



A new hybrid of *Tectaria* (Tectariaceae) from southern China

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Abstract

A new natural hybrid, *Tectaria* × *hongkongensis* (Tectariaceae), is described and illustrated from Hong Kong, China. It is a sterile hybrid supported by the abortive spores and cytological data [$2n = 120 (3x)$]. This hybrid is morphologically somewhat similar to *T. zeilanica* in the small size of plants, strongly dimorphic leaves, the shape of sterile fronds, and acrostichoid sporangia. Molecular data indicate its maternal parent is probably *T. harlandii*. *Tectaria* × *hongkongensis* is the first hybrid confirmed by morphological and cytological evidence in East Asia.

Key words: chromosome number, Hong Kong, hybrid origin

Introduction

Tectaria Cavanilles (1799: 109) is a large genus in ferns with extremely diverse morphology. The traditionally defined *Tectaria* is estimated to contain about 150 (Tryon & Tryon, 1982) to 210 species in pantropical areas (Holtum, 1991), of which about 50 in neotropics (Tryon & Tryon, 1982; Moran 1992, Rojas 2001, Smith 2006, Kessler & Smith 2007, Rojas & Sanín 2014, Riverón-Giró & Sánchez 2015). Molecular studies in recent years supported the monophyly of *Tectaria* in a broad sense which should include nearly all related satellite segregates with the basic number of chromosome being 40, such as *Heterogonium* C. Presl (1851: 142), *Psomiocarpa* C. Presl (1851: 161), *Tectaridium* Copeland (1926: 329) but excluding *Hypoderris* R. Brown ex Hooker (1838: t.1) (Ding *et al.*, 2014; Moran *et al.*, 2014; Wang *et al.*, 2014). *Tectaria* is a taxonomically difficult group which is caused by the probability of unrecognized hybrids, the lack of cytological information, and others (Tryon & Stolze, 1991: 23). Based on the unusual leaf architecture of collections in *Tectaria*, Tryon and Tryon (1982) speculated that the hybridization may be of some frequency in this genus. However, to date very few hybrids have been reported in *Tectaria* (e.g., Lellinger, 2003). In Malesia, a distribution center of *Tectaria*, total 105 species of *Tectaria* were recorded, of which only three postulated hybrids were proposed based merely on the morphological comparison (Holtum, 1991). There is not any hybrids of *Tectaria* reported in East Asia.

During the course of revising the *Tectaria* from China, we found an interesting collection (*Dong 3631*, IBSC) originally from Hong Kong which is obviously different in morphology from all known species in China and nearby regions. Morphological observations in the last decade showed that the spores are always aborted and the cytological study proved the collection is triploid with $2n = 120$, which indicates its hybrid origin. In the molecular tree based on several cpDNA regions this collection was associated with *Hemigramma decurrens* (Hooker, 1857: 359) Copeland (1928: 404) [= *T. harlandii* C.M. Kuo (2002: 173)], forming a well-supported terminal clade (Ding *et al.*, 2014). So *T. harlandii* is probably the maternal parent of this hybrid. This is the first confirmed hybrid of *Tectaria* in Asia by morphological and cytological evidence. To facilitate the communication and to better understand the remarkable morphological divergence in *Tectaria* we formally publish this hybrid here.

Tectaria × *hongkongensis* S.Y. Dong, **nothosp. nov.** (Figs. 1 & 2)

Type:—CHINA. Guangdong: Guangzhou, South China Botanical Garden (Introduced from Kadoorie Farm & Botanic Garden, Hong Kong, natural in Hong Kong), 30 m, 17 Sep 2011, S.Y. Dong 3631 (holotype, IBSC; isotypes, IBSC).

