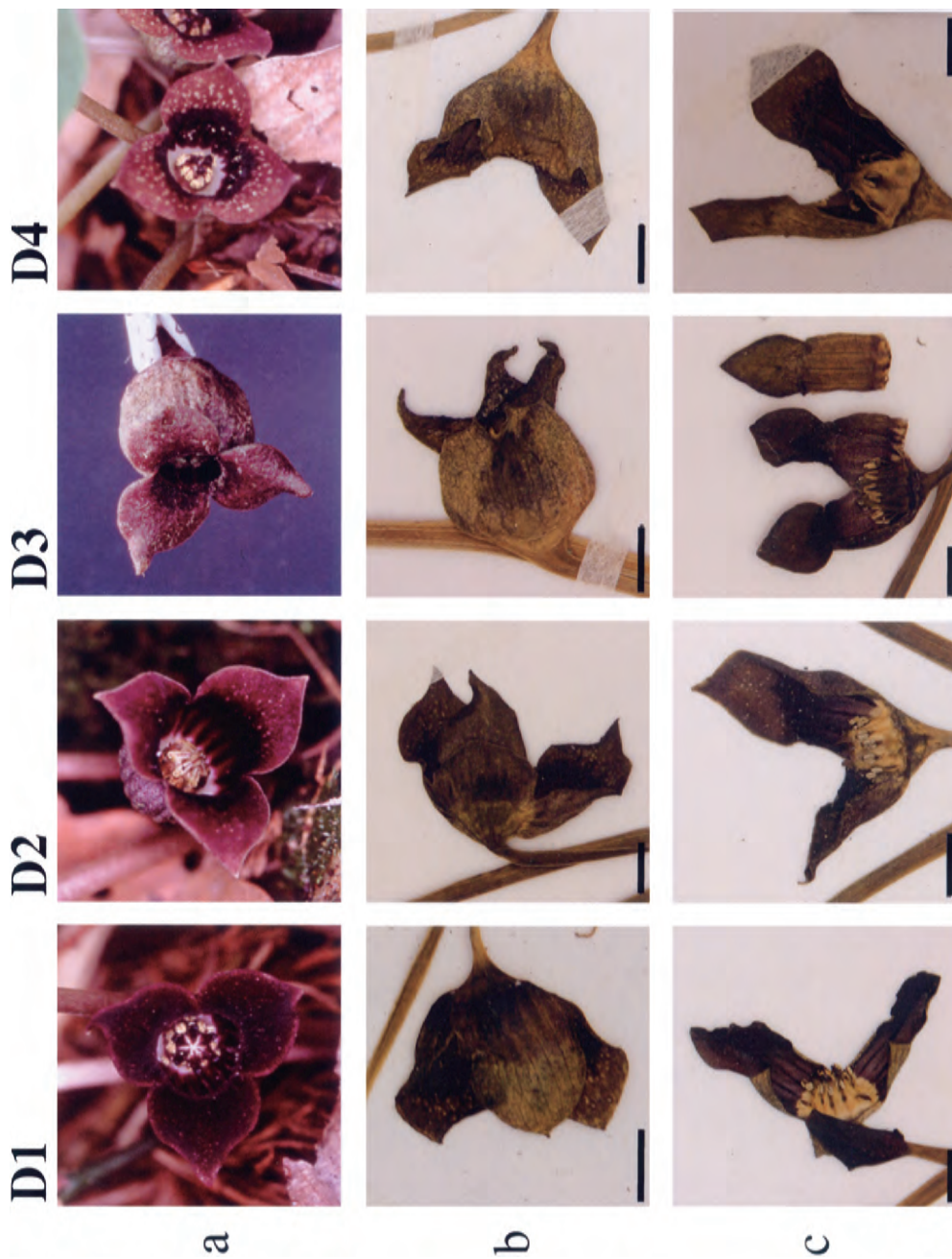


Fig. 1. Comparison between fresh (a) and dried flowers (b: outer form, c: inner form) for the eight forms of *Asiarum* sect. *Asiarum* plants recognized by Yamaji et al. 2007). D1. *A. sieboldii*; a: H. Yamaji 7010. c: H. Yamaji 7005. D2. *A. sieboldii*; a: H. Yamaji 7004. b: H. Yamaji 6035. c: H. Yamaji 7004. D3. *A. maryamiae*; a, b: H. Yamaji 7002. c: H. Yamaji 7001. D4. *A. dimidiatum*; a: H. Yamaji 8004. b, c: H. Yamaji 6190. Bar = 5 mm.



Fig. 1. Continued. L1. *Asarum heterotropoides* var. *heterotropoides*; a: H. Yamaji 4169, b, c: H. Yamaji 7023. L2. *A. tohokuense*; a: H. Yamaji 7008, b, c: H. Yamaji 6078. L3. *A. mikuniense*; a, b: H. Yamaji 7014, b: H. Yamaji s. n., 2002 (THS 71868). L4. *A. misandrum*; a, b: H. Yamaji 6200, c: H. Yamaji 6215. Voucher specimens are deposited at TUS otherwise stated. Bar = 5 mm.

area is surrounded by the distribution of form D4, and as Nakamura et al. (1982) reported that such plants also reduced the number of stamens and pistils under cultivated condition, we concluded that these plants should be included in form D4.

The number of specimens identified into each form was as follows: form D1 = 7, D2 = 9, D3 = 2, D4 = 35, L4 = 2, L1 = 138, L2 = 220, and L3 = 6. In addition to these, 118 specimens could not be identified into one form but be narrowed down to forms D1 and D2. Because the most distinct discriminant character between forms D1 and D2, the trichome condition of flowers, was especially fragile, it was difficult to discriminate them among the herbarium specimens. Highly discolored or collapsed specimens could not be identified to any forms.

### Comparison with taxa hitherto recognized in Japan

We compared the eight forms with taxa belonging to sect. *Asiasarum* hitherto known in Japan.

*Asarum sieboldii* was obviously hitherto recognized as a species including forms D1, D2, L2, and L3 by its distribution and the diagnostic characters described previously (Maekawa 1936b, Ohwi 1965, Satake and Momiyama 1982). Examination of the type specimen of *A. sieboldii* in the National Herbarium Nederland, Leiden University Branch (L) showed that the type is identified as forms D1 or D2 by its calyx tube: comparatively shallow, with wide throat, and dark colored inner surface. In addition, this specimen is supposed to have been collected in the west of central Honshu (Nakamura and Ômori 1990).

The type specimen of *A. heterotropoides* var. *heterotropoides* was collected in southern Sakhalin, and deposited at V. L. Komarov Botanical Institute (LE). It was identified as form L1 by its reflexed, small calyx lobes, and round, urceolate calyx tube.

The other specimens from Sakhalin were also identified as form L1.

Type specimen of *A. dimidiatum* was collected in Nagasaki, Kyushu and deposited in the University of Tokyo (TI). Though its reduced stamens and pistils were not reconfirmed in this specimen, Maekawa (1936a) recorded that its number of stamens and pistils were 6 and 3, respectively. Therefore, we confirmed that *A. dimidiatum* corresponds to form D4.

In Japan, *A. heterotropoides* var. *mandshuricum* is only reported to be distributed in the restricted area of central Kyushu (Hatusima 1993, Azegami 1996). This taxon is also distributed in Far East Russia, Northeastern China (Maximowicz 1872, Cheng and Yang 1983), and Korea (Yamaki et al. 1996). Its type specimens were collected in Far East Russia, and are deposited at V. L. Komarov Botanical Institute (LE). The distribution of this taxon in Japan and its characteristics reported by Hatusima (1993) completely corresponded to that of form L4. However, the typical form of the taxon on the continent, including the types is clearly distinct from form L4 in comparatively large, pentangular, gently recurved or patent calyx lobes, comparatively dark purple calyx, and pilose petioles and the abaxial surface of laminae. Therefore the attribution of form L4 is examined in the following chapter.

Forms D3, L2, and L3 did not corresponded to any taxa which have been hitherto recorded in Japan.

### Comparison with taxa and populations outside Japan

We compared the eight forms with the taxa and populations outside Japan. About 110 specimens from outside of Japan were also examined (Appendix).

As mentioned above, *Asarum heterotropoides* var. *mandshuricum* did not correspond to the form L4. On the other hand, *A.*

*misandrum* B. Oh & J. Kim, which was described from southern Korea, is similar to form L4 in having strongly recurved and triangular calyx lobes and glabrous petioles (Oh et al. 1997) and yellowish green pistil protuberances. We concluded that form L4 is identified as *A. misandrum*.

*Asarum sieboldii* f. *seoulense* (Nakai) C. Y. Cheng & C. S. Yang, which is also distributed in Northeastern China and Korea (Cheng and Yang 1983, Yamaki et al. 1996). This taxon is unique in having densely pilose petioles and the abaxial surface of laminae, which was not detected in sect. *Asiasarum* plants in Japan. Therefore we concluded that no Japanese plants correspond to this taxon.

Individuals recognized as *A. sieboldii* in Korea were almost similar to form D1 in this study in the floral color pattern, the number of stamens/pistils and the trichomes of flowers. In addition, they completely agreed with the form D1 in chemical and pollen characters (Yamaji et al. unpubl. data). Individuals recognized as *A. sieboldii* in southern China corresponded to forms D1 or D2.

*Asarum versicolor* (Yamaki) Y. Lee is distributed in central Korea, and is characterized by variegated leaves with some exceptions, smaller flowers than *A. sieboldii* (Yamaki et al. 1996, Lee and Lee 2000). The shape and size of flowers of this species is similar to forms L1 and L3, especially in the calyx tube with a narrow throat. Calyx lobes of this species are patent or oblique, undulate, acuminate at apex, and are similar to a part of form L1. Floral color pattern of this species is also similar to forms L1 and L3: ivory to light purple, olive green to purple in outer surface, dark purple at the throat, ivory white to ivory, sometimes light purple at the middle part, dark purple proximally, ivory white at the base. However, the number of cells of each trichome of flowers is almost three in *A. versicolor* though those of form L1 and L3 are 3–7 and 5–7, respectively. Peduncles of this species are longer, 3–6 cm,

than those of forms L1 and L3, 1–3 cm and 1–2 cm, respectively, though those of form L1 rarely had peduncles up to 6 cm. Consequently, we decided forms L1 and L3 as distinct from *A. versicolor* in this study.

*Asarum patens* (Yamaki) Y. Lee is unique in having long, protruded pistil protuberances, comparatively large and patent calyx lobes, and densely pilose leaves in adaxial surface. No individuals corresponding to this species were found in Japan.

### Conclusion

Among the eight forms, three forms have not been described previously.

The precedent systems of *Asarum* sect. *Asiasarum* (Maekawa 1936b) applied hierarchical classification including intraspecific taxa, and weighted each character with somewhat subjective standard to estimate the relationship of the taxa. However, such hierarchical classifications may force to inferences of phylogenetic relationships even if they are not yet supported by DNA evidence. Progress of molecular phylogenetics in the last decade promoted systematic study to infer the phylogeny with molecular information.

In this study, we intended to recognize morphologically distinct forms of this group, and to regard the recognized forms as hypothetical taxonomic units for the following study, e. g., a molecular phylogenetic study. Therefore, we do not discuss about phylogenetic relationship between the forms recognized in this study. We equally treated the forms as distinct species.

Exceptionally, we decided to include forms D1 and D2 into the same species. Though our analysis indicated that these two forms are different in floral characters by the CVAs, and they are supposed to have almost disjunct distributions from each other, discrimination of these forms in herbarium specimens is almost impossible. In the same way, the type specimen of *Asarum sieboldii*

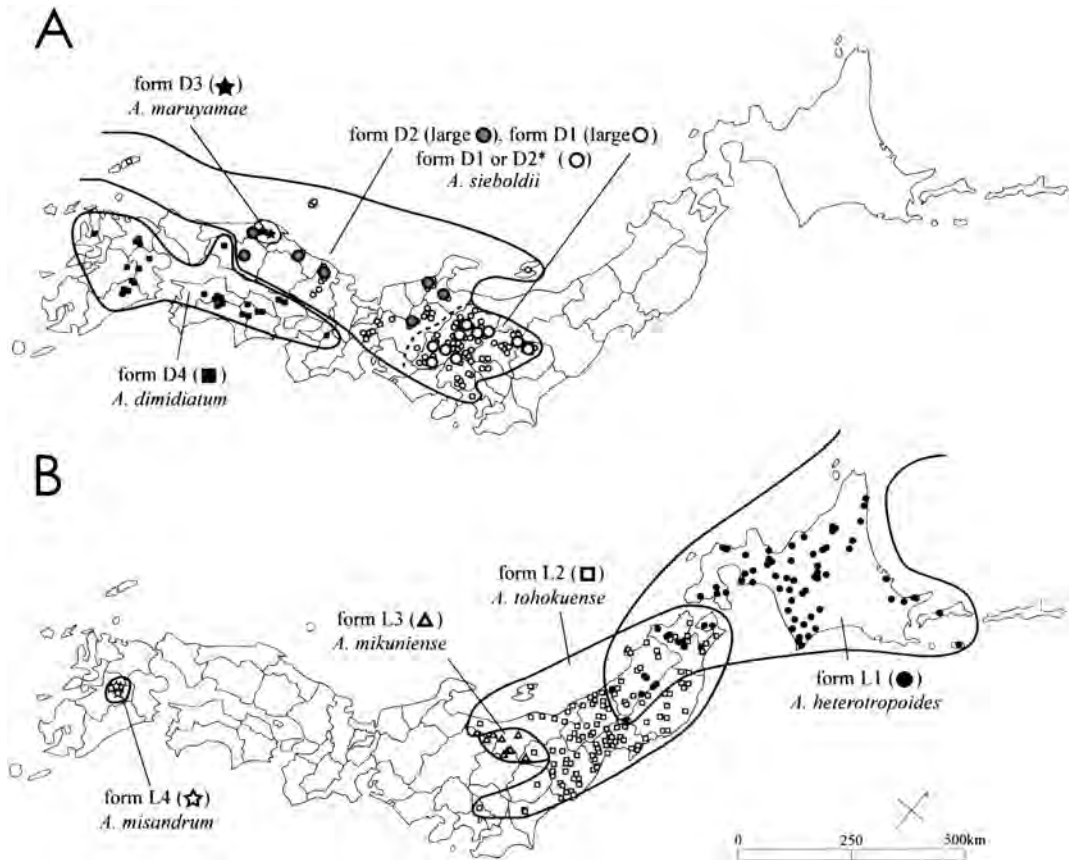


Fig. 2. Distributions of eight forms (seven species) of *Asarum* sect. *Asiasarum* in Japan. A: Form D species. B: Form L species. \*Specimens that could not be identified into one form but be narrowed down to form D1 and D2.

is impossible to place into either form. Hence we suspended the taxonomic treatment of two forms and treat them as a single taxon.

