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A new record of the genus *Yua* (Vitaceae) from Vietnam

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Abstract

Yua C.L. Li (Vitaceae), a genus previously known from China, Nepal and India, is newly recorded from Vietnam. A specimen discovered in the rainforest of Lao Cai province, northern Vietnam was identified as *Yua austro-orientalis* (F.P. Metcalf) C.L. Li based on both morphological and molecular data. To improve our understanding of relationships between *Yua* and *Parthenocissus* Planch., we present diagnostic characteristics for these two genera. We discuss leaf, stem and seed features used to distinguish between *Y. austro-orientalis* and *Y. thomsonii* (M.A. Lawson) C.L. Li, a species widely distributed in China, Nepal and northern India. The opportunity is taken to review the typification of all *Yua* taxa. A lectotype is selected for *Vitis thomsonii* M.A. Lawson.

Key words: Vitaceae, *Yua*, *Yua austro-orientalis*, New record, Vietnam, *Parthenocissus*

Introduction

Vitaceae (the grape family) consist of 15 genera and ca. 900 species mainly distributed in tropical and subtropical regions of both the Old World and New World (Wen 2007, Wen *et al.* 2015). Members of the family can be easily recognized by their leaf-opposed tendrils and unique seed characteristics (Chen *et al.* 2007, Wen 2007, Zhang *et al.* 2015).

Generic circumscription has changed substantially as our understanding of phylogenetic relationships within Vitaceae has increased through the analysis of molecular data (Wen *et al.* 2015). The genus *Yua* C.L. Li (1990: 2) [type, *Yua thomsonii* (M.A. Lawson 1875: 657) C.L. Li (1990: 5)] was segregated from *Parthenocissus* Planch. (1887: 447) by Li (1990) based on its two-branched tendrils and its leaf-opposed inflorescence, which forms a compound dichasium (Table 1). *Yua* includes two species, *Y. austro-orientalis* (F.P. Metcalf 1948: 132) C.L. Li (1990: 7) and *Y. thomsonii*; the genus was previously recorded from central and southern China, central Nepal and northern India (Chen *et al.* 2007, Wen 2007).

TABLE 1. Morphological comparison between *Parthenocissus* and *Yua*.

	<i>Parthenocissus</i>	<i>Yua</i>
Old stems	With sparse lenticels	With dense lenticels
Tendrils	Racemosely 4–12-branched with adhesive discs at tips	Bifurcate, without adhesive discs
Leaves	Simple, 3-foliolate, or palmate 5(–7)-foliolate	Palmate 5-foliolate
Inflorescences	Panicle or a loose corymbose polychasium, pseudoterminal	Compound dichasium, leaf-opposed
Seeds	Obovoid; ventral infolds furrowed upward from base to apex	Flat, pyriform; ventral infolds furrowed upward 2/3 from base

Vitaceae in Vietnam have been the subject of recent taxonomic studies by several authors (Pham 2003, Nguyen 2004, Nguyen 2012) who recognized seven genera: *Ampelopsis* Michx. (1803: 159), *Ampelocissus* Planch. (1884: 371), *Parthenocissus*, *Vitis* L. (1753: 202), *Cissus* L. (1753: 117), *Cayratia* Juss. (1818: 103) and *Tetrastigma* Planch. (1887: 423). During fieldwork in Lao Cai province of northern Vietnam in 2013, a collection, *Chen et al. VN0150*, was identified as *Yua austro-orientalis*, a genus and species previously unrecorded in Vietnam. The identity of this collection was confirmed based on both molecular and morphological data.

Materials & methods

Morphological analyses. We examined specimens from the following herbaria: A, CDBI, GH, HN, IBK, K, KUN, P, PE and VNM. The herbarium acronyms follow the Index Herbariorum (<http://sweetgum.nybg.org/ih/>). We also examined living material in the field. Leaf and stem characteristics of the new record and *Y. thomsonii* were observed under a microscope with camera attachment (Nikon SMZ1000 with a Nikon D700 digital camera). Photographs and measurements were taken using image software of NIS-Elements BR 3.1, Nikon Instruments Inc. Distribution of each species is based on herbarium labels (specimen labels) and published literature, such as Li (1990), Shetty & Singh (2000), Chen *et al.* (2007), and the Chinese Virtual Herbarium (<http://www.cvh.org.cn/>).

Molecular phylogenetic analyses. We extracted total genomic DNAs from silica gel-dried leaves of the collection, *Chen et al. VN0150*, and generated four new sequences (*atpB-rbcL*: KU923382, *rps16*: KU923383, *trnH-psbA*: KU923384, and *trnL-F*: KU923385). The primers and protocol used for PCR and sequencing in this study followed the protocols described in Lu *et al.* (2013).