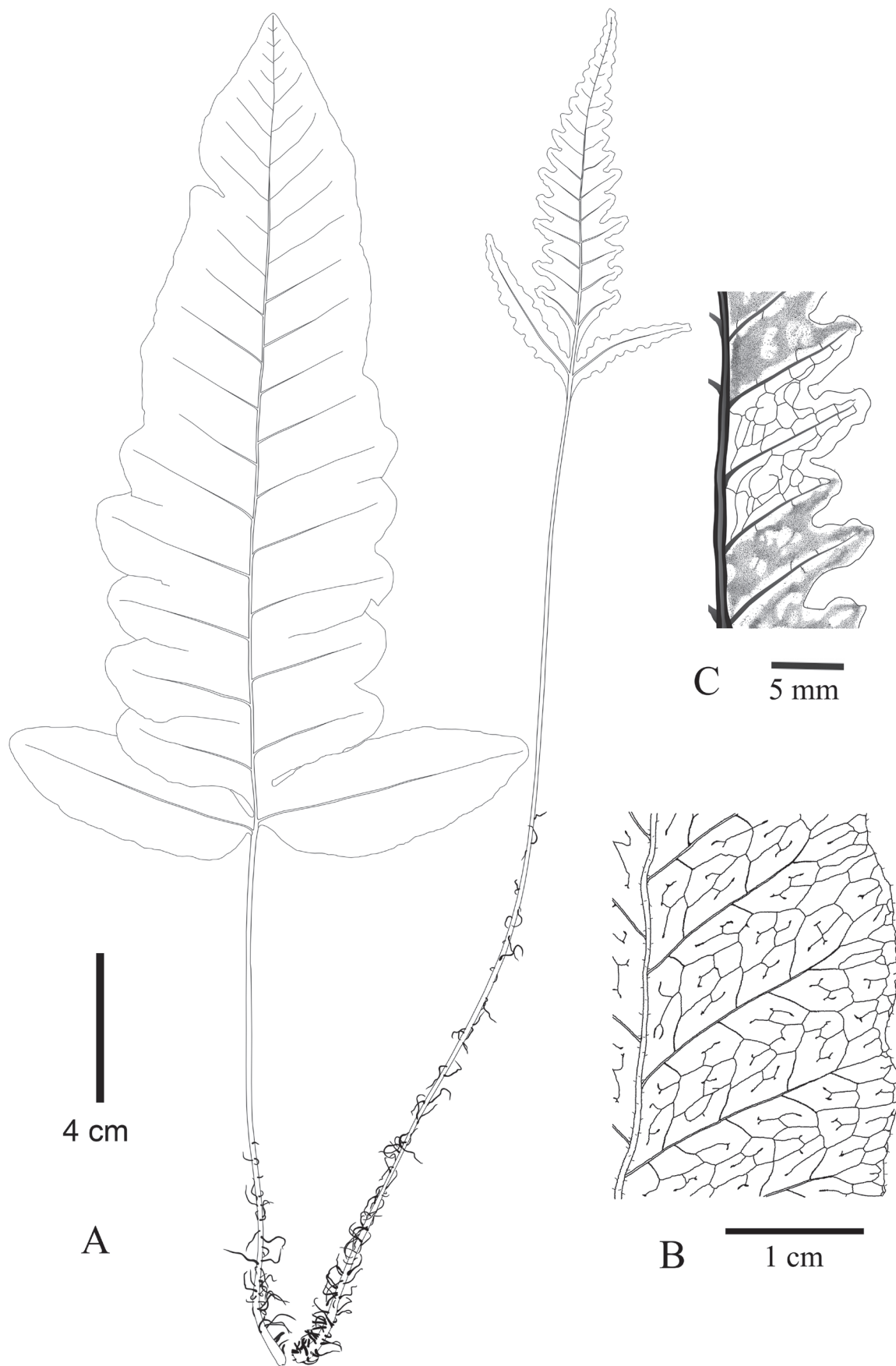


FIGURE 1. Line drawings of *Tectaria* × *hongkongensis* based on *S.Y. Dong 3631* (holotype, IBSC). A. Habit of sterile and fertile frond. B. Veins on sterile frond. C. Abaxial view of fertile fragment, showing acrotichoid sporangia and veins.

