NOTE

Asarum satsumense F. Maekawa (Aristolochiaceae), a Newly Recorded Species in Taiwan

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ABSTRACT: The present paper reports a newly recorded *Asarum*, *A. satsumense* F. Maekawa, collected from Taiwan. This species was for merely recorded as an endemic species in Kagoshima, southern Kyushu, Japan. However, recently it was found in northwestern Taiwan, Miaoli and Taichung Counties. *Asarum satsumense* resembles *A. macranthum* Hook. f. of Taiwan, but can be distinguished by having a more depressed pyriform perianth tube, larger perianth tube entrance, tessellate-reticulate apically but longitudinally thick-ridged basally inner surface of perianth tube (vs. tessellate throughout the inner wall), and denser supratectate warts on pollen grains. Taxonomic description, line drawing, pollen SEM plates, chromosome number, distribution information, and color photographs of floral characters of this newly recorded species are provided to aid its identification.

KEY WORDS: Aristolochiaceae, *Asarum*, *Asarum satsumense*, chromosome number, new recorded species, pollen.

INTRODUCTION

Asarum L. *s. l.* comprises about 85 perennial taxa that distribute in East Asia, Europe and North America (Kelly, 1998). According to the infrageneric system proposed by Kelly (1998), the section *Heterotropa* is the largest and by far the most taxonomically complicate section with about 50 species distributed primarily through Japan and China (Kelly, 1997). Because the floral characters are usually hardly recognized after the plants have been pressed as dried specimens, taxonomists often describe the local variations as new endemic species. Consequently, nearly all species in this section are locally endemic, and each species distributes in a restricted area. However, the recent discovery of *A. yaeyamense* Hatusima, a species long being considered as endemic to the Ryukyus, in north Taiwan (Lu et al., 2009) made an exception in this section.

Most recently, in our field survey, we found out an unknown *Asarum* species from the northwestern Taiwan. This species closely resembles *A. macranthum* Hook. f. in northern Taiwan on vegetative morphology, but differs from the latter by having a more depressed pyriform perianth tube, larger perianth tube entrance, and different reticulation pattern of the inner surface of perianth tube. By making detail comparison with the floras around Taiwan (e.g. Maekawa, 1932, 1933; Hatusima, 1971; Liu and Lai, 1976; Yinger, 1983; Hatusima and Yamahata, 1988, 1989; Huang, 1996; Huang et al., 2003; Sugawara, 2006), this species was conclusively recognized as *A. satsumense* F. Maekawa, used to be an endemic species in southern Kyushu, Japan. This is the other example to show that Taiwan and Japan (include Ryukyu) share same species in this section. It also suggests that the inventory and/or taxonomy of Taiwanese *Asarum* is still incomplete and needs further intensive studies.

In the present study, taxonomic description, line drawing, pollen SEM plates, chromosome number, distribution information, and color photographs of this newly recorded species are provided to aid species identification.

MATERIALS AND METHODS

Materials used in the present study were collected from the native habitats. Some living materials were transplanted into the greenhouse of Department of Life Science, National Taiwan Normal University for further observation and experiment. Floral characters were measured from fresh mature flowers by a Mitutoyo CD-6"CS digimatic caliper (accuracy: ± 0.02 mm). A total of 52 individuals of *A. macranthum* and 12 of *A. satsumense* were measured. Most materials were pressed and dried for voucher specimens deposited in the TNU herbarium. Voucher specimens for pollen and somatic chromosomes observation were also deposited in TNU.

Pollen grains for scanning electron microscopic (SEM) study were collected from fresh anthers and prepared by the method proposed by Erdtman (1952). The acetolyzed grains were dehydrated through ethanol series, critical point dried, coated with gold, and then examined with SEM, Hitachi SM 2400.