We add the new sequences into a dataset with a global sampling scheme of Vitaceae from Lu *et al.* (2013) and expanded taxon sampling of *Parthenocissus* and *Yua*. The combined dataset was partitioned into five subsets corresponding to five chloroplast regions and was analyzed with the maximum likelihood (ML) and Bayesian Inference (BI) methods. ML analyses were conducted in RAxML 8.1.11 (Stamatakis 2006), applying 1,000 bootstrap replicates with the substitution model selected in MrModeltest 2.3 (Nylander 2004). The Bayesian analysis was conducted in MrBayes 3.2.6 (Ronquist *et al.* 2012) as implemented on the CIPRES Science Gateway Portal (Miller *et al.* 2010).

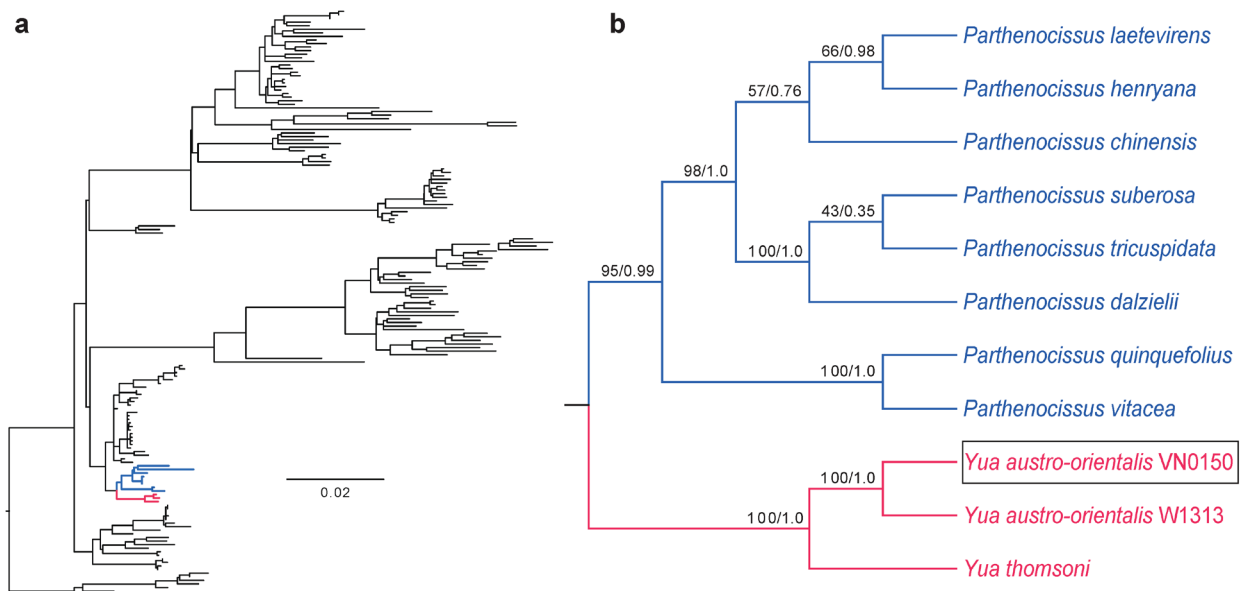


FIGURE 1. Maximum likelihood tree for Vitaceae; a) A phylogram overview based on the combined chloroplast data sets (*atpB-rbcL*, *rps16*, *trnC-petN*, *trnH-psbA*, and *trnL-F*); b) The clade including *Parthenocissus* and *Yua* with the newly recorded species *Y. austro-orientalis* highlighted. ML Bootstrap and Bayesian posterior probability values of major clades are indicated above branches.

Results

ML analyses of Vitaceae based on five chloroplast markers strongly supported *Yua* as sister to *Parthenocissus* (Fig. 1a). An enlarged figure of the clade *Parthenocissus*-*Yua* with support values is provided in Fig. 1b. The new specimen

collected from Vietnam (*Chen et al. VN0150*) grouped with *Y. austro-orientalis* with strong bootstrap support. Furthermore, by comparing specimens of *Parthenocissus* and *Yua* in the herbaria and the description in the Flora of China, we identified the collection as *Y. austro-orientalis*, a species previously unrecorded from Vietnam. *Y. austro-orientalis* is closely related to *Y. thomsonii*, but differs in having sub-leathery leaves (Fig. 2B; vs. papery leaves in *Y. thomsonii* in Fig. E), raised veinlets (Fig. 2C; vs. inconspicuously raised veinlets in *Y. thomsonii* in Fig. 2F), margins with angular teeth (Fig. 2D; vs. margins with rounded teeth in *Y. thomsonii* in Fig. 2G), dense lenticels (Fig. 2H; vs. relatively sparse lenticels in *Y. thomsonii* in Fig. 2L), and larger seed with rugose surface (Fig. 2I–K; vs. smaller seed with smooth surface in *Y. thomsonii* in Fig. 2M–O). *Y. thomsonii* is widely distributed in eastern, southern and central China and northeast India while *Y. austro-orientalis* only occurs in southeastern China and now, in northern Vietnam (Fig. 3). The new record of genus was collected from Lao Cai province of Vietnam and is indicated with an arrow in Fig. 3.