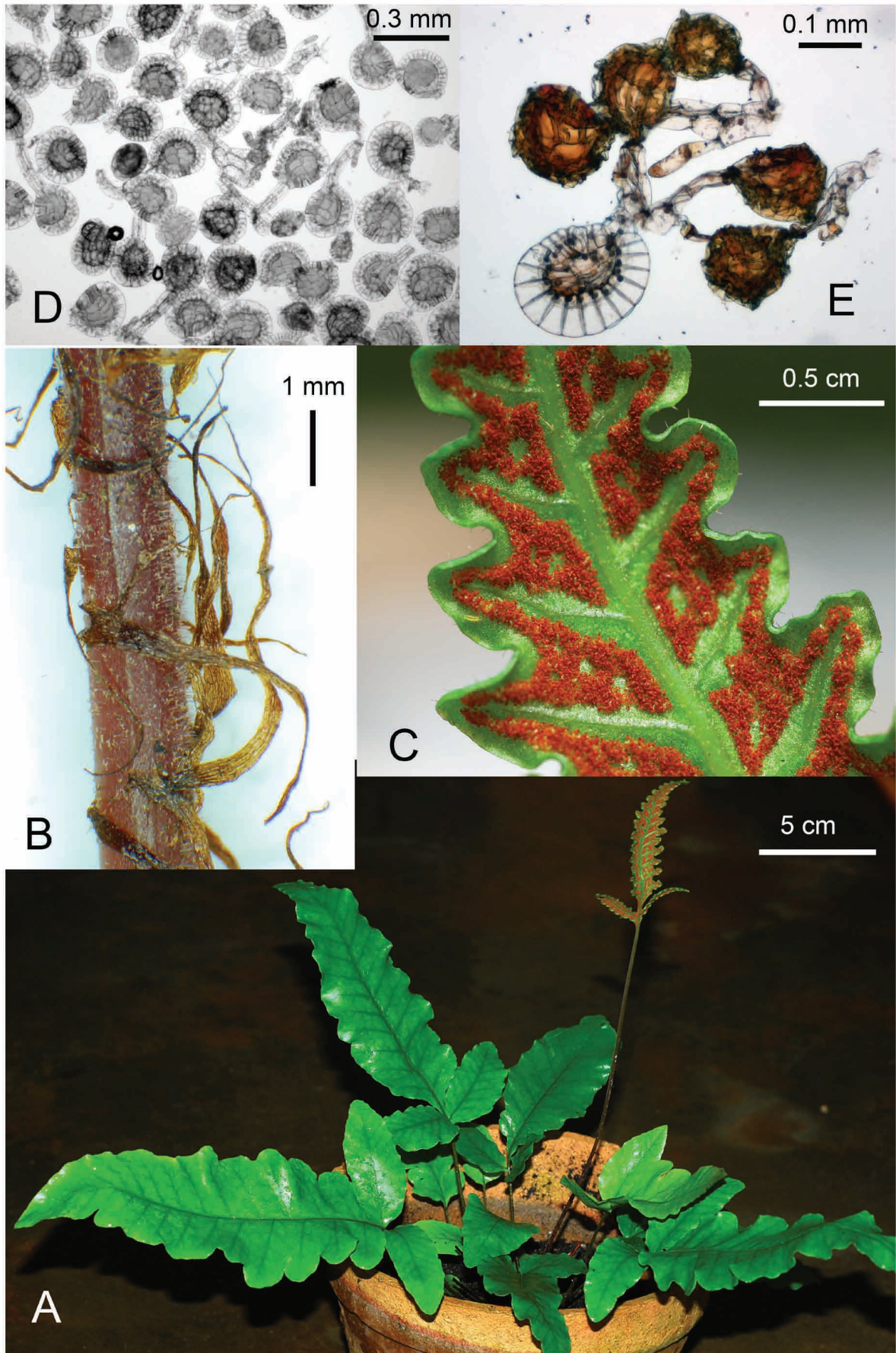


FIGURE 2. *Tectaria × hongkongensis* in culture. A. Habit. B. Scales on basal part of a stipe. C. Abaxial view of fertile lamina. D–E. Sporangia containing no spores (spores aborted).

