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SYSTEMATICS

Ypsilandra (Melanthiaceae; Liliaceae sensu lato), a new generic record for Taiwan

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ABSTRACT. *Ypsilandra thibetica* Franch. (Liliaceae *sensu lato*), previously known only from southcentral and southern China (Sichuan, S. Hunan and NE Guangxi), was recently found in mountainous regions of central and eastern Taiwan. The discovery adds a new record for the species, and for the genus, to the flora of Taiwan. *Ypsilandra* can be easily distinguished from other genera of Liliaceae by its rosette of basal leaves, racemose inflorescence, and 3-lobed capsules. This paper provides a taxonomic account of the genus, a line drawing and color photographs to aid in identification. The somatic chromosome number and karyotype formula ($2n = 34 = 18m+10sm^{4SC}+6st^{2SC}$) are reported for *Y. thibetica* for the first time.

Keywords: Chromosome cytology; Karyotype; Liliaceae; Melanthiaceae; Taiwan; Taxonomy; *Ypsilandra thibetica*.

INTRODUCTION

Liliaceae *sensu lato*, a family widespread throughout the world, consists of about 280 genera and 4,000 species (Cronquist, 1981). Taxonomy of the family in Taiwan has been revised recently by Ying (1988, 1989, 1990), Huang and Yang (1988), Hara (1987, 1988), Tanaka (1998, 2001a, 2001b), Lang et al. (1999), Ohashi (2000), Hiramatsu et al. (2001) and Peng et al. (2007). Twenty-two genera and 31 species, one subspecies and fourteen varieties were recorded in the Flora of Taiwan, 2nd Edition (Ying, 2000). During our botanical inventory of Taiwan, *Ypsilandra thibetica* Franch., a heretofore unrecorded species, was discovered in mountainous regions in central and eastern Taiwan. *Ypsilandra* Franch. comprises six species in mainland China, Bhutan, Myanmar, Nepal, and Vietnam (Chen and Tamura, 2000; Chen et al., 2003; Shaw, 2008). Our discovery of *Y. thibetica* on Taiwan represents a significant range extension for both the genus and the species.

MATERIALS AND METHODS

Plants of *Ypsilandra thibetica* from Nantou Hsien, Taiwan were cultivated in the experimental greenhouse of Academia Sinica, Nankang, Taipei, Taiwan. Somatic chromosomes were observed using at least three cells per individual. Methods of pretreatment, fixation, and staining of chromosomes for observations follow Oginuma and Nakata (1988). Classification of chromosome morphology is based on the position of the centromere (Levan et al., 1964).

Taxonomic Treatment

Ypsilandra Franch., Nouv. Arch. Mus. Hist. Nat. Paris, Ser. 2, 10: 93. *t.17*.1887. 丫蕊花屬

Herbs, perennial, glabrous. Rhizome stout, short. Leaves basal, in a rosette, linear to oblanceolate or spatulate-oblanceolate. Peduncle erect, simple, with several to many sheathing or bract-like leaves. Inflorescence scapiform, a terminal raceme, 4-30-flowered, ebracteate except in *Ypsilandra jinpingensis* (Chen et al., 2003). Flowers bisexual, actinomorphic. Tepals 6, persistent, with a basal nectary gland on adaxial surface. Stamens 6, free from tepals, exceeding or nearly as long as tepals; anthers reniform, basifixed, thecae confluent. Ovary superior, 3-loculed, placentation axile; ovules many per locule; style 1, stigma capitate to 3-cleft. Capsules 3-lobed apically, trigonous, loculicidal; seeds numerous, fusiform to linear, tailed at both ends.

Six species (*Ypsilandra alpina* F. T. Wang & T. Tang, *Y. cavaleriei* H. Lév. & Vaniot., *Y. jinpingensis* W. H. Chen, Y. M. Shui et Z. Y. Yu, *Y. kansuensis* R.N. Zhao & Z.X. Peng, *Y. thibetica* Franch., *Y. yunnanensis* W.W. Smith & Jeffrey); Bhutan, China, Myanmar, Nepal, Vietnam (Chen and Tamura, 2000; Shaw, 2008); one species in Taiwan (reported here).