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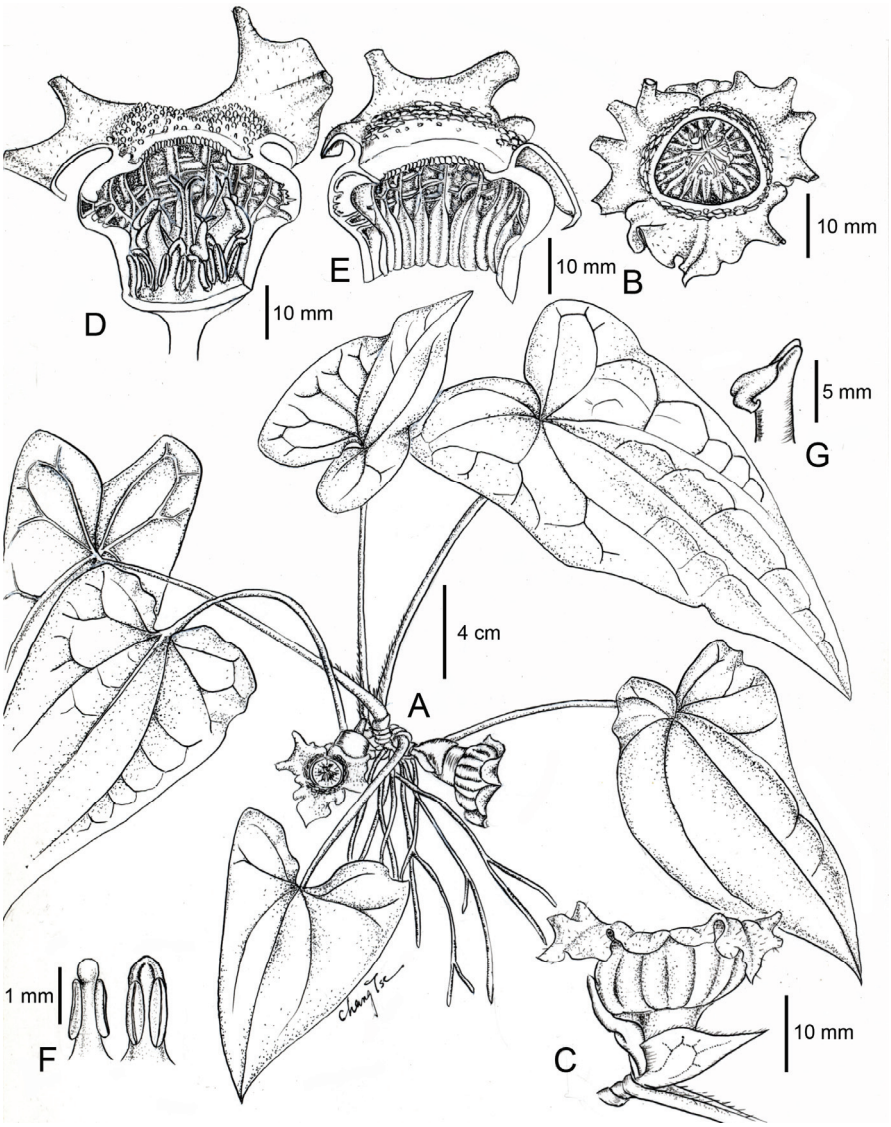


Fig.1. *Asarum satsumense* F. Maekawa. (C.T. Lu 851). A: Habit. B: Flower, front view, showing huge perianth tube entrance. C: Perianth tube, side-view. D: Dissected flower, showing stamens and pistils. E: Dissected perianth tube, showing longitudinal ridges on the inner wall. F: Stamens. G: Style and stigma.

Root tips for cytological study were pretreated with 0.1% colchicine for 3-4 hours at room temperature and fixed with a 3:1 (v:v) mixture of 99.5% ethanol and acetic acid for 1 day. After being macerated with 5% pectinase, the root tips were squashed in acetic orcein solution.

TAXONOMIC TREATMENTS

Asarum satsumense F. Maekawa, Bot. Mag. Tokyo 46: 580. 1932; Sugawara in Iwatsuki et al., Fl. Japan Ⅱa: 380. 2006.—TYPE: Kiusiu: Prov. Satsuma, Mt. Isomayama, *Y. Doi s.n.* (not traced)

薩摩細辛 Figs. 1, 2D-F

Heterotropa satsumensis (F. Maekawa) F. Maekawa, J. Jap. Bot. 9: 96. 1933.