Rhizome short-creeping, fronds strongly dimorphic. Sterile stipes 5–15 cm long, 1–2 mm thick, dark brown to castaneous, covered with short hairs (consisting of 3–4 cells), with some narrow scales confined to the base of or on lower stipe; scales brown, 4–6 mm long, ca. 0.2–0.5 mm wide, entire; lamina simple or trilobed, 12–22 long, 6–16 cm wide at base, lanceolate or triangular, crenate at margin or variously lobed towards base, cordate at base, obtuse at apex, fully developed fronds with a pair of basal pinnae; basal lobes or pinnae oblong, 4–9 cm long, 1.5–4 cm wide, entire, obtuse at apex, broadly cuneate at base, sessile; veins amply anastomosing, 4–6 veins arising from either side of main lateral veins, connecting, areoles with included free veinlets, veinlets variously directed, mostly branched, their ends thickened; lamina chartaceous or herbaceous when dry, glabrous except sparse minute hairs on either surface of rachis and on abaxial surface of main lateral veins, rachis adaxially flat and abaxially prominent. Fertile fronds much contracted, with much longer stipes to 20–23 cm long; fertile lamina trilobed, with a long central lobe and a short lateral one at base on either side; central lobe 9–10 cm long, 1.5–2 cm wide, distal part gradually narrowed, somewhat suddenly narrowed at base and connected (rarely separate) to lateral lobes; lateral lobes or pinnae obliquely spreading, lanceolate, 3–5 cm long, 3–5 mm wide, crenate or lobed one thirds to rachis, acuminate at apex, adnate to rachis; veins anastomosing, much simpler than those on sterile lamina, areoles lacking included free veinlets; sporangia distributed along connected veins between main lateral veins, sterile space present along either side of main lateral veins and on central part of veins' areoles, indusia wanting; spores aborted.

Additional specimens examined (paratype):—CHINA. Hong Kong: Kadoorie Farm & Botanic Garden, July 2005, *Wicky Lee s.n.* (IBSC).

Distribution:—Currently known natural in Hong Kong, cultivated in some gardens in southern China, such as FairyLake Botanical Garden, Shenzhen, and South China Botanical Garden, Guangzhou.

Reproduction:—We have kept on observing the development of spores since 2005 when the hybrid was initially introduced to South China Botanical Garden (SCBG) from Hong Kong. It can produce fertile fronds several times per year, but the spores seem never developed at all. We can see many sporangia on the abaxial surface of fertile lamina but when examining using lens or microscopes we found that the sporangia are all empty, without any spores developed inside the sporangia (Fig. 2: D, E). The originally introduced plant maintains alive all these years in SCBG and can bear new fronds, both sterile and fertile ones, every year on the tip of the creeping rhizome. The branched rhizome can be cut off and grows independently. So the *T. × hongkongensis* can be determined as a sterile hybrid.

Cytology:—To know the ploidy of *Tectaria × hongkongensis* we examined the chromosome numbers of somatic cells. Leaf tips were pretreated in 0.002 M 8-hydroxyquinoline solution at room temperature (about 25°C) for 6 h, fixed in 1 : 3 acetic-alcohol mixture (one part of glacial acetic acid and three parts of absolute ethanol) at 4°C for 12 h, macerated in 1 : 1 mixture of 1 M HCl and 45% acetic acid at 45° for 30 min, and then stained and squashed in 1% aceto-orcein.

The somatic chromosome number of *Tectaria × hongkongensis* was carried out to be $2n = 120$ (Fig. 3). It is a triploidy since the basic number of *Tectaria* is determined as $x = 40$ (Love *et al.*, 1977; Takamiya, 1996; Cheng & Zhang, 2010). Cytological data provide strong evidence for the hybrid origin of *T. × hongkongensis*.