Consequently, we recognized the following seven species in *Asarum* sect. *Asiasarum* in Japan; forms D1 and D2 = *A. sieboldii*, form D4 = *A. dimidiatum*, form L1 = *A. heterotropoides* var. *heterotropoides*, form L4 = *A. misandrum*; three new species described here are as follows: form D3 = *A. maruyamae*, form L2 = *A. tohokuense*, and form L3 = *A. mikuniense*.

The distribution of each form in Japan is shown in Fig. 2. *Asarum sieboldii* is

distributed in the west of central Honshu, Sadogashima Is. and Tsushima Is. *Asarum maruyamae* is distributed in the restricted area of western Honshu. *Asarum dimidiatum* is distributed in Shikoku, Kyushu and two restricted areas of western Honshu. *Asarum misandrum* is only recognized in the restricted area of central Kyushu. *Asarum heterotropoides* var. *heterotropoides* is distributed in Hokkaido, northern Honshu, Sakhalin, and the southern Kuriles. *Asarum tohokuense* was distributed in northern and central Honshu and Sadogashima Is. *Asarum mikuniense* is distributed in the restricted area of central Honshu.

Table 1. Comparison of *Asarum* sect. *Asiarum* species in Japan

	<i>A. sieboldii</i> (Forms D1, D2)	<i>A. mariyamae</i> (Form D3)	<i>A. dimidiatum</i> (Form D4)	<i>A. heterotripoides</i> (Form L1)	<i>A. tohokuense</i> (Form L2)	<i>A. mikaniense</i> (Form L3)	<i>A. misandrum</i> (Form L4)
Rhizome	straight	straight	straight	straight	straight	straight	straight or zigzag
Calyx tube	olive green with small purple spots dark purple	olive green with small purple spots dark purple	olive green with small purple spots dark purple	pink-dark purple	ivory-pale purple	olive green-purple	salmon pink to pale purple
Color pattern							
Outer surface	purple spots dark purple	purple spots dark purple	purple spots dark purple	ivory white-pale purple, with dark purple stripe	ivory white-pale purple, with dark purple stripe	ivory white-pale purple, with dark purple stripe	ivory white to ivory, with dark purple stripe
Inner surface							
Size (mm)	9.5-15	10-14	8.5-12	10-15	10-15	11-14	11.5-16
Diameter	5-9.5	7.5-10	5-8	5-10	6.5-10.5	6.5-10	5-8
Length	6-11.5	5-7	5.5-9.0	4-7.5	5.5-11	5-8	7.5-11
Throat width							
Longitudinal ridges							
Height (mm)	0.7-1.7	0.7-1.0	0.7-1.3	0.6-1.7	0.4-1.0	0.6-1.2	1.0-1.5
Number	17-26	15-17	15-24	15-27	15-21	17-21	19-27
Calyx lobe							
Shape	transverse ovatus deltoid-pentangular	pentangular	transverse ovatus deltoid-pentangular	deltoid	transverse ovatus deltoid	pentangular	deltoid
Apex	acute-acuminate	acuminate	acuminate	acute-acuminate	acuminate	acuminate	acute
Direction	recurved-oblique	patent-oblique	patent-oblique	recurved-patent	oblique	patent-oblique	strongly recurved
Length (mm)	4.5-13.5	5.5-9	5.5-9	3.5-9.0	5.0-9.5	7-11	4.0-7.5
Width (mm)	7.0-14.5	6-9	6.5-10.5	5.0-10.5	7.0-12.0	8-11	9.5-11
Trichomes in adaxial surface							
Number of cells	1-5	7-10	3-6	3-7	3-4	5-7	3-4
Length (µm)	20-140	220-240	80-140	80-150	60-120	120-180	70-100
Style protuberances							
Length (mm)	0.7-1.9	0.8-1.1	0.8-1.6	0.5-1.6	0.4-1.0	0.6-1.5	1.0-1.7
Tip condition	detached	closed	detached	closed	detached	closed-detached	closed
Distribution	Central and Western Honshu, Korea and south of central China	Western Honshu: Shimane Pref.	Western Honshu: (Nara, Hiroshima), Shikoku and Kyushu	Hokkaido, north east Honshu, Sakhalin and southern Kurile Islands	north of central Honshu	Central Honshu	Kyushu (Kumamoto) and southern Korea



Comparison of the recognized species in this study is shown in Table 1. For taxonomic key to the taxa, in addition to the qualitative characters, useful quantitative characters recognized in the univariate analyses (Yamaji et al. 2007) were also adopted.

### Taxonomic treatment

#### **Asarum** L.

Subgen. **Heterotropa** (Morr. & Decne.) O. C. Schmidt

Sect. **Asiasarum** (F. Maek.) Araki in Acta Phytotax. Geobot. **6**: 125 (1937) – L. Kelly in Amer. J. Bot. **85**: 1467 (1998) – *Asiasarum* F. Maek. in Nakai, Fl. Syl. Kor. **21**: 17 (1936). TYPE: *Asarum sieboldii* Miq.

Perennial herb. Rhizome about 5 mm in diameter, glabrous, zigzag or straight, slender, with leaf and flower trace, sometimes branched. Roots usually about 1 mm in diameter, fleshy, slender, distributed evenly along rhizomes. Hibernaculum at the axil of leaves and cataphylls, composed of cataphylls, preformed leaves and flower, unequal ovate or elliptic, obtuse, acute or acuminate at apex, olive green, purplish green, or purplish ivory, with purple veins, 10–16 mm long, 5–10 mm wide in hibernaculum with floral bud. Cataphylls 3, caducous, glabrous, ciliate, triangular ovate, obtuse, acute or acuminate at apex; proximal cataphyll: 1–3 mm long, 2–6 mm wide, median cataphyll: 4–14 mm long, 6–12 mm wide; distal cataphyll: 8–18 mm long, 7–20 mm wide. Leaves deciduous, solitary in shoot without flower, two, alternate in flowering shoot, petioles 3–20 cm long, adaxial ridges sparsely pilose, the other part pilose or glabrous; lower lamina ovate cordate–broadly cordate; upper lamina pentangular ovate cordate; membranous, palmately veined; abaxial surface glaucous, glabrous or pilose; adaxial surface green, variegated or non-variegated, sparsely pilose; margin ciliate, the cilia incurved toward the apex. Flower

solitary, actinomorphic. Peduncle erect or oblique, glabrous. Sepals 3, connate, forming calyx tube; external surface glabrous, striated longitudinally; inner surface glabrous or pubescent with trichomes, 15–27 ridged. Calyx lobes recurved, patent, or obliquely erect; adaxial surface glabrous or pubescent with trichomes; abaxial surface glabrous. Stamens 6 or 12, or variable 6–12 in two whorls; filament greenish ivory or light purple, anther extrorse, pale yellow. Ovary half inferior or superior, conic, slightly ribbed, 3–6-locular. Styles 3 or 6, or variable 3–6, free, with horn-like stylar protuberances at apex; stylar protuberances bifurcated, greenish ivory or dark purple, 0.4–3.0 mm long, close or detached each other, ovules 4–10 in each locule.

### Key to the Species of

#### **Asarum** Sect. **Asiasarum** in Japan

1. Inner surface of calyx tube entirely dark purple
2. Calyx tube roundish urceolate, 0.7–0.9 times longer than the external diameter; throat about half in diameter to external diameter; trichomes on adaxial surface of calyx lobe and tube 220–240  $\mu\text{m}$  long, composed of 7–10 cells; pistil protuberances generally greenish ivory (Shimane / Honshu) .... 1. *A. maruyamae*
2. Calyx tube cylindroid or urceolate, 0.5–0.7 times longer than the external diameter; throat more than half in diameter to external diameter; trichomes on adaxial surface of calyx lobe and tube 20–140  $\mu\text{m}$  long, composed of 1–5 cells; pistil protuberance purple at apex
3. Stamens and pistils 12 and 6 (west of central Honshu, Tsushima, Korea, and southeast China) ..... 2. *A. sieboldii*
3. Stamens and pistils usually 6 and 3, sometimes 6–12 and 2–6 (Honshu (Hiroshima, Nara), Shikoku, Kyushu) ... ..... 3. *A. dimidiatum*
1. Inner surface of calyx tube dark purple or

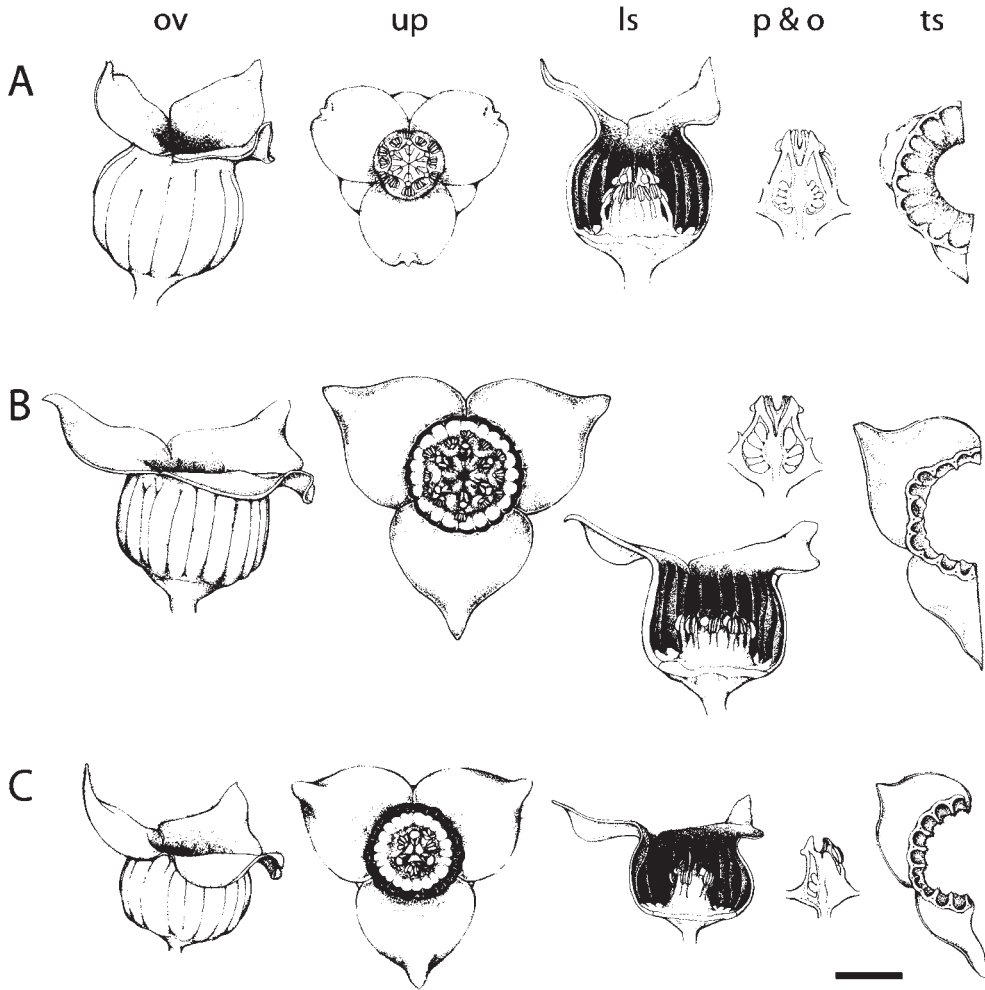


Fig. 3. Comparison of form D taxa: A: *Asarum maruyamae* (H. Yamaji 7002). B: *A. sieboldii* (H. Yamaji 6051). C: *A. dimidiatum* (H. Yamaji 8002). ov: Overlook view. up: Upper view. ls: Longitudinal section. p & o: Pistil and ovary. ts: Transverse section of calyx lobe. Bar = 5 mm. Voucher specimens are deposited at TUS.

rarely ivory white at throat, ivory white, ivory, or pale purple at middle, dark purple proximally

- 4. Throat narrow, less than half diameter of external diameter
- 5. Calyx lobe 4–8 mm long, 5–9 mm wide, triangular, reflexed in most flowers, sometimes patent or oblique (northern Honshu, Hokkaido, Sakhalin and the Kuriles) ..... 4. *A. heterotropoides*
- 5. Calyx lobe 7–10 mm long, 8–10 mm

wide, pentagonoid, patent or oblique, acuminate at apex (central Honshu) ....

