

Begonia ×*taipeiensis* (Begoniaceae), a new natural hybrid in Taiwan

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Abstract. A new natural hybrid of *Begonia*, *B.* ×*taipeiensis*, from northern Taiwan is described and illustrated. It grows on moist, rocky slopes on forest margins at 200-500 m elevation. Based on a comparison of morphology, geographical distribution, pollen stainability, seed set, cytological observations, and experimental crosses, we conclude that *B.* ×*taipeiensis* represents F₁ progeny from natural hybridization between *B. formosana* (Hayata) Masam. [sect. *Platycentrum* (Klotzsch) A. DC.] and *B. aptera* Blume [sect. *Sphenanthera* (Hassk.) Warb.].

Key words: *Begonia*; *Begonia aptera*; *Begonia formosana*; *Begonia* ×*taipeiensis*; Hybrids; Natural hybridization; Taiwan; Taxonomy.

Seven species of *Begonia* were treated in the first edition of the Flora of Taiwan (Liu and Lai, 1977). Subsequently, *Begonia lukuana* (Liu and Ou, 1982), *B. ravenii* (Peng et al., 1988), *B. fenchihuensis* (Ying, 1988), *B. austrotaiwanensis* (Peng and Chen, 1990), *B. tarokoensis* (Lai, 1990), *B. nantoensis* (Lai and Chung, 1992) and *B. hohuanense* (Ying, 1995) were reported as new to this island. A total of 12 species of *Begonia* were recognized (Chen, 1993) in the second edition of the Flora of Taiwan. Peng and Chen (1991) documented the hybrid status and parentage of *Begonia* ×*buimontana* Yamamoto (pro species), which is restricted to elevations between 1,000 and 1,600 m in southern Taiwan. We present here a report of another naturally occurring hybrid of *Begonia* in the northern part of this island.

Begonia* ×*taipeiensis C.-I Peng, hybr. nov. —TYPE: TAIWAN. Taipei Hsien: Wulai Hsiang, along trail to Hsiao-yi, ca. 3-5 km from Wulai. Abundant locally, forming a population ca. 1 m long × 0.6 m wide on a moist rock, 24° 50' N, 121° 34' E, ca. 200 m alt. Field collection made on 16 Apr 1991; type specimens pressed from cultivated plants. *Peng 13899* (holotype: HAST; isotypes: A, CAS, E, HAST, KUN, MO, PE, TAIF, TNM). 台北秋海棠 Figures 1, 2—D, E

Herbae perennes, erectae; rhizoma repens; caulis 6-45 cm altis; folia late lanceolata-ovata, 6-14 (-25) cm longa et 2.5-6.5 (-11.5) cm lata. Flores masc.: tepala 4, caduca. Flores fem.: tepala 5 vel 6; ovarium 2- vel 0-loculare, abortivum. Chromosoma numero, 2n = 41. Hybrida naturalis e *B. aptera* et *B. formosana*.

Erect, perennial, succulent herbs with creeping rhizomes. Rhizomes to 12 mm in diam.; stipules glabrous, widely ovate or triangular, to 8 (-17) mm long, 8 (-15) mm wide, apex apiculate. Stems 6-45 cm tall, to 4 (-12) mm in diam.; cauline stipules glabrous, caducous, ovate, to 13 mm long, 8 mm wide, apex apiculate, margin entire. Leaves sparingly scaberulous on both surfaces, sometimes densely covered by infinitesimal silver-gray spots, broadly lanceolate to obliquely ovate, 6-14 (-25) cm long, 2.5-6.7 (-11.5) cm wide, apex acuminate to apiculate, base obliquely cordate, margins irregularly serrulate or denticulate; venation palmate, veins 7-9; petioles glabrous or sparingly pilose, 1.5-26 (-35) cm long, to 6 mm in diam. Bracts in pairs, papery, glabrous, caducous, lanceolate or ovate, to 8 (-17) mm long, 3 (-12) mm wide, apex mucronate, margins ciliate. Inflorescence at complete development to 5 cm long; peduncles erect to pendulous, to 3 cm long, 1.5 mm in diam. Flowers of both sexes white or pinkish. Staminate flower: tepals 4, decussate, usually unopened, the outer two widely ovate to very widely ovate, 4-9 mm long, 4-10 mm wide, the inner two widely elliptic, 4-8 mm long, 3-6 mm wide; stamens 71-96, golf-club shaped, anthers obovate, 0.8-1.2 mm long, 0.4-0.5 mm across, filaments 0.3-0.5 mm long. Pistillate flower: tepals 5 or 6, unequal, obovate to widely obovate, 12-18 mm long, 6-15 mm wide; styles 2 or 3, yellow, 2.5-3.5 mm long, at their base fused ca. 1.2 mm, each bifid; ovary inferior, ellipsoid, 2-locular, longitudinally shallowly 1-grooved, 3-winged, abaxial wing 5-7 mm long, 5-7 mm wide, lateral wings 1.8-3 mm long, 7-10 mm wide; placenta axile, bilamellate. Abnormal hermaphrodite flowers occasionally seen. Their stamens 1 to several; styles 2 or 2½; ovary 2 or 0-locular and 1- or 2-winged. No fruit production from either pistillate or hermaphrodite flowers. Chromosome number, 2n = 41 (Figure 3).