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Ypsilandra thibetica Franch., Nouv. Arch. Mus. Hist. Nat. Paris sér. 2, 10: 94. *t. 17*. 1887; Chen, Fl. Reipubl. Popularis Sin. 14: 17. *t. 4*. 1980; Yang, Fl. Sichuan 7: 11. *pl. 3: 1-3*. 1991; Chen & Tamura, Fl. China 24: 86. 2000. 丫蕊花 Figures 1, 2

Helonias thibetica (Franch.) Tanaka, J. Jap. Bot. 73(2): 106. 1998.

Plants terrestrial or on moss covered rocks. Leaves spatulate-oblanceolate, green or flushed red, gradually tapering to petiole; petiole 2-9 cm long; leaf blade 9-15 × 1-5 cm, entire, apex acute or acuminate, venation parallel. Peduncle 15-25 cm long, with 2-6 lax bract-like leaves. Inflorescence 4-8 cm long, 4-20-flowered; pedicels 6-10 mm. Tepals white, pink, or pale green, spatulate-oblanceolate, 9-11 mm × 2.5-3.5 mm. Stamens antepetalous, concolorous with tepals; filament free, 13-15 mm long; anthers 1.7-2 mm long. Ovary pink or sometimes greenish, ca. 3 mm in diam.; style ca. 8-11 mm long; stigma capitate. Capsule with persistent tepals, filaments and styles. Seeds linear-fusiform, 4-6 mm long, body brownish, ca. 1 mm long, terminal appendages whitish.

Phenology. Flowering February to March; fruiting March to May.

Figure 1. *Ypsilandra thibetica* Franch. A, Habit; B, Inflorescence; C, Flower; D, D', D'', Fruit with persistent tepals, stamens, style and stigma in different views; E, Seed.

Distribution. China; NE Guangxi, S Hunan, Sichuan, Taiwan. In central mountain ranges in Taiwan: moist, mossy, rocky hillsides, shaded slopes along valleys; 1,400-1,800 m (Figure 3).

Specimens examined. **MAINLAND CHINA**. Sichuan ('Thibet oriental'), Baoxing Xian ('Prov. de Moupin'), *M. l'Abbé David-1870* (P, holotype! isotype!). **TAIWAN.** HUALIEN HSIEN: Hsiulin Hsiang, Power-maintenance Road, Chilai section, 1,793 m alt., 29 Mar 2008, *C. F. Chen et al. 3305, 3309* (TNM). NANTOU HSIEN: Hsinyi Hsiang, Jenlun Forest Road, mixed *Cryptomeria* plantation and broadleaved forest, on slope above road, alt. ca. 1,500 m, 1 Mar 2001, *T. W. Hsu 11211* (TAIE); 12 Feb 2003, *T. W. Hsu 11157* (TAIE), 3 Apr 2003, *T. W. Hsu 11173* (TAIE); 12 Feb 2003, *C.-I Peng et al. 19224* (HAST, 2 sheets); Luku Hsiang, Shanlinhsi ('Sunlinksea'), 21 Feb 2009, *C. T. Chao 412, 435, 436* (TCF).