- ..... 6. *A. mikuniense*
- 4. Throat wide, more than half diameter of external diameter
- 6. Calyx tube round urceolate, more than half as long as external diameter; calyx lobes patent or oblique, acuminate at apex (northern and central Honshu) ....
- ..... 5. *A. tohokuense*
- 6. Calyx tube round elliptical urceolate,

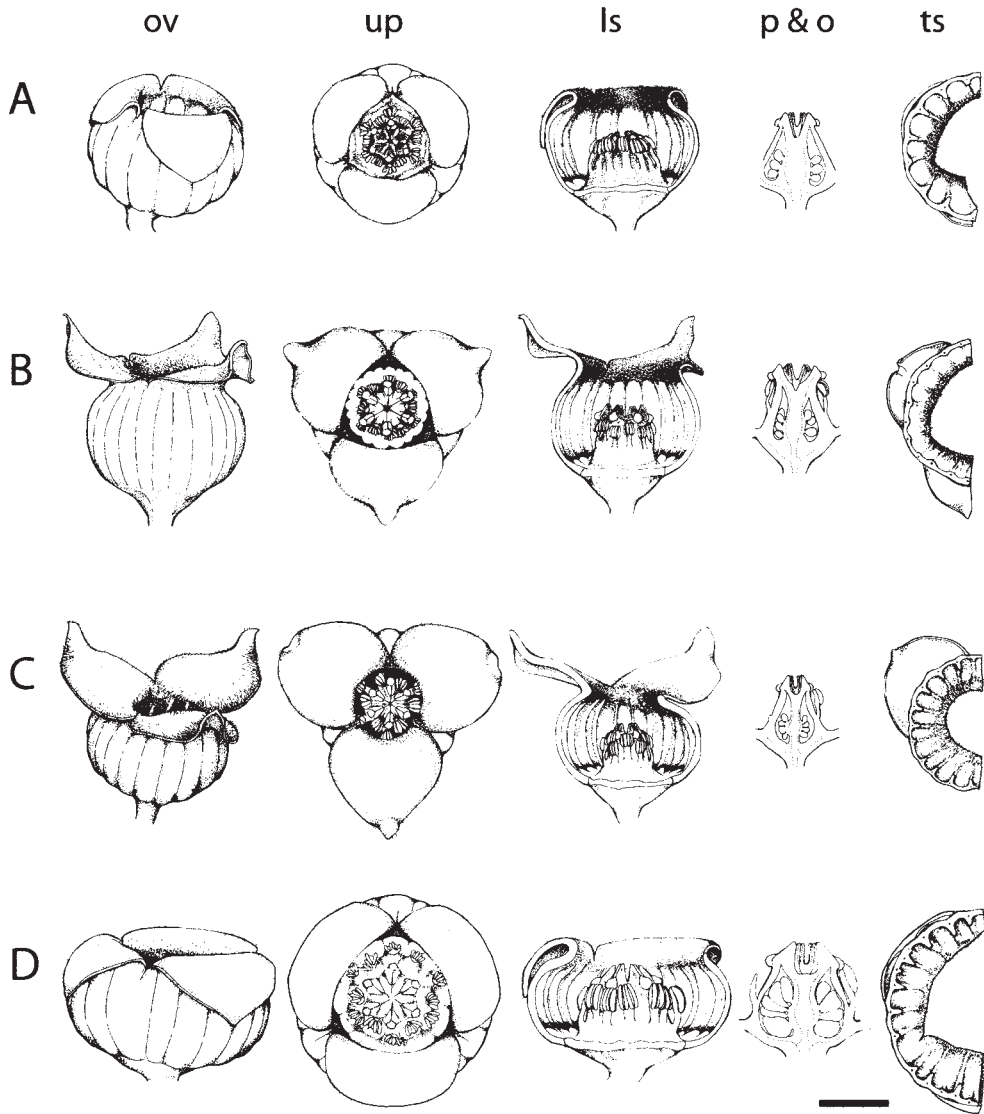


Fig. 4. Comparison of form L taxa: A: *Asarum heterotropoides* var. *heterotropoides* (H. Yamaji 7103). B: *A. tohokuense* (H. Yamaji 6065). C: *A. mikuniense* (H. Yamaji 6220). D: *A. misandrum* (H. Yamaji 6215). ov: Overlook view. up: Upper view. ls: Longitudinal section. p & o: Pistil and ovary. ts: Transverse section of calyx lobe. Bar = 5 mm. Voucher specimens are deposited at TUS.

about half as long as external diameter; calyx lobes completely reflexed, obtuse or acute at apex (Kumamoto, Kyushu) ..... 7. *A. misandrum*

1. *Asarum maruyamae* Yamaji & Ter. Nakam., sp. nov. [Fig. 3A]

Haec species ab *Asaro sieboldio* et *A. dimidiato*, fauces calycis constrictis, diametro tubo calycis fere dimidio brevissior, pilis 7–10-cellaris in pagina

daxaialibus tubo et lobis calycis, ab *A. heterotropoido* pagina tubo calycis purpureo vel atropurpureo differt.

TYPE: JAPAN. Honshu, Shimane Pref., Nogi-gun (currently Yasugi-shi), Hirose-machi, Ichihara, along Ichihara River, Ichihara Bridge, 9 Apr. 2003, H. Yamaji 9501 (holotype–TUS 337646, Fig. 5; isotype–TI, THS).

Rhizome straight. Hibernaculum mainly at axil of distal leaf. Leaves 6.5–11 cm long, 5–9 cm wide, acuminate at apex, sparsely pilose only on veins, non-variegated; petioles 9–12 cm long. Peduncle about 2 cm long. Calyx tube roundish urceolate, 7.5–10 mm long, 10–14 mm in diameter, throat 5–7 mm in diameter, 0.7–0.85 times longer than the diameter, throat 0.5–0.55 times wider than the diameter; outer surface purplish olive green; inner surface dark purple, ivory white at base, pubescent with trichomes, ridges 15–17, 0.7–1.0 mm high. Calyx lobes patent or oblique, undulate, pentangular, acuminate at apex, 5.5–9 mm long, 6–9 mm wide; adaxial surface pubescent with trichomes, brownish purplish or greenish. Trichomes of calyx 220–240  $\mu\text{m}$  long; cells 7–10 in number. Stamens 12 in two whorls; filaments 2.5–3.5 mm long; anther 15–20 mm long. Ovary 6-locular, greenish ivory, 7–10 mm long, 6–8.5 mm wide before fertilized; styles 6, greenish ivory, 0.8–1.1 mm long.

Japanese name: Izumo-saishin.

Distribution: Japan. Western Honshu (in the restricted area of Shimane Pref.; Fig. 2).

Although Nakamura (1986) reported that this species was distributed also in Hiroshima Pref., we could not confirm its occurrence there. Populations may be extinct there.

Habitat: In floor or margin of forest along stream, on rock cracks or mossy surface of rocks along stream in forest, or floor and margin of forest. Flowers in late March to early April. This species prefers rather wet condition and flowers open earlier than other

species.

Specimens examined. JAPAN. HONSHU. Shimane Pref.: Okuizumo-cho: T. Nakamura & J. Endo s. n., 2 May 1981 (TUS 284852, 284853, TUS 284854), H. Yamaji 7001 (TUS 284851), H. Yamaji 7002\* (TUS 284850). Unnan-shi: H. Yamaji 9502 (TUS 337607), H. Yamaji 9503 (TUS 337604–337606). \*Voucher specimens used for CVAs (Yamaji et al. 2007).

The specific epithet is dedicated to Mr. Iwao Maruyama, who first found the plant of this species in Shimane Pref. This species is characteristic in intermediate state between forms D and L species in pollen (Nakamura and Nagasawa 1987), chemical characters (Nakamura et al. 1987), and the shape of flower (Yamaji et al. 2007). It is possible that this species is of hybrid origin.

2. *Asarum sieboldii* Miq. in Ann. Mus. Bot. Lugd. Batav. **II**: 134 (1865); Prol. Fl. Jap. 66 (1866), ut “*Sieboldii*”– Maxim. in Mél. Biol. **8**: 397 (1871), pro maj.; in Bull. Acad. Imp. Sci. St.-Petersb. **17**: 163 (1872) part – Ohwi, Fl. Jap. ed. Engl. 399 (1965) – Ohwi & Kitag., New Fl. Jap. 601 (1983) – Sugim., Keys Herb. Pl. Jap. ed. rev. **1**: 54 (1983) – *Asiasarum sieboldii* (Miq.) F. Maek. in Nakai, Fl. Sylv. Kor. **21**: 22 (1936) – Satake & Momiy. in Satake & al. Wild Flow. Jap. **2**: 104, pl. 101 (1982). TYPE: JAPAN. Siebold s. n., no. 898-131-351, a part [lower] (holotype–L, non vidi; photocopy in web page of L !). [Fig. 3B]

*Asarum sieboldii* Miq. var. *japonicum* Maxim. in Mél. Biol. **8**: 399 (1871); in Bull. Acad. Imp. Sci. St.-Petersb. **17**: 164 (1872), in observ.

Rhizome straight. Hibernaculum mainly at axil of distal foliage leaf. Leaves 3.5–13 cm long, 3–12 cm wide, acuminate at apex, sparsely pilose at only veins, non-variegated; petioles 4–17 cm long. Peduncle 1–5 cm. Calyx tube cylindroid or urceolate, 5–9.5 mm long, 9.5–15 mm in diameter, throat 6–11.5 mm in diameter, length 0.5–0.65 times long, throat 0.55–0.85 times in diameter to

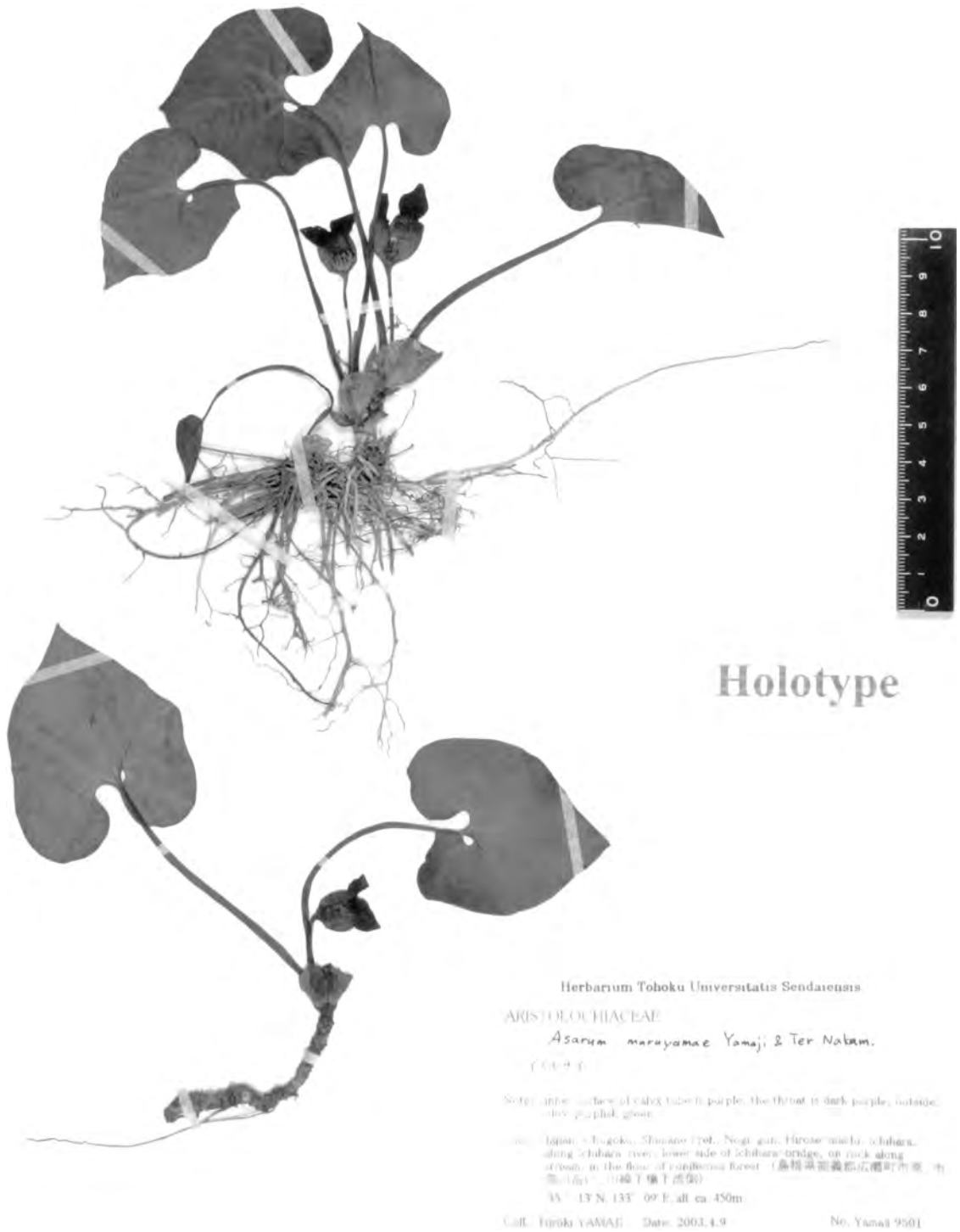


Fig. 5. Type specimen of *Asarum maruyamae* Yamaji & Ter. Nakam.

external diameter; outer surface purplish ivory or purplish olive green; inner surface dark purple, ivory white at base, glabrous or pubescent with trichomes, ridges 17–26, 0.7–1.7 mm high. Calyx lobes recurved, patent, or oblique, undulate, transverse ovatus deltoid or pentangular, acute or acuminate at apex, 4.5–13.5 mm long, 7.0–14.5 mm wide; adaxial surface glabrous or pubescent with trichomes, brownish pale purple with small ivory spots or dark purple. Trichomes of calyx 20–140  $\mu\text{m}$  long; cells 1–5 in number. Stamens 12 in two whorls; filaments 2.0–3.5 mm long; anther 11–16 mm long. Ovary 6-locular, greenish ivory to pale purple, 4–6.5 mm long, 5–8 mm wide before fertilized; styles 6, dark purple, 0.7–1.9 mm long.

Japanese name: *Usuba-saishin*.

Distribution: Japan. Central and western Honshu, Tsushima Is. and Sadogashima Is. (Fig. 2), Korea, central and eastern China.

Habitat: On floor and at margin of deciduous, mixed and coniferous forest. Flowers in April to May.