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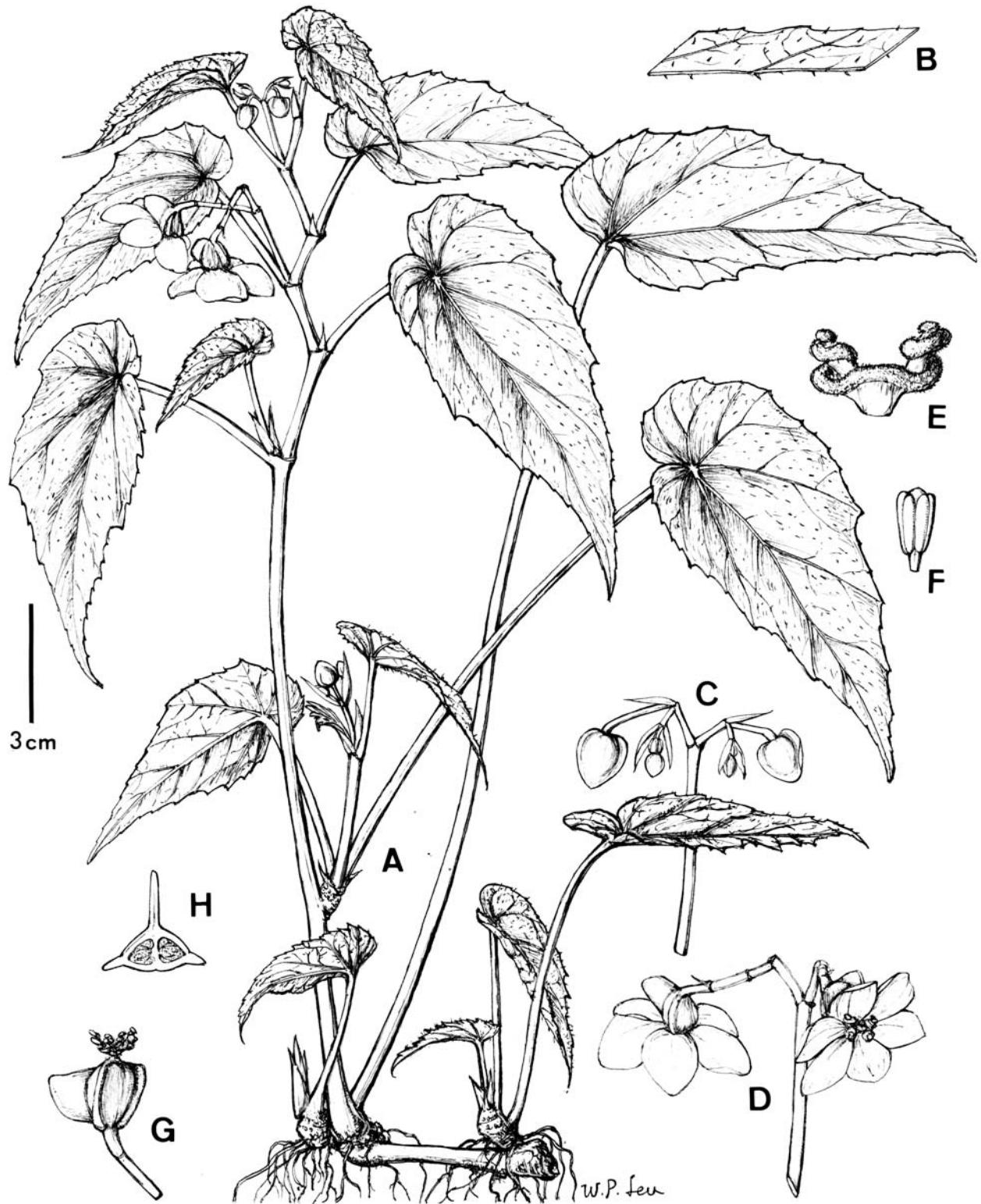