Perennial herbs. Rhizomes short. Leaves long petiolate; petiole dark brown, glabrous, 9.2-17.6 cm long; blade ovate to widely ovate, 8.5-9 cm long, 7.5 -7.8 cm wide, base cordate, basal lobes 3.5-3.7 cm long, 2.8-3.2 cm wide, apex acute; adaxial surface dark green, variegated, lusterless. Flower purple reddish to dark purple, solitary, axillary, decumbent on ground; pedicel short, ca. 1 cm long; perianth tube depressed pyriform, 9.1-12.5 mm long, upper 14.8-20.2 mm wide, base 10.7-12.9 mm wide, throat slightly constricted, with a narrow orifice rim, 1.3-3.3 mm wide; upper half of inner wall of perianth tube dark purple, tessellated with

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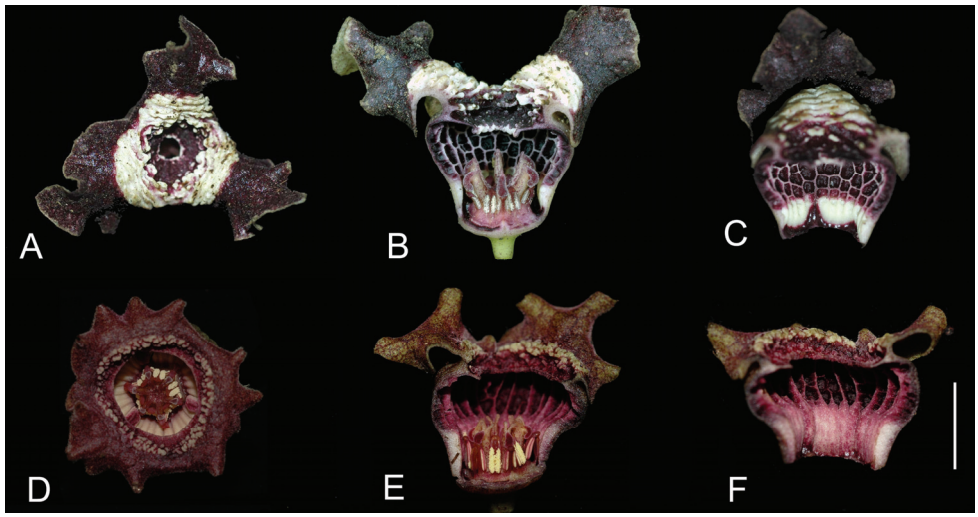


Fig. 2. Floral comparison of *A. macranthum* (A-C) and *A. satsumense* (D-F). bar = 10 mm. A, D: Front view, notice the different size of perianth-tube entrance. B, E: Dissected flower, showing perianth-tube shape, stamens and pistils. C, F: Dissected perianth tube, showing different reticulation types on the inner wall.

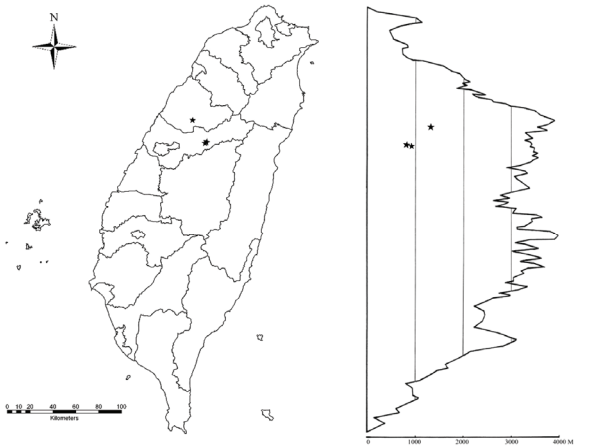


Fig. 3. Geographical distribution of *A. satsumense* in Taiwan.

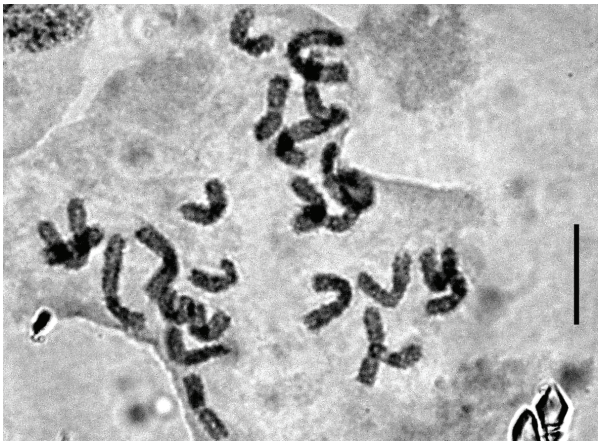


Fig. 4. Somatic chromosome of *A. satsumense*, 2*n* = 24. (C.T. Lu 851) (bar = 10 μm)

longitudinal and transverse ridges, lower half white, longitudinally ridged only, ridges thick, column-like, 26-30; limb 3-lobed; lobes spreading, deltoid ovate, margin undulate, 7.8-13.7 mm long, base rugose, adaxial surface covered with trichomes, abaxial surface glabrous; stamens 12, in 2 whorls, subsessile, anthers extrorse, 4.2-5.4 mm long; ovary superior to half inferior, styles 6, free, erect, lateral compressed, apex 2-forked, ca. 0.7-1.4 mm long; stigma linear, decurved, lateral or subterminal.