Chromosomes. The chromosome number and karyotype of *Ypsilandra thibetica* are documented here for the first time. Somatic chromosomes at mitotic metaphase of *Ypsilandra thibetica* were determined to be $2n = 34$, with bimodal variation in length (Figure 4). Of the 34 chromosomes two were markedly longer (about 2.9 μm) than the others; the remaining 32 shorter chromosomes varied gradually from about 1.3 to 2.2 μm long. Irrespective of length, 18 (Nos. 3, 4, 7, 8, 11-14, 17, 18, 23-26, 29, 30 and 33, 34), 10 (Nos. 1, 2, 5, 6, 9, 10, 27, 28 and 31, 32), and 6 (Nos. 15, 16, 19-22) chromosomes had median (m), submedian (sm) and subterminal (st) centromeres, respectively (Figures 4B, C). Secondary constrictions were observed at the interstitial region of the long arm in four submedian (Nos. 1, 2 and 5, 6) and two subterminal (Nos. 15 and 16) chromosomes. Thus, the karyotype formula of *Y. thibetica* is $2n = 34 = 18m+10sm^{4SC}+6st^{2SC}$. The same chromosome number was reported in two closely related genera: for seven species of *Heloniopsis* (Ono, 1926; Nakajima, 1933; Sakai, 1934; Chuang et al., 1962; Nakamura, 1967; Hsu, 1971; Kurosawa, 1982; Nishikawa, 1989; Kokubugata et al., 2004) and the sole species of *Helonias*, *H. bullata* (Miller, 1930; Utech, 1980). The karyotypes of *Heloniopsis orientalis* (Nakamura, 1967), *H. kawanoi*, *H. leucantha*, and *H. umbellata* (Kokubugata et al., 2004), and *Helonias bullata* (Utech, 1980) were given in those reports. Kokubugata et al. (2004) reported the karyotypes of all three species of *Heloniopsis* examined to be similar, showing a karyotype formula of $2n = 34 = 28m^{2SC}+6sm^{2SC}$. The karyotypes of *Heloniopsis orientalis* (Nakamura, 1967) and *Helonias bullata* (Utech, 1980) were also analyzed, but the classification of chromosome morphology used in those two reports was different from the classification used in this paper. Judging from the drawings of chromosome complements at mitotic metaphase of *Heloniopsis orientalis* (Figures 1-4: p. 2317) presented by Nakamura (1967) and the measurements of haploid chromosome length of *Helonias bullata* (Table 1: p. 156) presented by Utech (1980), the karyotype formula of *Heloniopsis orientalis* and *Helonias bullata* is regarded to be $2n$