Figure 1. *Begonia* \times *taipeiensis*. A, Habit; B, Leaf, cross section, showing surface trichomes; C, Inflorescence, showing unopened staminate flowers; D, Inflorescence, showing pistillate flowers; E, Style; F, Stamen; G, Ovary; H, Ovary, cross section, showing placentation. (from Peng 13899, HAST)

Additional specimens examined. **TAIWAN.** Taipei Hsien. Hsichih Town: Paiyunli, at base of a moist mountain slope along Shuiyuan Rd., co-occurring with *B. aptera* and *B. formosana*, ca. 210 m alt., 16 Jul 1995, *Peng 16320* (HAST). Wulai Hsiang: along trail from Wulai to Hsiaoyi, at mileage sign 16 km on road 9-Alt., which is ca. 2 km from Wulai bus station. Broadleaf forest. Lower part of a rocky slope, on rock face with dripping water, *Begonia formosana* being abundant along the road. 24°50'N, 121°34'E, ca. 200 m alt., 11 Nov 1991, *Peng 14804* (HAST); same locality, on seeping rocky slope face. Associated with bryophytes, *Selagenella*, *Alocasia*, *Rhynchotechum* and Thelypteridaceae ferns, ca. 220 m alt., 9 Jul 1992, *Peng 15100* (CAS, HAST, TAIF, TNM, OOM); en route from Wulai Station to Hsiaoyi, by Hsiaoyi mountain control station. At mileage sign 18 km on Hsien Rd. 9-A. Broadleaf forest along river. Roadside slope, ca. 300 m alt., 9 Jul 1992, *Peng 15105* (HAST); en route from Wulai to Hsiaoyi, mileage sign 5 km, ca. 150 m alt., 27 Jun 1995, *Peng 16278*

(HAST); en route from Wulai to Hsiaoyi, elev. ca. 270-310 m, 15 Nov 1990, *Leu 711* (2 sheets, HAST); en route from Wulai to Hsiaoyi, along Tunghou River. Disturbed broadleaf forest and *Cryptomeria* plantation, on lower part of a moist cliff, ca. 400-500 m, 11 Jun 1993, *Leu 1870* (HAST), *Leu 1871* (HAST); From Wulai to Hsiaoyi, between mileage signs 19 and 20 km on Hsien Rd. 9-Alt., on semi-shady slope beside road, 24° 50' 54" N, 121° 34' 53" E, ca. 240 m alt., 17 May 1993, *Liu 132* (HAST); en route from Wulai to Hsiaoyi, at mileage sign 16 km on Hsien Rd. 9-A. Beside road, on semishady slope along a small ditch. Herb ca. 25 cm tall; flowers pink-red. 24° 50' N, 121° 34' E, ca. 200 m alt., 17 May 1993, *Liu 133* (HAST).

Distribution and notes. Presently known only in Taipei Hsien, northern Taiwan (Figure 4), scattered for nearly 20 km along a mountain trail on west side of Nanshih River valley at ca. 200-500 m elevation in Wulai. It is also found disjunctly in Hsichih, ca. 25 km northeast of Wulai. Based on a comparison of morphology, distribution pattern, chro-