Specimens examined. **JAPAN. HONSHU. Gunma Pref.:** Mt. Akagi-yama: J. Sugimoto s. n., 31 May 1933 (KYO), K. Ibuka s. n., May 1935 (TI), unknown collector s. n., 6 May 1878 (TI). Kitagunma-gun: M. Tsuchiya 7933 (MAK 289691). Fujimi-mura: M. Mizushima s. n., 18 Jun. 1956 (MAK 2442). Fujiokashi: H. Kanai s. n., 1 May 1963 (TI), J. Murata, H. Ohba, & Y. Kadota 257 (KYO). Katashina-mura: H. Yamaji 6262\* (TUS 233254), K. Ueda & M. Ito s. n., 1 Jun. 1978 (KYO). Minakami-machi: H. Hara s. n., 20 Jun. 1959 (TI). Nakanojo-machi: K. Nakajima 335 (MAK 140095). Seta-gun: T. Yamazaki 7119 (TI). **Tochigi Pref.:** Nikko-shi: J. Ohwi & K. Okamoto s. n., 28 Apr. 1952 (KYO, TUS 28356), T. Makino s. n., 9 Jun. 1901 (MAK 140086), G. Murata & M. Tagawa s. n., 27 May 1962 (KYO), H. Kanai s. n., 25 May 1959 (TI), H. Yamaji 6276 (TUS 284600), H. Ohashi, Y. Tateishi, Y. Endo, T. Nemoto, H. Sakai & B. H. Choi 11597 (TUS 108642), H. Ohashi, H. Ohba, Y. Tateishi, J. Murata & S. Akiyama 1425 (TI), H. Kanai 6469 (TI), unknown collector s. n., 1980 (TUS 284745), S. Sugaya s. n., Apr. 1936 (TUS 28359), H. Ohashi, Y. Tateishi, Y. Endo, T. Nemoto, H. Sakai, & B. H. Choi 11260 (TUS 104333), G. Murata & M. Tagawa 108 (MAK 63079), T. Makino s. n., 9 Jun. 1901 (MAK

140086), H. Yamaji 6269 (TUS 233255), Y. Yabe s. n., 12 Jun. 1901 (MAK 140085), unknown collector s. n. (TUS 284742). **Saitama Pref.:** Chichibu-shi: unknown collector s. n., May 1884 (TI), J. Endo & T. Nakamura s. n., 1976 (TUS 284743, 284744), N. Kurosaki 7477 (KYO). **Tokyo Pref.:** Hachioji-shi: T. Makino s. n., 1925 (KYO). **Kanagawa Pref.:** Hadano-shi: Osaka Pref. Women's College 1128 (MAK 140094). **Niigata Pref.:** Sado-shi: G. Watanabe s. n., 20 Apr. 1904 (MAK 242096), S. Iwano 16794 (TUS 185335). **Yamanashi Pref.:** H. Uematsu s. n., Jun. 1949 (TI). Fujikawaguchiko-machi: N. Fukuoka s. n., 27 May 1964 (KYO), K. Suzuki 3783 (MAK 272300), H. Satoguchi 96084 (MAK 287487), G. Murata 16291 (MAK 40997), G. Murata s. n., 29 May 1962 (KYO), M. Togashi s. n., 7 Jun. 1966 (TI), J. Murata 11107 (TI). Hayakawa-cho: J. Endo & T. Nakamura s. n. (TUS 284737, TUS 284738, TUS 284739, TUS 284740). Hokuto-shi: H. Yamaji 6055 (TUS 284599). Koshu-shi: F. Maekawa s. n., 22 May 1938 (TI), K. Hisauchi s. n., 22 May 1938 (KYO). Minami-Alps-shi: J. Satoh s. n., 3 May 1974 (TI). **Nagano Pref.:** K. Suzuki 3811 (MAK 272299). Hakuba-mura: H. Yamaji 7010\* (TUS 284609, THS 71856), H. Yamaji 7011 (TUS 284596, THS 71899), H. Yamaji s. n., 3 May 2002 (THS 71854). Hara-mura: M. Furuse s. n., 24 May 1954 (KYO). Iida-shi: H. Yamaji 6051\* (TUS 284598, 337618), K. Muramatsu 491 (MAK 46603), K. Muramatsu 22136 (MAK 46604). Ina-shi: S. Yoshie 261 (MAK 140097), T. Sugawara 1828 (MAK 215157), Y. Garayama s. n., 1960 (MAK 310968), H. Yamaji 6050\* (TUS 233253). Kamiina-gun: H. Kanai s. n., 20 Jun. 1954 (TI). Kishimataira-mura: M. Ono s. n., 14 May 1964 (MAK 34465), H. Yamaji 9004\* (TUS 284606, THS 70320). Kiso-machi: B. Kitamura s. n., 28 Apr. 1963 (MAK 46601, 46602). Matsumoto-shi: T. Sugawara 1042901 (MAK 318120), N. Naruhashi & I. Kozima 1608 (KYO), N. Naruhashi & I. Kozima 1627 (KYO). Minamisaku-gun: K. Sato 1380 (TI), K. Sato 1197 (TI). Minowa-mura: H. Kanai, H. Ohashi, K. Hasegawa & K. Okubo s. n., 19 Jun. 1965 (TI). Nagano-shi: H. Yamaji 7012\* (TUS 284594), M. Minemura 1334 (MAK 14149). Nakanoshi: H. Yamaji 7013\* (TUS 284595, THS 71860). Okuwa-mura: H. Yamaji 7005\* (TUS 284607, THS 72989), H. Okuhara s. n., 1963 (MAK 264490). Omachi-shi: H. Kanai s. n., 2 Jun. 1961 (TI), S. Mimoro, S. Tsugaru, K. Nishiyama 1565 (KYO). Ooshika-mura: K. Asano 3029 (TI), Y. Furuse s. n., 20 May 1932 (TI), Katagiri 16 (TI), K. Muramatsu 919 (MAK 46607), K. Asano 3667 (TI). Saku-shi: T. Ikeda s. n., 5 May 1982 (TUS 88929), H. Kanai & K. Okubo s. n., 23 May 1965 (KYO). Shiojiri-shi: T. Sugawara 2051102 (MAK 329505). Tateshina-machi: T. Omura

s. n., 22 Jun. 1959 (KYO). Tatsuno-machi: H. Matsuda s. n., 2 May 1955 (TI). Ueda-shi: S. Mimoro, S. Tsugaru, K. Nishiyama 1704 (KYO), G. Murata, H. Koyama & H. Nishimura 30320 (KYO, MAK 161100). Yamanouchi-machi: S. Nishimaki s. n., 29 Apr. 1929 (TI). Yasuoka-mura: K. Muramatsu 22053 (MAK 46606), K. Muramatsu 22057 (MAK 46605), K. Muramatsu 2846 (MAK 46608). **Gifu Pref.:** Gujoshi: K. Shioda s. n., 9 May 1922 (KYO), H. Yamaji 6035\* (TUS 284602, 337616–337617 THS 71887), K. Shiota s. n., 30 May 1922 (KYO). Ibigawa-cho: H. Takahashi, Y. Goto, Y. Yamada & K. Kaneko 6189 (KYO). Nakatsugawa-shi: S. Tsugaru, G. Murata & T. Takahashi 23447 (KYO). Shirakawa-mura: H. Takahashi & H. Takano 1573 (KYO), H. Nagase 90366 (KYO), Y. Hisada s. n., 1965 (TUS 284747), H. Takahashi & H. Takano 1503 (KYO), S. Mimoro & S. Tsugaru s. n., 7 Jun. 1976 (KYO). Takayama-shi: H. Nagase 88312 (KYO). **Toyama Pref.:** Higashitonami-gun: T. Otaya s. n., 30 May 1934 (KYO), T. Otaya s. n., 10 May 1931 (KYO). Nanto-shi: G. Murata 67454 (KYO), T. Otaya (KYO), N. Satomi s. n., 13 May 1962 (KYO), T. Otaya s. n., 17 May 1931 (KYO), G. Murata & H. Nishimura 54 (TI), G. Murata, H. Nishimura, M. Wakabayashi & I. Kozima 54 (KYO), J. Endo & T. Nakamura s. n. (TUS 284741). Tonami-shi: H. Yamaji 7007\* (TUS 284604, 284605, 72987, 72988, 72990, 72992, 72993). **Ishikawa Pref.:** Mt. Shiritaka-yama: G. Masamune, N. Satomi & M. Togashi s. n., Apr. 1958 (MAK 9767), J. Endo & T. Nakamura s. n. (TUS 284735, 284736), G. Masamune, N. Satomi & M. Togashi s. n., Apr. 1958 (TI, KYO, TUS 28354), N. Satomi s. n., 13 May 1951 (TI), Hakusan-shi: G. Ikeo s. n., 26 May 1940 (KYO), S. Fujii 2464 (KYO), H. Yamaji 7006\* (TUS 284591, TUS 284611, THS 72986, THS 72991, THS 72994). **Shiga Pref.:** Mt. Ibuki-yama: N. Fukuoka 8073 (KYO), S. Takahashi s. n., 23 May 1932 (KYO), Higashioumi-shi: K. Iwatsuki s. n., 30 Apr. 1955 (KYO), G. Murata s. n., 30 Apr. 1955 (KYO). Maibara-shi: G. Koizumi (TI). Yogo-cho: Y. Tateishi & H. Hoshi 13730 (TUS 132095). **Mie Pref.:** Inabeshi: M. Nagasawa s. n., 1965 (TUS 284749, 284750), S. Kurosawa s. n., 5 May 1956 (TI), T. Shimizu s. n., 1 May 1955 (KYO), H. Yamaji 6030 (TUS 284601). **Wakayama Pref.:** Kitayama-mura: T. Hashimoto s. n., 1961 (TUS 284748). **Hyogo Pref.:** Asago-shi: K. Fukuda 2228 (KYO). Kami-cho: T. Kobayashi 20410 (KYO). Shin-onsen-cho: M. Hashimoto 9315 (KYO), T. Kobayashi 05723 (KYO). Taka-cho: T. Kobayashi 31493 (KYO). Toyooka-shi: H. Yamaji 9002 (TUS 284593, THS 71799, THS 71801). **Tottori Pref.:** Tottori-shi: A. Tanaka s. n., 12 May 1973 (KYO), H. Yamaji 6016\* (TUS 284603). **Shimane Pref.:** Iinan-

cho: H. Yamaji 9504 (TUS 337614–337615). Saigo-cho: N. Kurosaki 10006 (KYO), G. Murata, H. Koyama & H. Nishimura 45711 (KYO). **Hiroshima Pref.:** Miyoshi-shi: H. Yamaji 7004\* (TUS 284610). **KYUSHU. Nagasaki Pref.:** Tsushima-shi: unknown collector s. n., 6 May 1912 (MAK 140066). \*Voncher specimens used for CVAs (Yamaji et al. 2007).

**CHINA. SICHUAN:** C. S. Yang & C. Z. Zhou s. n. in 1993 (THS 76897). **SHAANSI:** Luonan-xian: unknown collector in 1992 (THS 76898–76899). **HUBEI:** E. Miki s. n., 2001 (THS 44022).

**KOREA. GANGWON-DO:** Cheongsong-gun: K. Yamaki & J.-H. Pak 1009 (THS 40319, THS 40320, THS 40321). Donghae-shi: K. Yamaki & J.-H. Pak 1007 (THS 40326). Inje-gun: H. Yamaji, S.-W. Lee, J.-S. Kim & J.-H. Pak 8170 (TUS 254010). Myogju-gun: H. Yamaji, S.-W. Lee, J.-S. Kim & J.-H. Pak 8182 (TUS 337628). Wonju-gun: H. Yamaji, S.-H. Jo & S.-W. Park 8115 (TUS 252562), H. Yamaji, S.-H. Jo & S.-W. Park 8122 (TUS 337637). **CHUNGCHONG-DO:** H. Yamaji & K. Choi 8095 (TUS 253998, 254012). Boeun-gun: K. Yamaki & J.-H. Pak 1020a (THS 40292, 40293). **JEOLLABUK-DO:** Puan-gun: H. Yamaji, S.-W. Lee & J.-H. Pak 8071 (TUS 337638). **JEOLLANAM-DO:** Jangseong-gun: K. Yamaki & J.-H. Pak 1017a (THS 40309), K. Yamaki & J.-H. Pak 1017b (THS 40310, 40311). Seungju-gun: K. Yamaki & J.-H. Pak 1015 (THS 40307, THS 40308). Changsong-gun: H. Yamaji, S.-W. Lee, J.-H. & Pak 8074 (TUS 254002). Wando-gun: H. Yamaji, S.-W. Lee & J.-H. Pak 8067 (TUS 254000, 254004). **GYEONGSANGBUK-DO:** S. Okamoto s. n., 18 Jun. 1935 (MAK 61907). Habchon-gun: K. Yamaki & J.-H. Pak 1018a (THS 40301), K. Yamaki & J.-H. Pak 1018b (THS 40300), K. Yamaki & J.-H. Pak 1018c (THS 40299), H. Yamaji & K. Choi 8110 (TUS 255259). Kumi-shi: H. Yamaji, J.-Y. Yang & J.-S. Kim 8052 (TUS 255262), K. Yamaki & J.-H. Pak 1001c (THS 40331, 40332), K. Yamaki & J.-H. Pak 1001b (THS 40333, 40334), K. Yamaki & J.-H. Pak 1001a (THS 40335, 40336). **GYEONGSANGNAM-DO:** Namhae-gun: K. Yamaki & J.-H. Pak 1014a (THS 40303, 40304), K. Yamaki & J.-H. Pak 1014b (THS 40305, 40306), T. Shinkawa s. n., 2000 (TUS 337608–337610). Milyang-gun: K. Yamaki & J.-H. Pak 1012 (THS 40302). Daegu City: H. Yamaji, J.-Y. Yang & J.-S. Kim 8090 (TUS 252210), K. Yamaki & J.-H. Pak 1011 (THS 40317, 40318). **JEJU-DO:** Sogwip'o-shi: H. Yamaji & S.-W. Lee 8141 (TUS 254007, 337629, 337640).

There are two populations of *A. sieboldii* which are different in the number of cells in trichomes on inner surface of calyx.

Moreover, they are isolated geographically. The CVA in the previous study (Yamaji et al. 2007) indicates that two forms are recognized by different in average but continuous quantitative morphological characters. However discrimination of these forms in herbarium specimens is almost impossible. Hence we suspended the taxonomic treatment of two forms into single taxon as mentioned above.

Based on difference in chemical contents reported by Nagasawa (1961), Fujita (1966) distinguished *Asarum sieboldii* var. *cineoliferum* Fujita from the typical chemical race, but the name is not validly published.

3. ***Asarum dimidiatum*** F. Maek. in J. Jpn. Bot. **12**: 30 (1936) – Ohwi, Fl. Jap. ed. Engl. 399 (1965) – Ohwi & Kitag., New Fl. Jap. 601 (1983) – *Asiasarum dimidiatum* (F. Maek.) F. Maek. in Nakai, Fl. Sylv. Korea. **21**: 22 (1936) – Satake & Momiy. in Satake & al., Wild Flow. Jap. **2**: 104, pl. 101 (1982) – *Asarum sieboldii* Mig. var. *dimidiatum* (F. Maek.) T. Sugaw., Fl. Jap. **2a**: 372 (2006). TYPE: JAPAN. Kyushu, Nagasaki, Apr. 1933, F. C. Greatrex s. n. (holotype–TI !). [Fig. 3C]

Rhizome straight. Hibernaculum mainly at axil of distal foliage leaf. Leaves 2–10 cm long, 1.5–8 cm wide, acuminate at apex, sparsely pilose at only veins, variegated or non-variegated; petioles 3–10 cm long. Peduncle 1–5 cm. Calyx tube cylindroid or urceolate, 5–8 mm long, 8.5–12 mm in diameter, throat 5.5–9.0 mm in diameter, length 0.5–0.65 times long, throat 0.65–0.8 times in diameter to external diameter; outer surface purplish ivory or purplish olive green; inner surface dark purple, ivory white at base, pubescent with trichomes, ridges 15–24, 0.7–1.3 mm high. Calyx lobes patent, or oblique, undulate, transverse ovatus deltoid or pentangular, acute or acuminate at apex, 5.5–9 mm long, 6.5–10.5 mm wide; adaxial surface pubescent with trichomes, brownish

pale purple with small ivory spots or dark purple. Trichomes of calyx 80–140 µm long; cells 3–6 in number. Stamens 6 or variable 6–12 in two whorls; filaments 1.8–2.6 mm long; anther 9–17 mm long. Ovary 3 or 3–6-locular, greenish ivory to pale purple, 3.5–5.5 mm long, 4–6.5 mm wide before fertilization; styles 3 or 3–6, dark purple, 0.8–1.6 mm long.