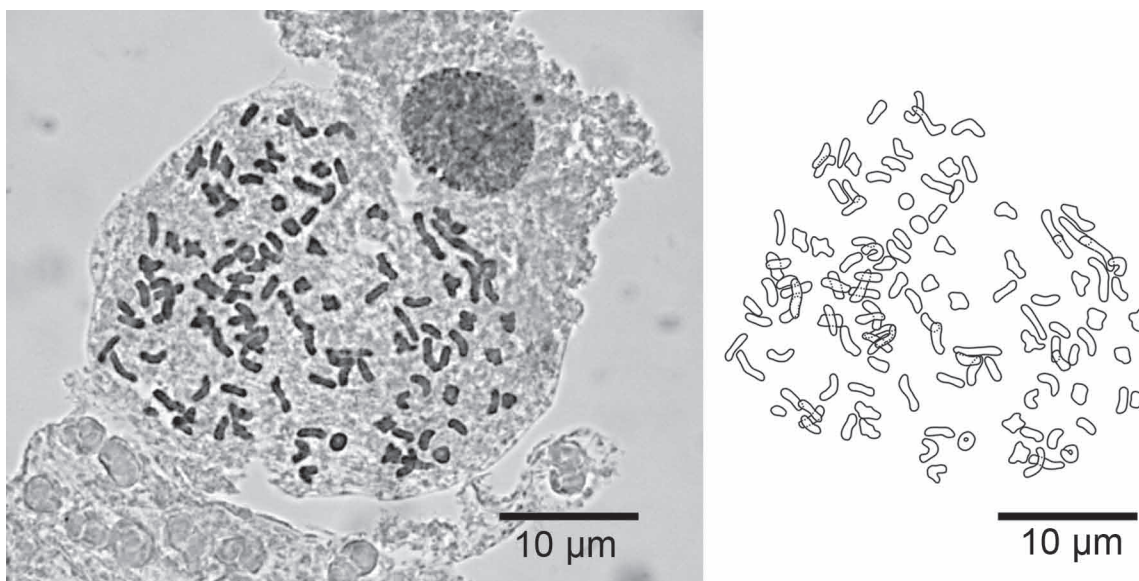


FIGURE 3. Mitotic metaphase chromosomes of *Tectaria × hongkongensis* [$2n = 120$ ($3x$)].

Postulated parents:—Morphological comparisons show that *Tectaria* × *hongkongensis* is most similar to *T. zeilanica* (Houttuyn, 1783: 43) Sledge (1972: 422), a common species of *Tectaria* in Hong Kong (Lee *et al.*, 2003). Both have the strongly dimorphic fronds, creeping rhizomes, similar shape of fertile fronds, acrostichoid or nearly so sporangia. Furthermore, the shape and division of the young or premature sterile fronds in *T. × hongkongensis* are very similar to the sterile fronds of *T. zeilanica*. The main differences between the two taxa lay in the fully developed sterile fronds of *T. × hongkongensis* being much bigger, nearly glabrous, and with a pair of much more prolonged basal lobes or pinnae. Except *T. zeilanica*, the hybrid does not seem similar to any other species of *Tectaria*. So *T. zeilanica* is postulated to be one of parents of *T. × hongkongensis* and the second parent is unknown to us based on morphology.

Molecular data, however, provide clues on the second parent of *Tectaria* × *hongkongensis*. In the molecular tree based on several regions of cpDNA (*atpB*, *ndhF* plus *ndhF-trnL*, *rbcL*, *rps16-matK* plus *matK*, and *trnL-F*), the sampled *T. × hongkongensis* (Dong 3631) was resolved as sister to two samples of *Hemigramma harlandii* (= *T. harlandii*) (Ding *et al.*, 2014). This suggests that *T. harlandii* is probably the maternal parent of *T. × hongkongensis*. In the size of plants *T. × hongkongensis* is intermediate between *T. zeilanica* and *T. harlandii*, and the latter two are only species with strongly dimorphic leaves and acrostichoid sori in southern China (including Hong Kong). Cytological data are also in line with the hypothesis that *T. × hongkongensis* is derived from the hybridization between *T. zeilanica* and *T. harlandii* because *T. harlandii* is tetraploid with $n = 80$ (Tsai & Shieh, 1985) whereas *T. zeilanica* was reported with $n = 80$ from Sri Lanka (Manton and Sledge, 1954) and $n = 40$ from Taiwan (Tsai and Shieh, 1977, 1985), though we fail to examine the chromosome numbers of both species from Hong Kong. We have also tried to test the phylogenetic relationships between *T. × hongkongensis* and *T. zeilanica* using nuclear genes (*SAD1*, *TPLATE*, *PgiC*) but failed due to the inappropriate markers and the difficulty of the sequencing itself. It remains for further studies to confirm the paternal parent of *T. × hongkongensis*.

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