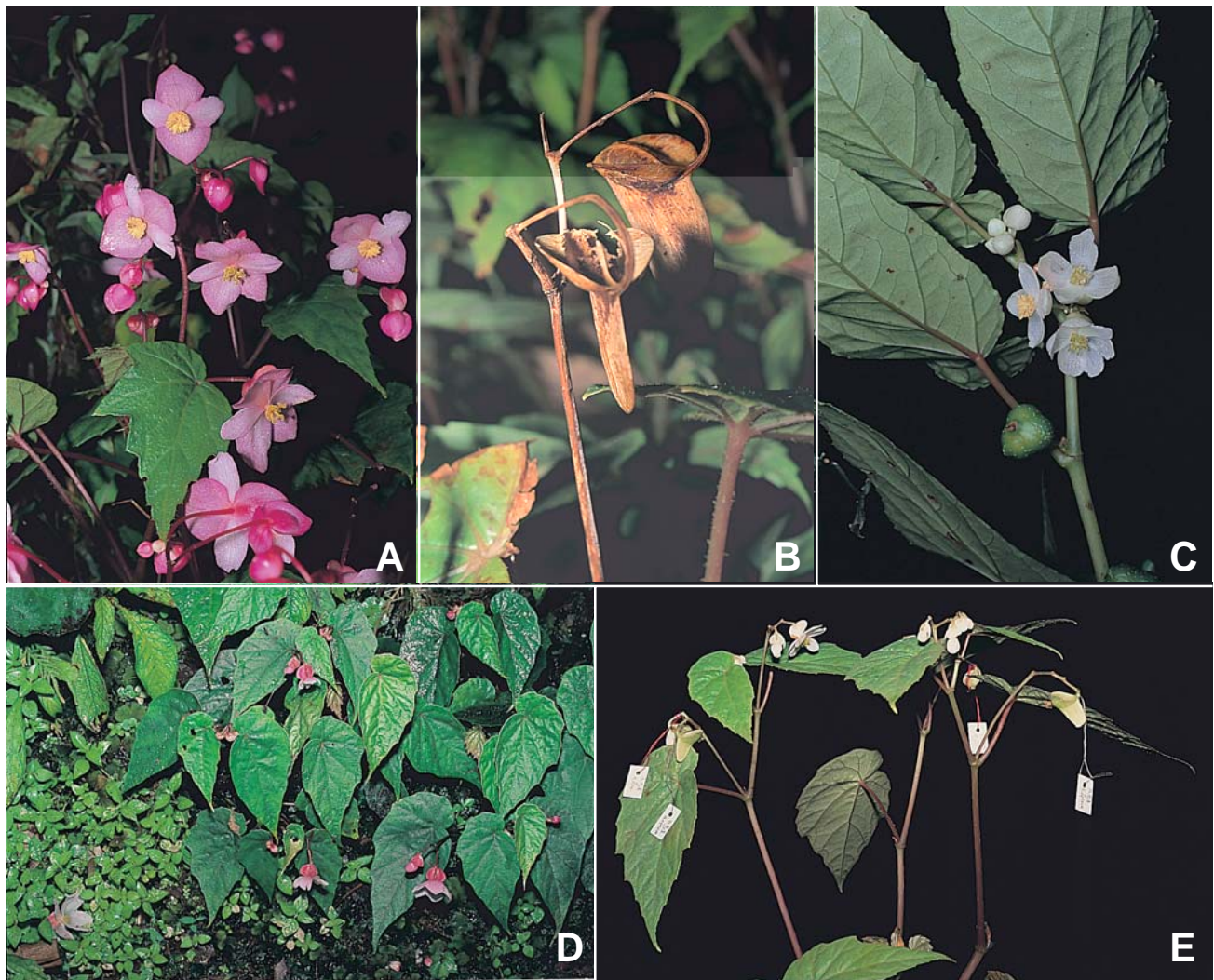


Figure 2. Photographs of *Begonia*. A, *B. formosana*, habit; B, *B. formosana*, mature and dehiscent capsules; C, *B. aptera*, habit; D, *B. ×taipeiensis*, habit, showing fully open pistillate flowers and precociously dropped staminate flower buds; E, *Begonia ×taipeiensis* in cultivation, forming plump capsules with completely shrunken seeds after experimentally backcrossing to putative parents.