Distribution and habitat: This species disjunctively distributes in southern Kyushu (Kagoshima Pref.) of Japan and Taiwan. In Taiwan, two populations were found in northwestern part (Miaoli County and Taichung County) (Fig. 3). It grows under the semishaded evergreen broadleaved forest.

Phenology: According to Flora of Japan (Sugawara, 2006), this species is flowering and fruiting from March to May in Japan, while in Taiwan, it is flowering and fruiting from January to April.

Specimens examined: Taiwan: Miaoli County: Taian Township, Mt. Malapangshan, elev. ca. 1100-1300 m, *C. T. Lu 1441* (TNU). Taichung County: Hoping Township, Chiapaotai, Pahsienshan Forest Recreation Area, elev. ca. 900 m, Feb. 25, 2006, *C. T. Lu 851* (TNU); same loc., Apr. 22, 2005, *C. T. Lu 709* (TNU); Kukuan, Mar. 19, 1998, *Y. P. Cheng 2153* (TAIF).

Chromosome numbers: The somatic chromosome number 2*n*=24 of *A. satsumense* based on the Taiwanese materials was reported in this study (Fig. 4). It was the same as which of Japanese materials (Ono, 1960) and all other species of *Asarum* sect. *Heterotropa* in Taiwan (Sugawara and Ogisu, 1992; Huang et al., 1995; Lu and Wang, 2009; Lu et al., 2009) and the Ryukyus (Yuasa and Maekawa, 1976).

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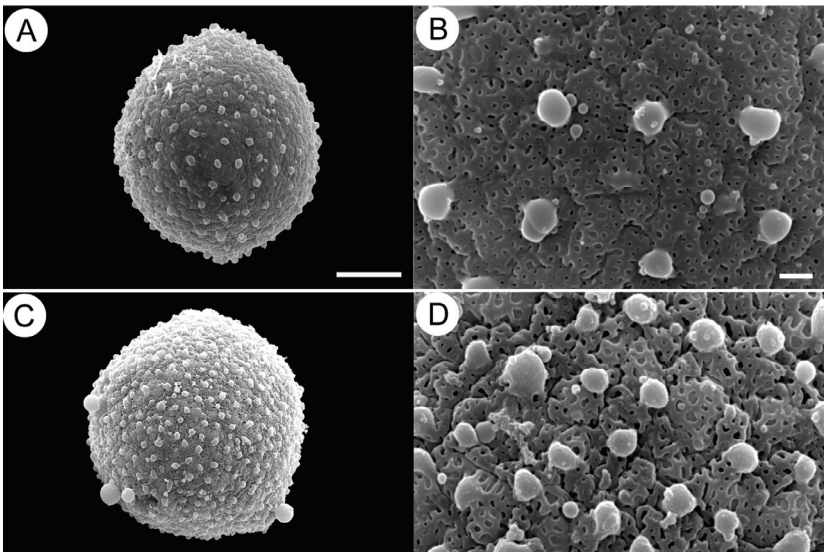


Fig. 5. Pollen micromorphology of A. macranthum (A-B) (*C.T. Lu 879*) and A. satsumense (C-D) (*C.T. Lu 851*). A, C. bar = 10 μm; B, D. bar = 1 μm.

Table 1. A comparison of the floral characters between A. macranthum and A. satsumense. For each quantitative character, values represent means±SD.

Characters	*A. macranthum*	*A. satsumense*
Perianth lobe	deeply undulate	undulate
Length	14.47±3.35 mm	11.53±1.84 mm
Rugose appendage	5.61±1.39 mm	2.70±0.33 mm
Orifice rim	well developed, sometimes deorsum reflexed, 3.73±0.62 mm wide	narrow, 2.34±0.60 mm wide
Perianth tube		
Shape	pyriform	depressed pyriform
Entrance	small, 3.83±0.72 mm in diameter	large, 7.83±1.81 mm in diameter
Upper part diameter	15.19±2.11 mm	18.44±1.54 mm
Length	11.17±1.44 mm	10.87± 0.89 mm
Upper part diameter/ length	1.37±0.16	1.71±0.23
Reticulation pattern inside	tessellated from base to upper region, longitudinal ridges 24	tessellated apically, but only longitudinally ridged basally, longitudinal ridges 28±2