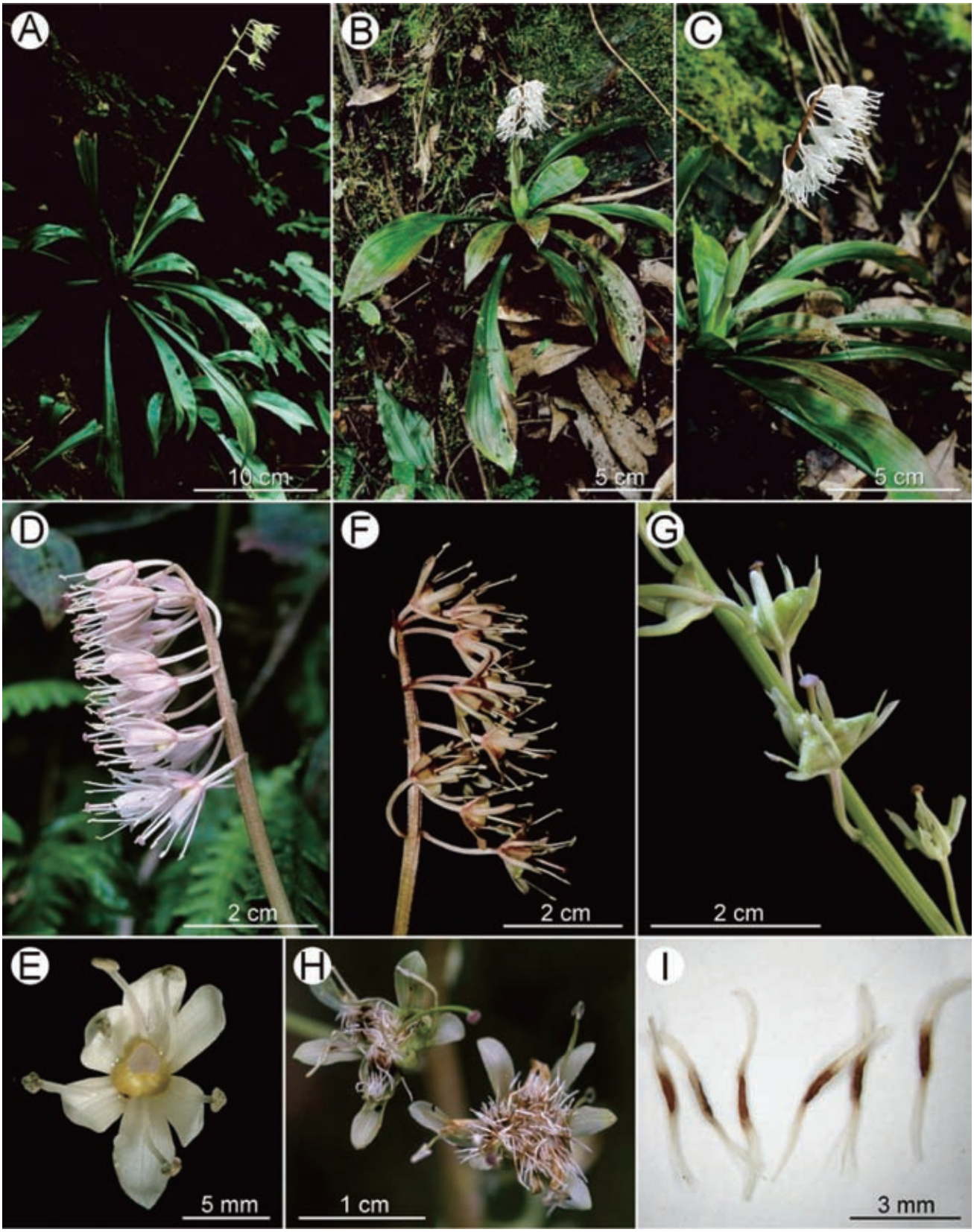

Figure 2. *Ypsilandra thibetica* Franch. A-C, Habit; D, Inflorescence; E, Flower; F, Infructescence; G, Capsules; H, Dehiscing capsules with seeds; I, Seeds.

= 34 = 24m^{6SC}+10sm, and 2*n* = 34 = 8m+24sm^{4SC}+2st^{2SC}, respectively. The karyotype formula for *Ypsilandra thibetica* presented here is clearly distinguishable from those of *Heloniopsis* and *Helonias*.

Notes. Ypsilandra is a member of the Liliaceae *sensu lato*. Takhtajan (1997) treated the genus in the Heloniadaceae, while Tamura (1998) and the Angiosperm Phylogeny Group (2009) classified it in the Melanthiaceae. The close relationships between the North American *Helonias* and the Asian *Heloniopsis* and *Ypsilandra* have been noted repeatedly. The three genera exhibit many similarities in morphology and anatomy (Tanaka, 1997a, 1997b, 1997c, 1997d, 1997e, 1998), palynology (Takahashi and Kawano, 1989), and ecology (Kawano and Masuda, 1980). Tanaka (1998) reduced *Heloniopsis* and *Ypsilandra* to synonymy under *Helonias*. Nevertheless, molecular evidence confirms that the three genera are distinct, and the taxonomic reduction may be unnecessary (Fuse and Tamura, 2000).

Geographically, *Helonias*, *Ypsilandra*, and *Heloniopsis* are allopatrically distributed. *Helonias*, a monotypic genus, is in southeastern North America (Zomlefer, 1997). In contrast, *Ypsilandra* and *Heloniopsis* are widespread in eastern Asia (Tanaka, 1997e). The distribution range of *Ypsilandra* is west of that of *Heloniopsis*. Our discovery of *Ypsilandra* in Taiwan represents a significant range extension of *Ypsilandra thibetica* and the first report of sympatric occurrence of *Ypsilandra* and *Heloniopsis*.

Although two editions of the Flora of Taiwan have already been published (1975-1979; 1994-2003), many new species and distribution records continue to be reported. Some of these include a holoparasitic species of *Phacellanthus* (Orobanchaceae), recently discovered in the cloud zone of a mixed *Chamaecyparis*/broadleaved forest (Chung et al., 2010); *Clematis chinensis* var. *tatushanensis*, reported along a lowland forest margin in western Taiwan (Yang, 2009); *Begonia* ×*chungii*, a natural hybrid, reported from an experimental forest/eco-resort in central Taiwan (Peng and Ku, 2009); three new species of *Asarum*, two from northeastern Taiwan and one from the southern end of the Central Mountain Range (Lu and Wang, 2009); also from this mountain range, but at a lower elevation, *Swertia changii* (Chen and Yang, 2008); and a new species, *Veronicastrum loshanense*, found near a waterfall in eastern Taiwan (Chen and Chou, 2008). Nearly all of these plants are herbaceous and have a very restricted range of distribution. These recent findings indicate that the documentation of the island's vast and unique biodiversity is incomplete. Support is necessary for the continuation of these botanical inventories, especially to areas of difficult access and to those areas rarely botanized.