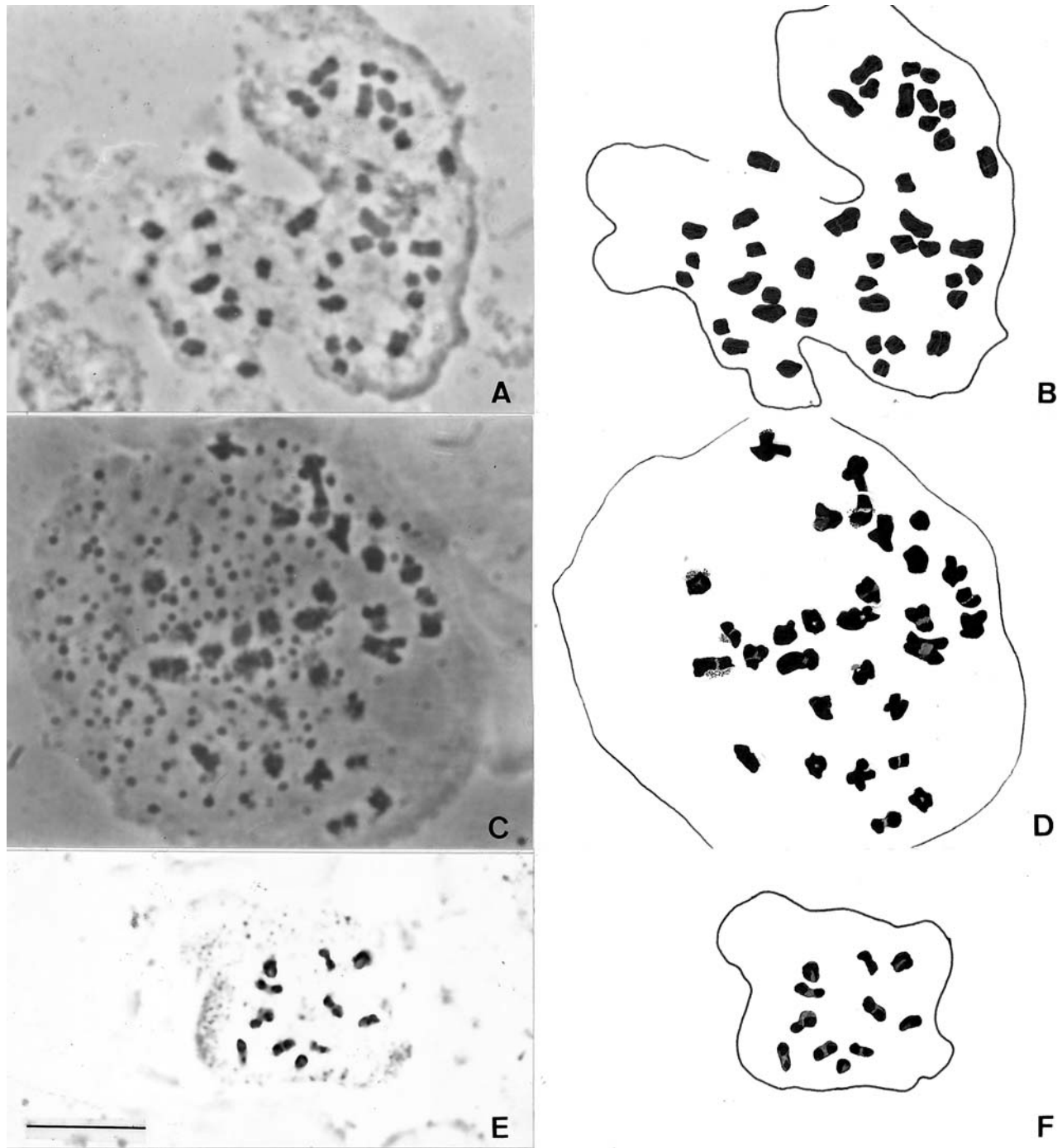


Figure 3. Microphotographs and camera lucida drawings of chromosome spreads. A-B, *B. xtaipeiensis*, $2n = 41$, from Peng 14804 (HAST); C-D, *B. formosana*, $n = 30$, from Leu 1579 (HAST); E-F, *B. aptera*, $n = 11$, from Peng 14702 (HAST). Bar equals 10 μm .