Japanese name: Kurofune-saishin.

Distribution: Japan. Western Honshu (Nara, Hiroshima), Shikoku, and Kyushu (Fig. 2).

Habitat: On floor and at margin of deciduous, mixed, and coniferous forest. Flowers in late April to May.

Specimens examined. **JAPAN. HONSHU. Nara Pref.:** Gose-shi: H. Yamaji 9001 (TUS 284585). Hiroshima Pref.: Konan-shi: H. Yamaji 8009 (TUS 284588). **SHIKOKU. Kagawa Pref.:** Shodo-shima Is.: M. Togashi s. n., 13 May 1961 (TI), H. Yamaji s. n., 30 May 2003 (THS 73063, 73180, 73181, 73182). **Tokushima Pref.:** Mt. Marusasa-yama: T. Yamazaki s. n., 6 Jun. 1984 (TI). Mima-shi: K. Abe s. n., 1954 (TUS 284714, 284715), T. Kasai s. n., 1912 (MAK 140100), H. Yamaji 8002 (TUS 284582). Miyoshi-shi: M. Takahashi 1575 (TUS 89920), K. Abe s. n., 1959 (TUS 284709), K. Abe s. n., 1976 (TUS 284711). Naka-cho: K. Abe s. n., 1958 (TUS 284708). Yoshinogawa-shi: H. Yamaji 8001 (TUS 284583, 284581). **Kochi Pref.:** Niyodogawa-cho: K. Watanabe s. n., 25 May 1889 (TI), unknown collector s. n., 17 Apr. 1890 (TI). **Ehime Pref.:** Imabari-shi: T. Makino s. n., 1888 (MAK 140102). Kumakougen-cho: G. Murata & T. Shimizu s. n., 1959 (MAK 63078), K. Uemura 40 (MAK 140103), T. Okuhira s. n., 5 May 1895 (MAK 140104), M. Takahashi 2018 (TUS 114359), T. Sugawara 1073 (MAK 197239), M. Wakabayashi s. n., 1980 (MAK 180961, 180962, 180963, 180964, 180965). Matsuyama-shi: H. Yamaji 8004\* (TUS 284580), K. Yamaki 80 (THS 72649). Uchiko-cho: S. Yamamoto s. n., 1981 (TUS 284710). **KYUSHU. Fukuoka Pref.:** Soeda-machi: J. Ohuchi 117 (TI), T. Hashimoto s. n., 1960 (TUS 284717), T. Yamazaki s. n., 13 May 1959 (TI), H. Yamaji 6190\* (TUS 284586, 284584). Kikuchi-shi: Y. Koga 11683 (TI). **Kumamoto Pref.:** Takamori-machi: H. Yamaji 8005 (TUS 284587). Yatsushiro-shi: Y. Hamada s. n., 1979 (TUS 284716). **Ooita Pref.:** Beppu-shi: H. Yamaji 8007\* (TUS 284590). Taketa-shi: J. Endo & T. Nakamura s. n., 1980 (TUS 284718), K. Ito s. n., 1973



(MAK 325557, 325685). **Miyazaki Pref.:** Hinokage-cho: M. Amano 1002 (TI). Kitakawa-cho: H. Yamaji 8006 (TUS 284589, THS 72985). Shiiba-son: S. Hatusima & S. Sako 31509 (TI, MAK 204535). \*Voucher specimens used for CVAa (Yamaji et al. 2007).

The number of stamens and pistils are not stable in populations of southern Kyushu. In such populations, some individuals are similar to *A. sieboldii* in these characters. However, the distribution of such populations is not adjacent to that of *A. sieboldii* though that of typical populations of *A. dimidiatum* is adjacent to it (Nakamura et al. 1982).

4. **Asarum heterotropoides** F. Schmidt in Mém. Acad. Sci. St.-Petersb. Sci. Phys.-Math., sér. 7, **12** (2): 171 (1868) – H. Hara in Bot. Mag. Tokyo **48**: 889 (1934) – Ohwi, Fl. Jap. ed. Engl. 399 (1965) – Ohwi & Kitag., New Fl. Jap. 601 (1983) – Sugim., Keys Herb. P. Jap., ed. rev. **1**: 53 (1983) – *Asiasarum heterotropoides* (F. Schmidt.) F. Maek. in Nakai, Fl. Sylv. Korea. **21**: 19 (1936) – Satake & Momiy. in Satake & al. Wild Flow. Jap. **2**: 104, pl. 101 (1982) – *Asarum sieboldii* subsp. *heterotropoides* (F. Schmidt.) Kitam. in Acta Phytotax. Geobot. **20**: 207 (1962). LECTOTYPE (designated here): SAKHALIN. 1861, Glehn 760.01, with an inscription “Typus!” (LE–non vidi; microfiche in KYO !).

var. **heterotropoides** [Fig. 4A]

*Asarum sieboldii* var. *sachalinensis* Maxim. in in Mém. Biol. **8**: 399 (1872), in observ.; Bull. Acad. Imp. Sci. St.-Petersb. **17**: 164 (1871) – F. Maek. in Nakai, Fl. Sylv. Korea. **21**: 19 (1936), pro syn.

Rhizome straight. Hibernaculum mainly at axil of distal foliage leaf. Leaves 4–10 cm long, 3.5–10 cm wide, obtuse to acuminate at apex, sparsely pilose only on veins, non-variegated; petioles 6–15 cm long. Peduncle 1–6 cm. Calyx tube round-urceolate, 5–10 mm long, 10–15 mm in diameter, throat 4–

7.5 mm in diameter, length 0.45–0.75 times long, throat 0.4–0.5 times in diameter to external diameter; outer surface purplish brown, dark purple, or pale pink; inner surface dark purple or rarely ivory white at throat, ivory white to light purple at middle, dark purple belt proximally, ivory white at base, pubescent with trichomes, ridges 15–27, 0.6–1.7 mm high. Calyx lobes reflexed or patent, deltoid, acute or acuminate at apex, 3.5–9.0 mm long, 5.0–10.5 mm wide, adaxial surface pubescent with trichomes, dark purple or pale pink, dark purple or rarely ivory white at base. Trichomes of calyx 80–150 µm long; cells 3–7 in number. Stamens 12 in two whorls; filaments 2.2–3.7 mm long; anther 12–22 mm long. Ovary 6-locular, pale purple, 2.2–3.7 mm long, 5–8 mm wide before fertilized; styles 6, dark purple, 0.5–1.6 mm long.

Japanese name: Okuezo-saishin.

Distribution: Southern Sakhalin, the southern Kuriles and Japan (Hokkaido and northern Honshu).

Habitat: In floor and margin of deciduous, mixed, and coniferous forest. Flowers in late April to June.

Specimens examined. **SAKHALIN.** K. Kimura s. n., 22 Jul. 1932 (KYO), U. Faurie s. n., 1908 (KYO), U. Faurie s. n., Jun. 1908 (KYO), G. Koizumi s. n., 26 Jul. 1940 (KYO), M. Itsumi s. n., 19 Jul. 1945 (MAK 87972), K. Washimi s. n., Jun. 1931 (KYO), T. Naito s. n., 1931 (MAK 48138), K. Kimura s. n., 18 Jul. 1932 (KYO), A. Kimura s. n., 1 Jun. 1927 (TUS 188196).

**KURILE ISL.** Kunashiri Is.: unknown collector s. n., 1935 (KYO), G. Murata s. n., 1931 (KYO). Shikotan Is.: S. Tono s. n., 15 Jun. 1933 (TI).

**JAPAN. HOKKAIDO.** *Soya Subpref.:* Hamaton-betsu-cho: H. Yamaji 6301\* (TUS 233266, TUS 233267). *Abashiri Subpref.:* Kitami-shi: H. Yamaji 6302\* (TUS 233297). Kiyosato-cho: H. Yamaji 6303\* (TUS 284571). Shari-cho: J. Ohwi s. n., 4 Jul. 1934 (KYO), K. Takita 1638 (KYO), S. Kobayashi s. n., 31 Jul. 1967 (MAK 128335). Tsubetsu-cho: T. Matsumoto s. n., 31 May 1970 (MAK 98935). *Kamikawa Subpref.:* Asahikawa-shi: H. Koidzumi s. n., May 1912 (TI), G. Murata & T. Yahara 37765 (KYO), H. Yamaji 6299\* (TUS 233264, 233265). Furano-shi: H. Yamaji 7126 (TUS 284563, 284870,

284871, THS 73002). Kamikawa-cho: H. Yamaji 7127 (TUS 284560). Minamifurano-cho: H. Yamaji 7124 (TUS 284574), H. Yamaji 7125 (TUS 284559, 284562), H. Nakamura s. n., 1994 (MAK 318798). Nakagawa-cho: G. Murata, H. Koyama & T. Yahara s. n., 23 Jun. 1978 (KYO). Nayoro-shi: H. Yamaji 6300\* (TUS 233249, 233291). **Sorachi Subpref.**: Bibai-shi: S. Saito 1046 (TI). Fukagawa-shi: Y. Aida s. n., 16 May 1987 (KYO). Furano-shi: T. Fukuhara 253 (KYO). Horokanai-cho: G. Murata, H. Koyama & T. Yahara 37814, 37841 (KYO), K. Yonekura & E. Hayasaka 96406 (TUS 180575). Kuriyama-cho: H. Yamaji 7119\* (TUS 284573), H. Yamaji 6304\* (TUS 337634). Uryu-cho: G. Murata, H. Koyama & T. Yahara 38609 (KYO). Yubari-shi: N. Satomi 24648 (KYO). **Teshio Subpref.**: Mts. Mashike: H. Hara & S. Kurosawa s. n., 12 Jun. 1976 (TI). **Nemuro Subpref.**: Mt. Rausu-dake: S. Okamoto s. n., 24 Aug. 1958 (KYO), J. Endo & T. Nakamura s. n., 1976 (TUS 284720). **Ishikari Subpref.**: Ishikari-shi: J. Murata & T. Sato 21308 (TUS 125157). Sapporo-shi: K. Miyabe s. n., 2 Jun. 1892 (TI), unknown collector s. n., 1885 (MAK 34448), J. Murata & T. Sato 21342D (TI), M. Mizushima s. n., 23 May 1943 (TI). Tobetsu-cho: H. Yamaji 6298 (TUS 233262). **Hiyama Subpref.**: Esashi-cho: K. Deguchi 4626 (KYO). **Tokachi Subpref.**: Hiroo-cho: H. Yamaji 7134 (TUS 284882). Makubetsu-cho: H. Yamaji 7133\* (TUS 284872). Memuro-cho: H. Yamaji 7128 (TUS 284875, THS 73003). Nakasatsunai-mura: H. Yamaji 6309\* (TUS 233260). Obihiro-shi: H. Yamaji 7130 (TUS 284874), H. Yamaji 7129 (TUS 284876). **Hidaka Subpref.**: Biratori-cho: H. Yamaji 7121 (TUS 284868), H. Yamaji 7122\* (TUS 284881). Erimo-cho: H. Yamaji 7135\* (TUS 284569, 284883), Y. Tateishi 1969 (TI). Hidaka-cho: G. Murata & T. Yahara 37586 (KYO), H. Yamaji 6308\* (TUS 233256), H. Yamaji 6307 (TUS 233299), H. Yamaji 7123 (TUS 284567). Niikappu-cho: H. Yamaji 6280\* (TUS 233258). Samani-cho: H. Yamaji 4062\* (TUS 337622), H. Hara 3526 s. n., 24 May 1933 (TI), H. Yamaji 4142\* (TUS 337623), H. Yamaji 7104 (TUS 337624), H. Yamaji 7105 (TUS 337641), H. Yamaji 4169\* (TUS 337626), H. Yamaji 4155\* (TUS 337625), H. Yamaji 4111 (TUS 337621). Shin-hidaka-cho: H. Yamaji 7114 (TUS 284575), H. Yamaji 6291\* (TUS 233296), H. Yamaji 7113 (TUS 284577), H. Yamaji 7115 (TUS 284866, 284885, THS 73005). Urakawa-cho: H. Yamaji 7107 (TUS 284877), H. Yamaji 7109 (TUS 284880), H. Yamaji 7106 (TUS 284886), H. Yamaji 7111 (TUS 284887, THS 73004), H. Yamaji 7112 (TUS 284865), H. Yamaji 7138 (TUS 284566), H. Yamaji 7110 (TUS 284888). **Iburi Subpref.**: Kimobetsu-cho: H. Yamaji 7117 (TUS 284572). Mukawa-cho: H. Yamaji 6305 (TUS