Pollen morphology: The present study first describes the pollen morphology of *A. satsumense* based on the Taiwanese materials. The pollen grains are oblate spheroid with 4 or 5 colpoids, ca. 32.5 × 34.2 μm (P × E), tectum rugulato-perforate with small supratectate warts (Fig. 5). Palynological comparison between *A. satsumense* and the closely related *A. macranthum* Hook f. reveals similar tectum features but *A. satsumense* has denser supratectate warts (Fig. 5).

Notes: The floral morphology of this new recorded species, *A. satsumense*, is closely related to *A. macranthum* (Figs. A-C). However, *A. satsumense* can be distinguished from *A. macranthum* in having more compressed pyriform perianth tube with the obviously higher ratio of upper part diameter to perianth tube length (1.71±0.23 vs. 1.37±0.16 on average), larger perianth tube entrance (7.83±1.81 mm vs. 3.83±0.72 mm on average), shorter perianth lobe (11.53 ±1.84 mm vs. 14.47±3.35 mm on average), and narrow orifice rim (2.34±0.60 mm vs. 3.73±0.62 mm on average). More importantly, their perianth tubes display different reticulation patterns inside: *A. satsumense* forms tessellated reticulation apically and thick, column-like longitudinal ridges basally (Fig. 2F), while *A. macranthum* forms 24 rows of tessellated reticulation throughout the inner surface (Fig. 2C) (Table 1). Additionally, their pollen grains are slightly different as mention above.

The geographical distribution pattern of this species is an intriguing issue. So far, nearly all the species in the section *Heterotropa* were described as endemic or growing in the neighboring region. However, *A. satsumense* is disjunctively distributed in southern Kyushu (Kagoshima Pref.) of Japan and Taiwan. The Japan-Taiwan disjunctive distribution is rather seldom in the vascular flora of Taiwan. Based on an extensive survey of the flora, Hsieh (2002) identified 189 species belonging to this distribution pattern, i.e. endemic to Taiwan and Japan (including the Ryukyus), whereas 1360 species shared with mainland China. The low

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percentage of Japan-Taiwan endemism lead him to draw a coincident conclusion with Hosokawa (1958)--the floristic relationship between Japan and Taiwan is through their mutual relationship to the lowland and lower montane flora of mainland China (Hsieh, 2002). *Asarum satsumense* was most probably derived from the ancestor in the mainland China. Therefore, the populations inhabited in Japan and Taiwan have long been isolated to limit their gene flow. Despite high similarity in almost all the characters, the Taiwanese plants still have minor morphological difference from Japanese one (larger leaves and slightly smaller flowers) when compare with the description of the Flora of Japan (Sugawara, 2006). It suggests the genetic differentiation may have been raised from historical geographic isolation in this species. By using allozymes and cpDNA markers, population genetic studies of *Trochodendron aralioides*, a relic species restrictively distributed in Japan, the Ryukyus and Taiwan, demonstrated that the populations can be steadily grouped into Japan-Amami and Taiwan-Iriomote clusters (Wu, 2001; Wu et al., 2001). Nevertheless, further phylogeographic studies for *A. satsumense* are needed to resolve the relationship between the populations of Japan and Taiwan as well as the close relations in the mainland China.

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臺灣新紀錄植物－薩摩細辛 (馬兜鈴科)

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摘要：本文報導臺灣產馬兜鈴科細辛屬新紀錄植物-薩摩細辛。本種原本僅知分布於日本九州鹿兒島地區，為當地特有種；最近我們發現其亦分布於臺灣苗栗與台中一帶。本種與臺灣特有之大花細辛頗為相似，但可由壓扁之西洋梨形的花被筒、較大之花被筒開口，花被筒內特殊之網紋形式 (花被筒上半部具棋盤格狀脊形隆起，下半部僅具縱向脊形隆起) 以及花粉具較多的上頂蓋瘤突與大花細辛區別。本文提供該種之形態描述、手繪圖、體染色體數目、花粉 SEM 圖片、地理分布、花部特徵照片以及與大花細辛之詳細比較以供鑑定參考。

關鍵詞：馬兜鈴科、細辛屬、薩摩細辛、染色體數目、新紀錄種、花粉。

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