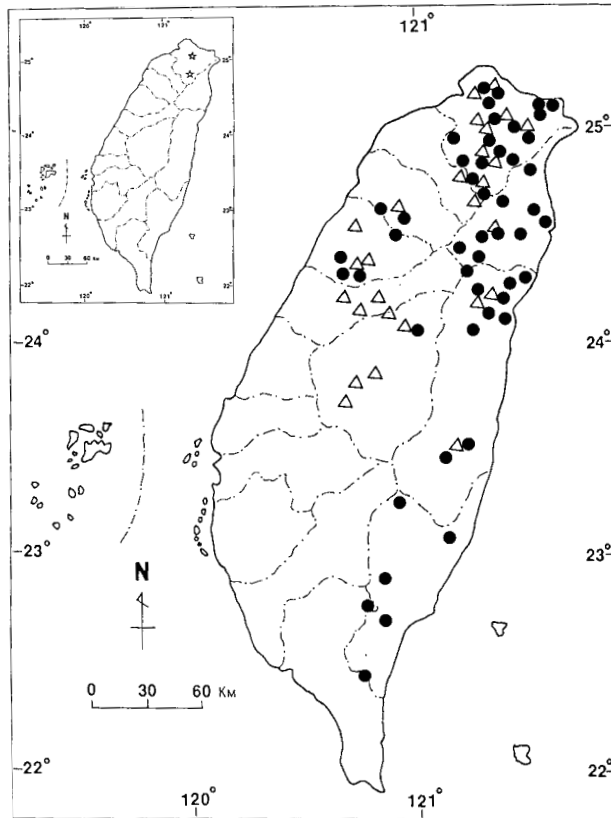


Figure 4. Distribution of *Begonia aptera* (triangles), *B. formosana* (dots) and *Begonia ×taipeiensis* (inset; stars) in Taiwan.

mosome cytology and the results of experimental hybridization, we concluded that plants of *B. ×taipeiensis* are F_1 hybrids between *B. aptera* Blume [sect. *Sphenanthera* (Hassk.) Warb.] and *B. formosana* (Hayata) Masam. [sect. *Platycentrum* (Klotzsch) A. DC.].

The hybrid nature of *B. ×taipeiensis* was initially suspected because of the peculiar flowering habit. As in *B. ×buimontana* Yamamoto, a documented natural hybrid in Taiwan (Peng and Chen, 1991), staminate flowers of *B. ×taipeiensis* usually develop normally up to the late bud stage and then drop off before they open. Fully open staminate flowers were observed only in one collection, *Liu 132* (HAST, see above). Pistillate flowers were always fully open at anthesis, and bud drop did not occur. Fruit set was never observed in the wild. We also found occasional hermaphrodite flowers, which is unusual for *Begonia*. Plants brought back from the wild and cultivated in the experimental greenhouse behaved similar to plants in nature.

Pollen fertility of *B. ×taipeiensis* was estimated by determining the percentage of stainable pollen using malachite green-acid fuchsin-orange G stain of Alexander (1969). Pollen was squeezed out for study from anthers of precociously dropped flower buds of all of the living collections we maintained in the experimental greenhouse of the Institute of Botany, Academia Sinica, Taipei. They revealed nearly complete abortion of the pollen grains. Many grains were aberrant in shape (Figure 5). Cytological studies showed that the meiotic chromosome configurations of *B. ×taipeiensis* typically consisted of some sticky, often disoriented bivalents, univalents and multivalent associations (Peng and Chiang, 2000: Figure 2).

Table 1. Comparison of *Begonia ×taipeiensis* with putative parents, *B. aptera* and *B. formosana*.

Characters	<i>B. aptera</i>	<i>B. ×taipeiensis</i>	<i>B. formosana</i>
Creeping rhizome	lacking	present	present
Leaf			
Shape	lanceolate	lanceolate to ovate	ovate to very widely ovate
Length : width ratio	2.2-4.2 : 1	1.7-2.6 : 1	1.1-2.0 : 1
Pubescence (no./ cm ²)			
Two-armed glandular trichome	127 ± 26	101 ± 30	108 ± 14
Multiseriate trichome	lacking	8 ± 3	11 ± 5
Silver-gray speckles (diam., mm)	0.05-0.25	0.125-0.5	0.625-2.5
♀ flower			
Number of ovary cell	3	2 or 0*	2
Number of wings per ovary	0	1*, 2* or 3	3
Number of style	3	2, 2½*, 3	2
Number of perianth	6	5-6	5-8
Length of pedicel (mm)	4-6	6-12	12-20
♂ flower			
Number of stamens per flower	49-81	71-96	82-124
Inflorescence length (cm)	1.5-5	1-5	6-13
Pollen stainability (%)	78-98	0-1 (-18)	83-100
Chromosome number	<i>n</i> = 11	2 <i>n</i> = 41	<i>n</i> = 30
Flowering season	Jun - Aug	Apr - Dec	Mar - Dec

*Abnormal, hermaphroditic flower.