233261), H. Yamaji 7120 (TUS 284869). Muroran-shi: M. Hara s. n., 1980 (KYO). Noboribetsu-shi: H. Yamaji 7118 (TUS 284867). Toyako-cho: H. Yamaji 7116 (TUS 284873). **Shiribeshi Subpref.**: Otaru-shi: T. Nakamura s. n., 1977 (TUS 284719), H. Yamaji 6297\* (TUS 233248), H. Yamaji 6297 (TUS 233248), H. Yamaji 7103 (TUS 284579). Rankoshi-cho: H. Koyama & N. Fukuoka 3087 (KYO). Shimamaki-mura: H. Takahashi, S. Uematsu, E. Kushibiki & Y. Kikuzawa 9153 (TUS 200407), H. Yamaji 7102 (TUS 284565). **Oshima Subpref.**: Hakodate-shi: M. Togashi s. n., 16 Jun. 1969 (TI), M. Kurosawa s. n., 12 May 1970 (KYO), H. Yamaji 6293\* (TUS 233263), H. Yamaji 7101 (TUS 284564), H. Yamaji 7100 (TUS 284570). Shiriuchi-cho: A. Kudo s. n., 20 May 1908 (MAK 140065). **HONSHU. Aomori Pref.**: Aomori-shi: Y. Takeuchi s. n., 3 May 1969 (TUS 15239), F. K. s. n. (TI), K. Hosoi s. n., 22 Jun. 1932 (MAK 2441), Suem s. n., 1913 (TI), U. Mizushima 10597 (TI), T. Yamazaki, H. Ohba, Y. Kadota & J. Murata s. n., 7 Jul. 1975 (KYO), S. Sugaya & C. Kimura s. n., 8 Jul. 1965 (TUS 28329), A. Kimura & S. Sugaya s. n., 1 Jul. 1953 (TUS 28320–28325, 28328), K. Hasegawa s. n., 1964 (TI), A. Kimura & S. Sugaya & C. Kimura s. n., 3 Jul. 1952 (TUS 28326, 28327), M. Suzuki, K. Yonekura & T. Azuma 94005 (TUS 182919), H. Yamaji s. n., 7 Jul. 1998 (THS 72158–72162). Fukaura-machi: H. Ohba, Y. Tateishi, Y. Kadota & J. Murata s. n., 12 Jul. 1975 (KYO). Hirosaki-shi: H. Yamaji 6160\* (TUS 284891 (TUS 233247, 284890), T. Sugawara 1005 (MAK 197242), T. Sugawara s. n., 3 Jun. 1978 (MAK 173340). Mutsu-shi: H. Yamaji 7022 (TUS 284578, 284889), H. Yamaji 7023\* (TUS 284576). Noheji-machi: H. Yamaji 6150\* (TUS 284568, 284892). Towada-shi: K. Yonekura 92439 (TUS 155067). **Akita Pref.**: Mt. Taihei-zan: unknown collector s. n., 29 May 1940 (TI), G. Furuie s. n., 1940 (TI). Akita-shi: J. Endo & T. Nakamura s. n., 1976 (TUS 284751), H. Yamaji 6170\* (TUS 284894). Nikaho-shi: M. Takenouchi (MAK 287121). Senboku-shi: M. Mizushima s. n., 1960 (MAK 334133). **Iwate Pref.**: Kitakami-shi: H. Yasumoto s. n., 19 Jul. 1962 (MAK 34442). Nishiwaga-machi: H. Yasumoto s. n., 20 Jul. 1962 (MAK 34443). Oushu-shi: H. Yasumoto s. n., 7 Aug. 1957 (MAK 2440). **Miyagi Pref.**: Kurihara-shi: K. Sugawara s. n., 7 Jul. 1966 (TUS 28330–28332), H. Yamaji 6120\* (TUS 284893). \*Voucher specimens used for CVAs (Yamaji et al. 2007).

This species shows larger morphological variation than other species of sect. *Asiasarum*. In color of calyx tube on abaxial surface, populations in Tohoku district, Honshu, are mostly pink to pale purple,



# Holotype

Herbarium Tohoku Universitatis Sendaiensis

ARISTOLOCIACEAE

*Asarum tohokuense* Yamaji & Ter. Nakam.

トウヨクササシ

Note: inner surface of calyx tube is ivory, the throat is dark purple, outside is purplish ivory.

Loc.: JAPAN, Honshu, Miyagi Pref., Sendai-shi, Aoba-ku, Aobadai, Kagitōri (宮城県前市青葉区青葉台角取)

Coll.: Hiroko Yamaji (山脇弘樹). Date: 1 May 2005.



Fig. 6. Type specimen of *Asarum tohokuense* Yamaji & Ter. Nakam.

while specimens from Hokkaido are mostly pale purple to dark purple. Populations in Tohoku district, Honshu and Hidaka district, Hokkaido sometimes have patent and acuminate calyx lobes. Nevertheless, these are difficult to discriminate clearly (Yamaji et al. 2006), so we suspend the taxonomic subdivision and treated them into a single taxon.

f. **viridis** (Sugaya) Yamaji & Ter. Nakam., comb. nov.

*Asiasarum heterotropoides* (F. Schmidt) F. Maek. f. *viridis* Sugaya in Ecol. Rev. **14**: 52 (1955). TYPE: JAPAN. Honshu, Aomori. Mt. Hakkoda, prope Sukayu, 1 Jul. 1953, A. Kimura & S. Sugaya (TUS 28317).

Japanese name: Moegi-okuezo-saishin.

This form is described for plants with yellowish green flowers.

**5. *Asarum tohokuense*** Yamaji & Ter. Nakam., sp. nov. [Figs. 4B, 6]

Haec species *Asaro sieboldio* et *A. dimidiato*, interior pagina calycis tobo eburneo vel pallido, ab *A. heterotropoido* fauces calycis quam diametro tubo calycis fere dimidio lata differt.

TYPE: JAPAN. Honshu, Miyagi Pref., Sendai-shi, Aoba-ku, Aobadai, Kagitori, 1 May 2005, H. Yamaji s. n. (holotype-TUS 337647, Fig. 6; isotype-TI, THS).

Rhizome straight. Hibernaculum mainly at axil of distal foliage leaf. Leaves 5–13 cm long, 3–13 cm wide, acuminate at apex, sparsely pilose at only veins, non-variegated; petioles 3–16 cm long. Peduncle 1–4 cm. Calyx tube round urceolate, 6.5–10.5 mm long, 10–15 mm in diameter, throat 5.5–11 mm in diameter, length 0.55–0.85 times long, throat 0.55–0.75 times in diameter to external diameter; outer surface ivory to pale purple sometimes with purple small spots; inner surface dark purple at throat, ivory white to ivory, sometimes light purple at middle, dark purple belt proximally, ivory

white at base, pubescent with trichomes, ridges 15–21, 0.4–1.0 mm high. Calyx lobes obliquely erect, undulate, transverse ovatus deltoid, acuminate at apex, 5.0–9.5 mm long, 7.0–12.0 mm wide, adaxial surface pubescent with trichomes, ivory to pale purple, purple or dark purple at base. Trichomes of calyx 60–120  $\mu\text{m}$  long; cells 3–4 in number. Stamens 12 in two whorls; filaments 2.2–3.2 mm long; anther 10–16 mm long. Ovary 6-locular, greenish ivory to pale purple, 5–8 mm long, 6–8 mm wide before fertilized; styles 6, dark purple, 0.4–1.0 mm long.

Japanese name: Tôgoku-saishin.

Distribution: Japan. Honshu (Tohoku, northern Chubu, eastern Kanto and Sadogashima Is.; Fig. 2).

Habitat: On floor and at margin of deciduous, mixed, and coniferous forest. Flowers in April to May.

Specimens examined. **JAPAN. HONSHU. Aomori Pref.**: Aomori-shi: Y. Takeuchi s. n., 2 May 1960 (TUS 2899), Y. Takeuchi s. n., 3 May 1969 (TUS 15238). Hiranai-machi: Y. Takeuchi s. n., 1968 (TUS 3248). Hirosaki-shi: H. Yamaji 6165 (TUS 284621, 233289), H. Yamaji 7021 (TUS 284622, 284625), T. Kurosawa, Y. Iokawa, K. Yonekura, & T. Azuma 4572 (TUS 188514). Noheji-machi: H. Yamaji 6155 (TUS 284617, 284864), H. Yamaji 7025 (TUS 284646), H. Yamaji 7024 (TUS 284641), A. Kudo 20 (MAK 140068). **Akita Pref.**: Mt. Chokai-san: T. Kaneko s. n., 13 Apr. 1960 (TUS 28363). Akita-shi: H. Yamaji 6175\* (TUS 284623, 233290), H. Hoshi & T. Ohmiya 3028 (TUS 150368). Kita-akita-shi: H. Muramatsu s. n., 4 May 1931 (TI). Noshiro-shi: T. Nakajima s. n., 1914 (TI). Oga-shi: R. Fujii 20 (TI), R. Fujii in s. n. 21 Apr. 1956 (TI). Oodate-shi: T. Sugawara s. n., 16 Apr. 1979 (MAK 173377). Yokote-shi: Y. Horii 1789 (KYO). Yurihonjo-shi: H. Yamaji 6180 (TUS 284624, 284629), Y. Horii 1734 (KYO). Yuzawa-shi: M. Takahashi 317 (TUS 75007), Y. Satake s. n., Apr. 1938 (TI). **Iwate Pref.**: Hachimantai-shi: H. Yamaji 6145 (TUS 284627). Iwate-gun: K. Toba s. n., 26 May 1929 (TI). Kamaishi-shi: S. Sasamura s. n., 5 May 1936 (TI). Morioka-shi: H. Yamaji 6140 (TUS 284620, 284626), K. Toba s. n., 12 May 1933 (TI). Nishiwaga-machi: H. Yamaji 6135 (TUS 284619). Ofunato-shi: H. Yamaji 6065\* (TUS 284618, 284628), G. Toba s. n., 17 May 1903 (MAK 140070). Oushu-shi: unknown collector s. n., 1933 (MAK 24927). Tono-shi: O. Sano

- 18 (MAK 140069), S. Sasamura s. n., 25 May 1928 (TI). **Miyagi Pref.:** Mt. Mitumine: H. S. Ogura 472 (TUS 68897). Ishinomaki-shi: J. Iketsu & Y. Sasaki 1627 (TUS 140304), H. Tahara s. n., 30 Apr. 1906 (MAK 140075), Y. Tateishi, T. Kajita & H. Kobayashi 14300 (TUS 141156). Iwanuma-shi: T. Koga & Y. Tateishi 11 (TUS 152603). Kakuda-shi: Y. Tateishi, T. Nemoto & T. Ohmiya 10318 (TUS 133180), K. Sohma 3440 (TUS 111156), T. Mori 7873 (TUS 171443), T. Mori 7422 (TUS 171444). Kami-machi: H. Ohashi, T. Naito & T. Wakasugi 11774 (TUS 110846). Kawasaki-machi: T. Azuma & S. Toyoda 313 (TUS 171749), H. Yamaji 6075 (TUS 284616), T. Azuma & K. Yonekura 104 (TUS 159364), T. Azuma, T. Kurosawa & K. Yonekura 199 (TUS 173847). Kurihara-shi: S. Korenaga, K. Kondo, K. Sakamoto, H. Sagara, K. Suzuki & K. Takaki 401 (TUS 188452), T. Takahashi s. n., 29 Apr. 1977 (TUS 134457), H. Yamaji 6115 (TUS 284630), H. Yamaji 6125 (TUS 284615), H. Yamaji 6130 (TUS 284631–284632). Marumori-machi: T. Mori 4130 (TUS 171445), K. Akiyama, R. Onodera, T. Katahira, H. Kimura, H. Goto, J. Seo, M. Naruse, A. Murakami & I. Yoshimoto 821 (TUS 179232), H. Ohashi, T. Mori, T. Kurosawa, A. Yokota, H. Kobayashi & T. Nishinosono 50035 (TUS 150246). Minamisanriku-cho: S. Sugaya, T. Fujita & E. Nakagawa s. n., 9 May 1955 (TUS 28346). Murata-machi: C. Kimura, T. Fujita & H. Sakai s. n., 5 May 1984 (TUS 100632), S. Ogawa & H. Sakai 49 (TUS 100152). Natori-shi: H. Ohashi, Y. Tateishi, S. Ogawa, Y. Endo, H. Hoshi, B. H. Choi & T. Ohmiya 11304 (TUS 104788), Y. Tateishi, K. Goshima & H. Sakai 10185 (TUS 91327), Y. Tateishi, S. Ogawa, B. H. Choi, Y. Endo, T. Nemoto & Y. Sato 10109 (TUS 105852). Sendai-shi: T. Kyogoku s. n., 24 Apr. 1961 (TUS 28345), K. Yonekura 142 (TUS 169756), T. Fujita, B. Otsuji s. n., 30 Apr. 1955 (TUS 28350, TUS 28353), K. Yonekura 323 (TUS 156483), A. Kimura s. n., 21 May 1932 (TUS 28352), A. Takehara 45 (TUS 137258), K. Yonekura 93190 (TUS 188512), N. Kurosaki s. n., 12 May 1979 (KYO), T. Hoshino, Y. Tateishi, T. Kajita & K. Yonekura 50 (TUS 181304), H. Ohashi s. n., 7 Jun. 1959 (TUS 28356), E. Iishi s. n., 1904 (MAK 140077), M. Takahashi, H. Takahashi & K. Nakamura s. n., 22 Apr. 1977 (KYO), H. Ohashi s. n., 3 May 1959 (TUS 28355, 28357), A. Kimura s. n., 29 Apr. 1929 (TUS 28362), H. Ohashi & T. Yasumura 3390 (TI), H. Ohashi 3391 (KYO), R. Endo s. n., 26 Apr. 1914 (TUS 28361), Y. Ueno 36872 (TUS 182863), K. Yonekura 92200 (TUS 156316), C. Kimura s. n., 6 May 1975 (TUS 41051), Y. Aiba & T. Maruyama s. n., 9 May 1978 (TUS 51482), K. Suzuki 248 (TUS 58821, 152855), H. Sakai & Y. Endo s. n., 22 Apr. 1983 (TUS 84889), H. Ohashi & T. Yasumura s. n., 24 May 1959 (TUS 28351). Shiroishi-shi: H. Ogura s. n., 3 May 1958 (TUS 28347–28349, 28364), Y. Ueno s. n., 24 May 1981 (TUS 67512), E. Murakami s. n., 19 Apr. 1981 (TUS 67511). Taiwacho: H. Hoshi & T. Kajita 2323 (TUS 188451). Tomiya-machi: A. Yokota 89 (TUS 188453), A. Yokota 216 (TUS 188509), A. Yokota 217 (TUS 188510). Zao-machi: H. Yamaji 6070 (TUS 233292). **Yamagata Pref.:** F. Maekawa & H. Hara 76-A257 (TI). Iide-machi: H. Yamaji 6080 (TUS 233294). Kaminoyama-shi: J. Endo & T. Nakamura s. n., 1975 (TUS 284729), E. Hayasaka, R. Hirano, K. Mitara, H. Motose, T. Nagaki, Y. Narukawa, R. Toyoda & H. Yajima 262 (TUS 188513), K. Saito, Y. Saito, K. Shudo, A. Suto, T. Suzuki, T. Takahashi, K. Tanaka & M. Tsutsumi 133 (TUS 188515, 188516). Mogami-machi: H. Yamaji 6110 (TUS 233257, 284634). Murayama-shi: G. Kato 252 (MAK 140076), M. Kato 273 (MAK 140074), M. Takahashi, H. Takahashi & K. Nakamura s. n., 4 May 1977 (TUS 63380), K. Sohma, M. Takahashi, H. Takahashi, M. Sato & K. Natanura s. n., 4 May 1977 (KYO, MAK 165936). Nishikawa-machi: S. Tsugaru & T. Takahashi 6639, 6657 (KYO), S. Tsugaru & T. Takahashi 6580 (KYO), H. Yamaji 6078\* (TUS 233243). Oe-machi: M. Mizushima s. n., 1959 (MAK 339264, 339265). Oguni-machi: H. Yamaji 6085 (TUS 233287, 284633), M. Wakabayashi s. n., 20 May 1979 (TUS 180723, MAK 173611), M. Ito 454 (KYO). Sakata-shi: I. Sato s. n., 1907 (MAK 238405). Shonai-machi: H. Yamaji 6105 (TUS 233244, 284636). Tsuruoka-shi: K. Mori s. n., 1937 (MAK 28794), J. Endo & T. Nakamura s. n., 1976 (TUS 284727–284728), S. Kobayashi s. n., 2 May 1968 (MAK 247642), H. Yamaji 6100\* (TUS 233295, TUS 284613), S. Tsugaru & T. Takahashi 6827 (KYO), S. Tsugaru & T. Takahashi 6828 (KYO), N. Kurosaki 10278 (KYO), T. Nagasawa 21 (MAK 140071), Tsuruoka girl's Highschool 774 (MAK 140072), unknown collector s. n., 1914 (MAK 140073). Yamagata-shi: N. Doi s. n., 12 Apr. 1934 (TI), N. Kurosaki 10312 (KYO). Yonezawa-shi: K. Deguchi, K. Ozaki & T. Yamaguchi 3501 (KYO), E. Kinoshita s. n., 9 Jun. 1979 (KYO). **Fukushima Pref.:** Y. Kurosawa s. n., 17 May 1958 (TI), Y. Nakahara s. n., 13 Jun. 1904 (TI). Mt. Azuma-san: H. Kanai s. n., 9 Jun. 1957 (TI). Fukushima-shi: H. Yamaji 6060\* (TUS 284614), unknown collector s. n., 20 May 1905 (MAK 140081), K. Tamura (KYO), K. Nemoto s. n., 1894 (MAK 140078), J. Endo & T. Nakamura s. n., 1976 (TUS 284732–284733), unknown collector s. n., 17 May 1904 (MAK 140080). Iwaki-shi: T. Nemoto 186 (TUS 59684), S. Kurosawa s. n., 23 May 1957 (TI), J. Endo & T. Nakamura s. n., 1976 (TUS 284726), T. Nemoto 114 (TUS 70377), J. Iketsu & K.