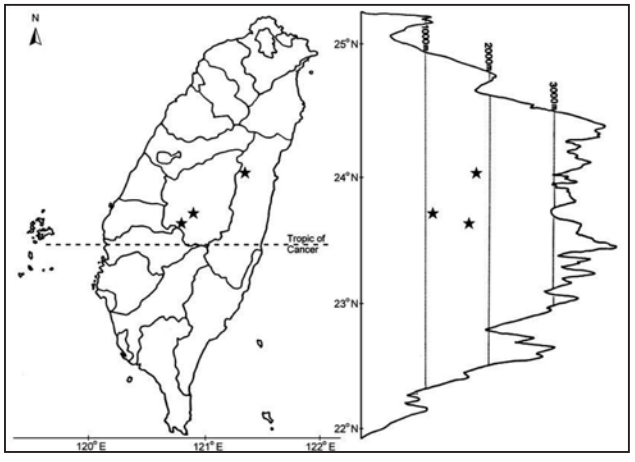

Figure 3. Latitudinal and altitudinal distributions of *Ypsilandra thibetica* Franch. in Taiwan.

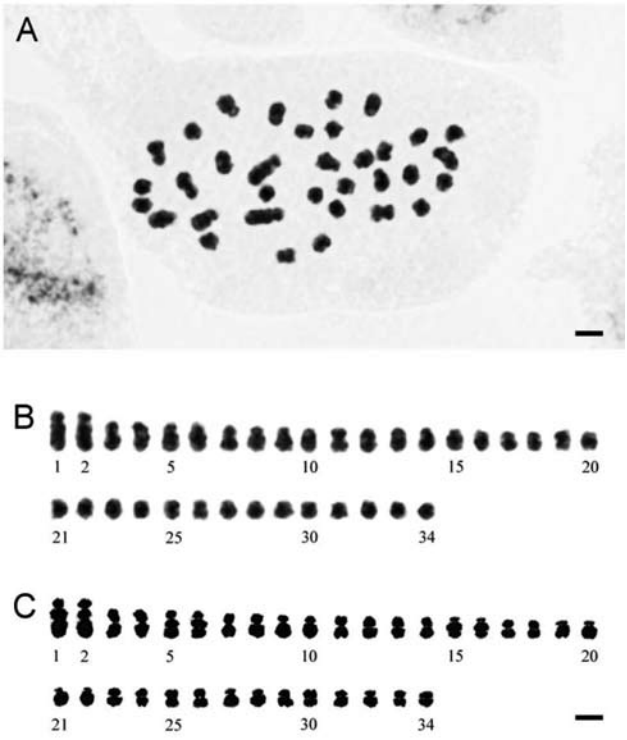

Figure 4. Somatic chromosomes at mitotic metaphase of *Ypsilandra thibetica* (2*n* = 34, *Peng 19224*). A and B, Photomicrograph; C, Drawing of a photograph of B. Scale bar = 2 μm.

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台灣產黑藥花科(廣義的百合科)新紀錄屬植物：丫蕊花

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本文發表台灣中部及東部山區產的黑藥花科 (廣義的百合科) 新紀錄植物丫蕊花 (*Ypsilandra thibetica*)，過去僅知分布於中國大陸四川、湖南南部及廣西東北部；此發現為台灣增添了一個新紀錄屬。本文提供丫蕊花的描述、分布、繪圖及彩色照片，並首次報導其染色體數及核型為 $2n = 34 = 18m + 10sm4SC + 6st2SC$。

關鍵詞：染色體細胞學；核型；百合科；黑藥花科；台灣；分類學；丫蕊花。