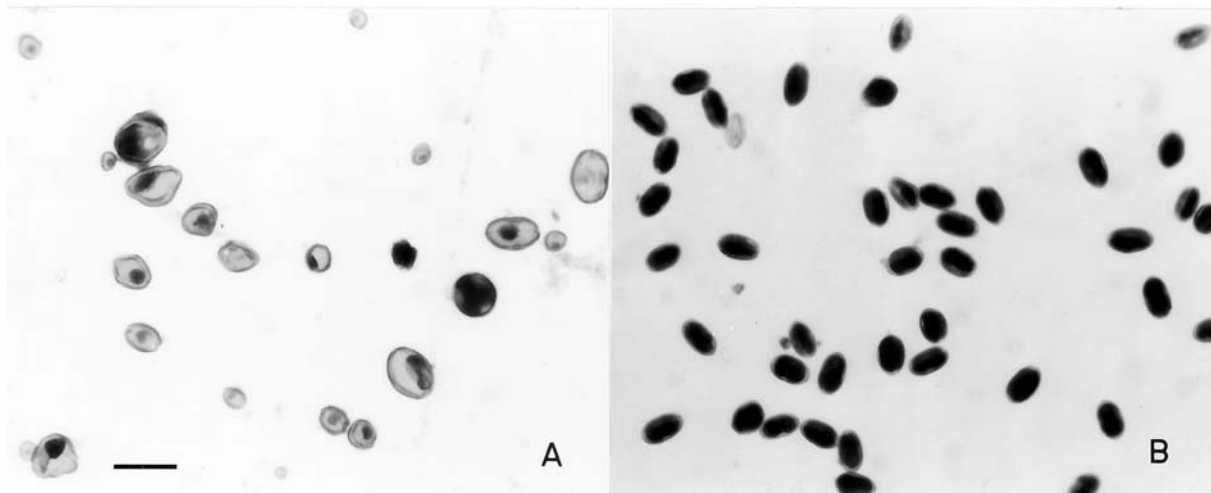


Figure 5. Aberrant and aborted pollen of *Begonia* \times *taipeiensis* (A) vs. mostly normal and stainable pollen of other species of *Begonia*, e.g. *B. aptera* (B). Bar equals 20 μ m.

Begonia \times *taipeiensis* (Figure 2D) was suspected to represent a natural hybrid between *B. aptera* and *B. formosana* based on a comparison of morphology and distribution ranges. *Begonia aptera* (Figure 2C) is a cane-like species (to 110 cm) with lanceolate leaves and clusters of short-peduncled inflorescences drooping from upper leaf axils. Its flowers are pure white and the fruits are fleshy, somewhat berry-like, wingless and 3-loculed. *Begonia aptera* is common in the northern half of Taiwan at about 50-2,000 m elevation. By contrast, *B. formosana* (Figure 2A) has thick, horizontal rhizomes and ovate to widely ovate

leaves; erect stems are seen during the flowering season. Its inflorescences are long-peduncled and the flowers are white to reddish pink. The fruits are 2-loculed, unequally 3-winged, dry capsules, the abaxial wing protruded prominently (Figure 2B). *Begonia formosana* is widespread throughout the northern half and eastern part of Taiwan, also at an elevation of 50-2,000 m. The two species overlap widely geographically and altitudinally. In fact, of the more than 12 species of *Begonia* in Taiwan, *B. aptera* and *B. formosana* are the only two species distributed in Taipei Hsien, where *B. x taipeiensis* is found. Plants of *B. x taipeiensis* are often found intermixed with or growing near *B. aptera* and/or *B. formosana*. Plants of *Begonia x taipeiensis* are intermediate in many vegetative and floral characters between the putative parents, as shown in Table 1 and Figure 6.