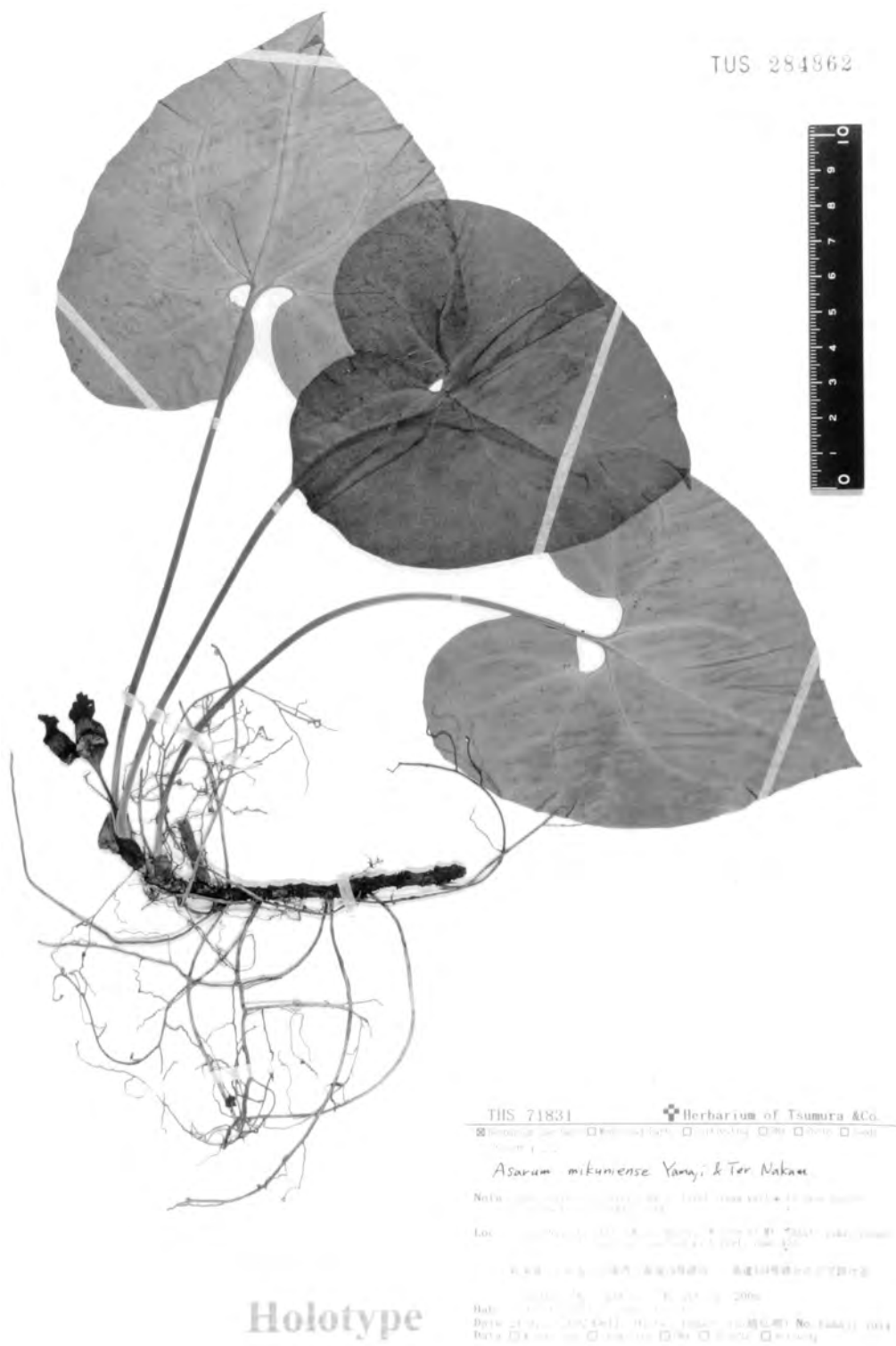


Fig. 7. Type specimen of *Asarum mikuniense* Yamaji & Ter. Nakam.

Iketsu 1393 (TUS 127943), T. Kurosawa, J. Iketsu & K. Yonekura 4344 (TUS 188511). Kitashiobara-mura: unknown collector s. n., 16 May 1905 (MAK 140082). Kori-machi: H. Yamaji 6061 (TUS 284635). Koriyama-shi: Y. Tamaki s. n., 1909 (MAK 140079), H. Ohashi, T. Kajita, B. Ye & K. Yonekura 28346 (TUS 182921). Minamiaidu-machi: Y. Utagawa s. n., 1977 (MAK 324763). Minamisohma-shi: K. Yonekura 95297 (TUS 181150), K. Yonekura 93125 (TUS 188508). Namie-machi: H. Yamaji 7020 (TUS 284637, THS 72997). Naraha-machi: T. Nemoto 2945 (TUS 122887). Nihonmatsu-shi: G. Takahashi s. n., 28 Apr. 1938 (TI). Nishigo-mura: G. Murata, J. Noguchi, M. N. Tamura, T. Fukuhara & H. Shibaike 68852 (KYO), Y. Satoh s. n., 14 May 1971 (TUS 70548), H. Kanai s. n., 24 May 1957 (TI). Ookuma-machi: H. Yamaji 7019 (TUS 284640). Shirakawa-shi: N. Imai 24 (MAK 140083). Sohma-shi: Y. Ueno 29358 (TUS 72885), J. Iketsu, H. Iketani & T. Kajita 1478 (TUS 144508). Tamura-shi: H. Yamaji 7016 (TUS 284648, 72999–73001), M. Endo s. n., 9 May 1936 (KYO). **Tochigi Pref.:** Mashiko-machi: H. Yamaji 7017\* (TUS 284645, 284647, 72995, 72998). **Ibaraki Pref.:** Mt. Tsukuba-san: H. Muramatsu s. n., 5 Jun. 1928 (TI), Honda s. n., 4 May 1924 (TI), J. Sugimoto s. n., 6 May 1928 (KYO), M. Honda s. n., 2 May 1926 (TI), T. Makino s. n., 1920 (KYO), T. Makino s. n., May 1897 (MAK 171905), J. Endo & T. Nakamura s. n. (TUS 284731), T. Makino s. n., May 1897 (MAK 171905), F. Maekawa 7833 (TI), T. Makino s. n., 1920 (TI), T. Makino s. n., 27 May 1900 (MAK 140088). **Tokyo Pref.:** Hachioji-shi: T. Makino s. n. (TUS 284722). **Niigata Pref.:** Arakawa-machi: T. & Y. 6677 (TI). Asahi-mura: S. Kobayashi s. n., 2 May 1968 (MAK 247646). Itoigawa-shi: H. Yamaji 7008\* (TUS 284644, 284682, 71844, 72163), H. Yamaji s. n., 3 May 2002 (THS 71846). Kamihayashi-mura: H. Yamaji 6090 (TUS 284642, 72164). Murakami-shi: M. Togashi s. n., 7 May 1943 (TI), S. Kobayashi s. n., 30 Apr. 1968 (MAK 247604), H. Yamaji 6095 (TUS 233242). Niigata-shi: N. Kurosaki 13019 (TUS 87704). Sado-shi: Y. Ikegami s. n., 24 May 1936 (TI). Sanpoku-machi: S. Iwano 18656 (TUS 185342). Shibata-shi: M. Wakabayashi s. n., 1979 (MAK 173612). Yuzawa-machi: S. Iwano 16793 (TUS 185336). **Nagano Pref.:** Otari-mura: H. Yamaji 6045\* (TUS 233293), H. Yamaji 7009 (TUS 284639), J. Endo & T. Nakamura s. n., 1975 (TUS 284730), H. Yamaji s. n., 3 May 2002 (THS 71901). \*Voucher specimens used for CVAs (Yamaji et al. 2007).

6. **Asarum mikuniense** Yamaji & Ter. Nakam., sp. nov. [Figs. 4C, 7]

Haec species *Asaro heterotropoido* valde affinis est, sed lobis calysis grandibus, pentagonis ovatis, patentibus ad obliquis erectis, acuminatis ad apicem differt.

TYPE: JAPAN. Honshu, Niigata Pref., Minamiuonuma-gun (currently Minamiuonuma-shi), Muika-machi, Sakashita, 21 Apr. 2002, H. Yamaji s. n. (holotype–TUS 284862, Fig. 7; isotype–TI, THS).

Rhizome straight. Hibernaculum mainly at axil of distal foliage leaf. Leaves 5–12 cm long, 4–10 cm wide, acuminate at apex, sparsely pilose at only veins, non-variegated; petioles 7–16 cm long. Peduncle 1–2 cm. Calyx tube round urceolate, 6.5–10 mm long, 11–14 mm in diameter, throat 5–8 mm in diameter, length 0.45–0.8 times long, throat 0.4–0.55 times in diameter to external diameter; outer surface olive green to purple; inner surface dark purple at throat, ivory or light purple at middle, dark purple belt proximally, ivory white at base, pubescent with trichomes, ridges 17–21, 0.6–1.2 mm high. Calyx lobes patent or oblique, undulate, pentangular, acuminate at apex, 7–11 mm long, 8–11 mm wide, adaxial surface pubescent with trichomes, olive green to purple, dark purple at base. Trichomes of calyx 120–180 µm long; cells 5–7 in number. Stamens 12 in two whorls; filaments 2.7–3.2 mm long; anther 12–14 mm long. Ovary 6-locular, greenish ivory to pale purple, 4–5.5 mm long, 6–8 mm wide before fertilized; styles 6, dark purple, 0.6–1.5 mm long.

Japanese name: Mikuni-saishin.

Distribution: Japan. Central Honshu (north ridge of Gunma, Tochigi, Nagano and south ridge of Niigata Prefs.; Fig. 2).

Habitat: On floor and at margin of deciduous, and mixed forest. Flowers in late April to June.

Specimens examined. JAPAN. HONSHU. Gunma Pref.: Katashina-mura: J. Endo & T. Nakamura s. n., 1983 (TUS 284721). Minakami-machi: J. Endo & T.

Nakamura s. n., 1976 (TUS 284723), H. Kanai 3448 (TI), H. Kanai s. n., 8 Jun. 1951 (TI), H. Yamaji 6255 (TUS 233250, 284860, 337633). **Niigata Pref.:** Minamiuonuma-shi: H. Yamaji 7014\* (TUS 284857, 284862, 71829, 71830). Myoko-shi: J. Endo & T. Nakamura s. n., 1976 (TUS 284724), H. Yamaji 6234\* (TUS 233252). Uonuma-shi: H. Yamaji 9003 (TUS 284858, 284861, 71794). **Nagano Pref.:** Iiyama-shi: H. Yamaji 6241 (TUS 233252). Sakae-mura: H. Yamaji 6220\* (TUS 284855), M. Mizushima s. n., 28 Jun. 1956 (MAK 2444), Nakano-shi: H. Yamaji s. n., 3 May 2002 (THS 71867). \*Voucher specimens used for CVAs (Yamaji et al. 2007).

This species is distributed mainly at higher altitudes of the Echigo Mountains. However, populations in south ridge of Niigata Pref. are in comparatively low altitude. This species is sometimes difficult to distinguish from *A. heterotropoides* var. *heterotropoides*. The first diagnostic point between them is its size of calyx lobes.