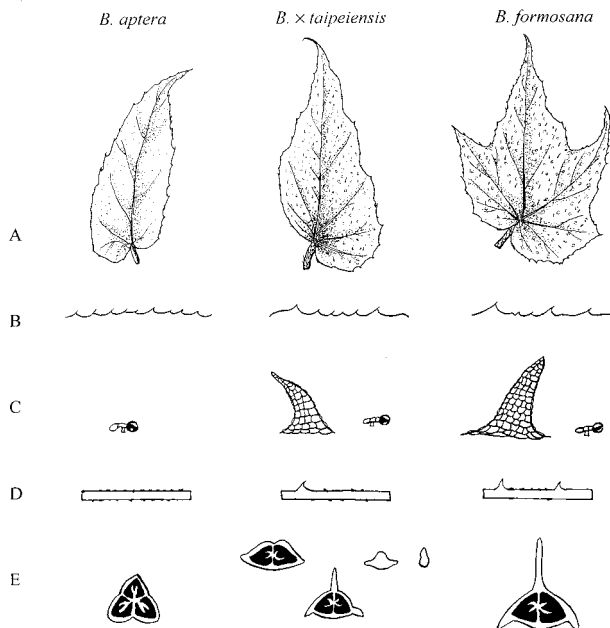


Figure 6. Comparison of *Begonia* \times *taipeiensis* with putative parents, *B. aptera* and *B. formosana*. A, Leaf; B, Leaf margin; C, Leaf surface trichome; D, Leaf, cross section; E, Ovary, cross section, showing placentation.

Cytological data are most supportive of the putative parentage of *B. x taipeiensis*. *Begonia aptera* has $n = 11$ (Figure 3E-F) and *B. formosana* has $n = 30$ (Figure 3C-D) chromosomes (Figure 2) and they have been assigned to different sections of the genus. *Begonia x taipeiensis* has a somatic chromosome number of $2n = 41$ (Figure 3A-B), exactly as would be expected in F_1 hybrids between the putative parents. In order to substantiate our hypothesis that the new species is derived from natural hybridization between *B. aptera* and *B. formosana*, we attempted artificial crosses between them. These trials consistently resulted in germinable seeds and healthy F_1 plants, but only when *B. formosana* was used as the female parent. Molecular data obtained from sequences of the *atpB-rbcL* spacer of chloroplast DNA also confirmed that unidirectional hybridization between the putative parents in the wild resulted in the formation of *B. x taipeiensis* (Peng and Chiang, 2000). These experimental hybrids closely resembled *B. x taipeiensis* in aspect and morphology. They also shed staminate flowers precociously. Occasionally the staminate flowers opened, but the anther sacs either were empty or contained only a few aborted pollen grains. Ex-

perimental backcrossing attempts to putative parents using *B. ×taipeiensis* as the ovule donor produced plump capsules (Figure 2E) with completely shrunken seeds.

In conclusion, *B. ×taipeiensis* is an F_1 hybrid between *B. aptera* and *B. formosana*. As a result of discrepancy in chromosome number and/or disharmony in the genomes from the parental species, it is pollen-sterile, sheds staminate flowers prematurely, and fails to set fruit. Although *B. ×taipeiensis* is completely sterile, once established, it is able to persist in a given location due to its perennial habit. As in nearly all other congeners, it is also capable of vigorously reproducing from fragments of leaves, stems or rhizomes. Although both parents are widespread and sympatric in the mountainous areas of the northern half of Taiwan, *B. ×taipeiensis* is known only from Wulai and Hsichih in the Taipei basin (Figure 4). We believe more intensive and careful field studies will show this natural hybrid to be more abundant than now documented.

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台灣產之新天然雜交種：台北秋海棠

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本文報導採自台灣北部的新天然雜交種秋海棠，台北秋海棠 (*Begonia ×taipeiensis*)，並提供拉丁文描述、植物繪圖與分布圖。由形態特徵、地理分布、花粉可染度、種子結實率、染色體細胞學觀察以及人工雜交試驗，初步證實台北秋海棠為水鴨腳 (*B. formosana* (Hayata) Masam.) 與圓果秋海棠 (*B. aptera* Blume) 的天然雜交 F_1 後裔。雖然台北秋海棠目前僅發現於台北縣汐止與烏來海拔約 200 至 500 公尺的山區林道旁濕潤之土坡或岩壁，但其親本植物廣布於台灣北部山區，且生育地多有重疊，透過更仔細的調查與研究，或將發現更多的台北秋海棠族群。

關鍵詞：秋海棠；圓果秋海棠；水鴨腳；台北秋海棠；雜交種；天然雜交；台灣；分類學。