7. ***Asarum misandrum*** B. Oh & J. Kim in Kor. J. Plant Taxon. **27:** 493 (1997) – *Asarum sieboldii* var. *mandshuricum* f. *misandrum* (B. Oh & J. Kim) Y. Lee in Bull. Kore. Pl. Res. **1:** 17 (2000). TYPE: KOREA. Chollanam-do, Wando-gun, Wando-up, Mangsok-ri, 5 May 1995, B. Oh & J. Kim 95001 (holotype–CBU !; isotype–CBU !).

[Fig. 4D]

*Asarum heterotropoides* var. *mandshuricum* auct. non Maxim.: Hatus. in J. Phytogeogr. & Taxon. **41:** 69 (1993).

Rhizome zigzag or straight. Hibernaculum mainly at axil of cataphylls. Leaves 6–7 cm long, 6–9 cm wide, obtuse to acute at apex, glabrous, non-variegated; petioles 13–20 cm long. Peduncle 4–7.5 cm. Calyx tube transverse round urceolate, 5–8 mm long, 11.5–16 mm in diameter, throat 7.5–11 mm in diameter, length 0.45–0.5 times long, throat 0.6–0.7 times in diameter to external diameter; outer surface ivory, salmon pink, or light purple; inner surface ivory white, ivory or light pink at middle part and throat, dark purple belt proximally, ivory white at base,

pubescent with trichomes, ridges 19–27, 1.0–1.5 mm high. Calyx lobes reflexed, nearly appressed to calyx tube, deltoid, acute at apex, 4.0–7.5 mm long, 9.5–11 mm wide, adaxial surface pubescent with trichomes, salmon pink to pale purple, ivory white to ivory at base. Trichomes of calyx 70–100  $\mu$ m long; cells 3–4 in number. Stamens 12 in two whorls; filaments 2.5–2.6 mm long; anther 12–14 mm long. Ovary 6-locular, greenish ivory to pale pink, 4.5–5.5 mm long, 7–8 mm wide before fertilized; styles 6, ivory, 1.0–1.7 mm long.

Japanese name: Aso-saishin (nom. nov.).

Distribution: Japan. Kyushu (found only on the foot of Mt. Kura-take and Mt. Tsûmushi-yama, Kumamoto Pref., the Aso Mountains; Fig. 2). Korea: Chollanam-do, Teju-do (Oh et al. 1997).

Habitat. In open grassland and at margin of forests. Flowers in late April to May.

Specimens examined. **JAPAN. KYUSHU. Kumamoto Pref.:** Aso-shi: H. Yamaji 6200\* (TUS 233288), T. Hamada s. n., 17 May 1994 (TUS 218539, TUS 218540), H. Yamaji 6215\* (TUS 233245). Kikuchi-shi: T. Nakamura s. n., 1980 (TUS 284734). \*Voucher specimens used for CVAs (Yamaji et al. 2007).

**KOREA. JEJU-DO:** J. Pak s. n., Apr. 2006 (TUS 337645).

As mentioned above, the population of this species in Japan have hitherto been recognized as *A. heterotropoides* var. *mandshuricum*, a taxon mainly distributed in Korea, Northeastern China and Far East Russia (Hatusima 1993, Azegami 1996). However, *A. heterotropoides* var. *mandshuricum* is clearly distinct from the populations in comparatively large, pentangular, gently recurved or patent calyx lobes, comparatively dark purple calyx tube and calyx lobes, and having pilose petioles and the abaxial surface of laminae. On the other hand, a recently described species from southern Korea, *A. misandrum* (Oh et al. 1997), is similar to the population in having strongly recurved and triangular calyx lobes



and glabrous petioles. We concluded that population in the Aso Mountain, Kyushu, is identified as *A. misandrum*.

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日本国内のカンアオイ属ウスバサイシン節植物には今まで4分類群が知られていたが、本研究はイズモサイシン *Asarum maruyamae*, トウゴクサイシン *A. tohokuense*, ミクニサイシン *A. mikuniense* の3新種を含む7種が分布することを明らかにした。今までの同節の分類体系の多くは葉や萼裂片の形状、雄蕊・雌蕊の数を重視しているが、本研究では種の識別点として、より明瞭な萼筒内壁のカラーパターン、萼筒形状、萼筒開口部の幅、萼裂片の形態、萼筒内壁の隆起の数、高さを採用した。

7種はほぼ異所的に分布し、ウスバサイシン *A.*

Yamaki K., Terabayashi S., Okada M. and Pak J.-H. 1996. A new species and new variety of *Asiasarum* (Aristolochiaceae) from Korea. *J. Jpn. Bot.* **71**: 1–10.

*sieboldii* は本州中西部、中国中南部および朝鮮半島に、アソサイシン (新称) *A. misandrum* は九州・阿蘇山地および韓国南部に、オクエゾサイシン *A. heterotropoides* var. *heterotropoides* はサハリン南部・千島列島・北海道・東北北部に、トウゴクサイシンは関東北部、東北一円に、ミクニサイシンは関東北部に、イズモサイシンは中国地方に、クロフネサイシン *A. dimidiatum* は本州西部、四国、九州に分布する。

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## APPENDIX.

Representative specimens examined belonging to the taxa distributed outside Japan.

1. *Asarum heterotropoides* F. Schmidt var. *mandshuricum* (Maxim.) Kitag.

Manshuria austro-orientali: River Ussuri, River Sungali, C. J. Maximowicz, 7–19 May 1860 (LE–syntype), Ussuri, fl. prop Sungatsche, 7–19 May 1860 (LE–syntype), C. J. Maximowicz, 7 May 1860, with description “Typus” (LE–syntype), three collections were mounted together, Lifudin, C. J. Maximowicz, 21 May 1860, Lifudin, C. J. Maximowicz, 26 May 1860, Nautu, C. J. Maximowicz, 17 May 1860 (LE–syntype).

**CHINA. JILIN:** Huadian-shi: H. Yamaji 2004. 5/25-1-3 (THS 75348–75349), H. Yamaji 2004. 5/25-2-2 (THS 75352–75354). Ji’an-shi: H. Yamaji 2004. 5/29-2-2 (THS 75387–75388), H. Yamaji 2004. 5/29-4-3 (THS 75395), H. Yamaji 2004. 5/29-5-2 (THS 75398). **LIAONING:** K. Kondo s. n., 3 May 1920 (TI), H. Yamaji 2004. 5/30-1-1 (THS 75402–75403), H. Yamaji 2004. 5/30-2-1 (THS 75404–75405). Xinbin Manzu Zizhixian: C. Z. Zhou s. n., 1996 (THS 76901).

**KOREA.** V. Komarov s. n., 15 Jun. 1897 (TI). **KYONGGI-DO:** Namyangju-gun: K. Yamaki & J.-H.

Pak 1004 (THS 40329–40330). **GANGWON-DO:** J. Murata & Im, H. T. s. n., 1984 (TI), unknown collector (TI). Myogju-gun: H. Yamaji, S.-W. Lee, J.-S. Kim & J.-H. Pak 8180 (TUS 337627). Pyeongchang-gun: K. Yamaki & J.-H. Pak 1006 (THS 40327–40328). **GYEONGSANGBUK-DO:** Y. Fukumoto s. n., Apr. 1928 (MAK 140067).

2. *Asarum sieboldii* Miq.

f. *maculatum* (Nakai) Yamaji

**KOREA. GYEONGSANGNAM-DO:** T. Shinkawa s. n., 2000 (TUS 337611–337613), T. Nakai s. n., 16 May 1928 (TI). Namhae-gun: K. Yamaki & J.-H. Pak 1013a (THS 40312), K. Yamaki & J.-H. Pak 1013b (THS 40313), H. Yamaji, S.-W. Lee & J.-H. Pak 8060 (TUS 253999). **JEOLLABUK-DO:** Puan-gun: H. Yamaji, S.-W. Lee & J.-H. Pak 8070 (TUS 337639). **JEOLLANAM-DO:** Wando-gun: K. Yamaki & J.-H. Pak 1016a (THS 40314), K. Yamaki & J.-H. Pak 1016b (THS 40316), H. Yamaji, S.-W. Lee & J.-H. Pak 8065 (TUS 252211). **JEJU-DO:** T. Takagi s. n. in Apr. 1939 (TI), J. Murata & Im H. T. s. n., 4 Jun. 1984 (TI), J. Murata & H. T. Im 16023 (TI). Mt. Hallasan: T. Nakai s. n., 10 May 1913 (TI–lectotype, isolectotype), T. Nakai s. n., 12 Jun. 1913 (TI). Jeju-shi: H.

Yamaji & S.-W. Lee 8132 (TUS 252321), K. Yamaki & J.-H. Pak 1019c (THS 40296), Namjeju-gun: H. Yamaji & S.-W. Lee 8129 (TUS 252322), K. Yamaki & J.-H. Pak 1019a (THS 40298), K. Yamaki & J.-H. Pak 1019d (THS 40294, THS 40295), Pukcheju-gun: H. Yamaji & S.-W. Lee 8143 (TUS 254006), Seogwipo-shi: K. Yamaki & J.-H. Pak 1019b (THS 40297), H. Yamaji & S.-W. Lee 8140 (TUS 252323, 337630–337631), H. Yamaji & S.-W. Lee 8130 (TUS 252326).

*f. seoulense* (Nakai) C. Y. Cheng & C. S. Yang

**RUSSIA.** Vladivostok: N. Palczevsky s. n., 1903 (MAK 149202), G. Ponomarchunk, K. Ulanova & O. Jadikina s. n., 1974 (MAK 184239), K. Ueno s. n., 2000 (THS 76905).

**CHINA. JILIN:** Changbai Chosenzu Zizhixian: H. Yamaji 2004. 5/27-3-1 (THS 75377–75378), H. Yamaji 2004. 5/27-2-1 (THS 75375–75376), H. Yamaji 2004. 5/27-5-1 (THS 75379), H. Yamaji 2004. 5/27-1-1 (THS 75373–75374). Huadian-shi: H. Yamaji 2004. 5/25-1-2 (THS 75346–75347). Ji'an-shi: H. Yamaji 2004. 5/29-5-1 (THS 75396–75397). Tonghua-shi: H. Yamaji 2004. 5/29-1-1 (THS 75383–75384).

**LIAONING:** Benxu Manzu Zizhixian: C. Zhou s. n. in 1996 (THS 76902).

**KOREA. GANGWON-DO:** Taebaek-shi: K. Yamaki & J.-H. Pak 1008a (THS 40322–40323), K. Yamaki & J.-H. Pak 1008b (THS 40324–40325), H. Yamaji, S.-H. Jo & S.-W. Park 8127 (TUS 254011). Chunchon-gun: H. Yamaji, S.-W. Lee, J.-S. Kim & J.-H. Pak 8168 (TUS 254014). **KYONGGI-DO:** T. Nakai s. n., 1913 (TI). Kanghwa-gun: H. Yamaji & S.-M. Seo 8150 (TUS 252324), H. Yamaji & S.-M. Seo 8155 (TUS 252325). Kapyong-gun: H. Yamaji, S.-M. Seo, C.-Y. Chong & B.-H. Choi 8162 (TUS 254008), H. Yamaji, S.-M. Seo, C.-Y. Chong & B.-H. Choi 8165 (TUS 252319, 254005). Seoul City: T. Mori s. n., 16 May 1910 (TI–syntype), N. Okada s. n., 5 May 1945 (TI–syntype).

3. *Asarum versicolor* (Yamaki) Y. Lee

**KOREA.** unknown collector (KYO), U. Faurie s. n., 1906 (KYO). **KYONGGI-DO:** Kapyeong-gun: K. Yamaki & J.-H. Pak 1002a (TI–holotype, THS 40266–isotype), K. Yamaki & J.-H. Pak 1002b (THS 40291), K. Yamaki & J.-H. Pak 1002c (THS 40290), K. Yamaki & J.-H. Pak 1002d (THS 40289), K. Yamaki & J.-H. Pak 1003a (THS 40288), K. Yamaki & J.-H. Pak 1003b (THS 40287), H. Yamaji, S.-M. Seo, C.-Y. Chong & B.-H. Choi 8160 (TUS 252320), H. Yamaji, S.-M. Seo, C.-Y. Chong & B.-H. Choi 8167 (TUS 254004). **GANGWON-DO:** Weonseong-gun: K. Yamaki & J.-H. Pak 1005a (THS 40282–40283), K. Yamaki & J.-H. Pak 1005b (THS 40284–40285). Wonju-gun: H. Yamaji, S.-H. Jo & S.-W. Park 8120 (TUS 252577). Chunchon-gun: H. Yamaji, S.-W. Lee, J.-S. Kim & J.-H. Pak 8169 (TUS 254013). Inje-gun: H. Yamaji, S.-W. Lee, J.-S. Kim & J.-H. Pak 8175 (TUS 254009). **CHUNGCHEONGBUK-DO:** Boeun-gun: K. Yamaki & J.-H. Pak 1020b (THS 40280–40281), K. Yamaki & J.-H. Pak 1020c (THS 40279), H. Yamaji & K. Choi 8100 (TUS 252318). Kyongsangnam-do: S. Okamoto s. n., 1935 (KYO).

4. *Asarum patens* (Yamaki) Y. Lee

**KOREA. GANGWON-DO:** K. Yamaki (THS 74327). **CHUNGCHEONGBUK-DO:** H. Yamaji & K. Choi 8105 (TUS 254003, 337635). **CHUNGCHEONGNAM-DO:** Kangju-gun: K. Yamaki & J.-H. Pak 1021a (THS 40273–40274), K. Yamaki & J.-H. Pak 1021b (THS 40275), K. Yamaki & J.-H. Pak 1021c (THS 40276–40277). **GYEONGSANGBUK-DO:** Kumi-shi: K. Yamaki & J.-H. Pak 1001d (TI–holotype; THS 40262–isotype, THS 40264), K. Yamaki & J.-H. Pak 1001e (THS 40267–40268), H. Yamaji, J.-Y. Yang & J.-S. Kim 8050 (TUS 255263), H. Yamaji, J.-Y. Yang & J.-S. Kim 8053 (TUS 255261). **JEOLLANAM-DO:** Kurye-gun: H. Yamaji, S.-W. Lee & J.-H. Pak 8078 (TUS 254001). Daegu City: K. Yamaki & J.-H. Pak 1010a (THS 40269–40270), H. Yamaji, J.-Y. Yang & J.-S. Kim 8080 (TUS 252561), H. Yamaji, J.-Y. Yang & J.-S. Kim 8085 (TUS 255260).