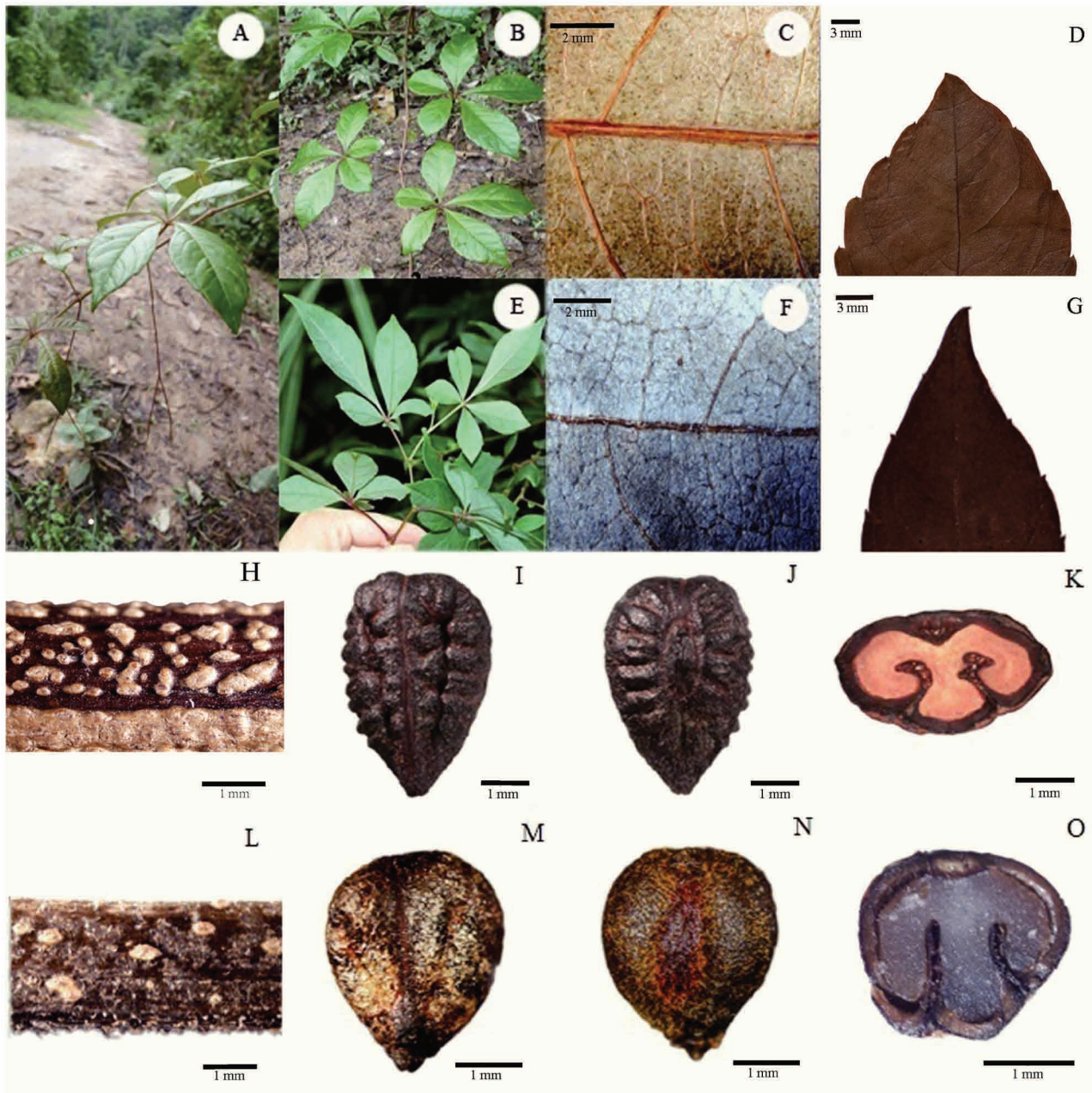


FIGURE 2. A. Habitat, Sapa, Lao Cai province, Vietnam. Comparative leaf characteristics between *Y. austro-orientalis* (B–D) and *Y. thomsonii* (E–G). Lenticels on stems of *Y. austro-orientalis* (H) and *Y. thomsonii* (L). Dorsal, ventral views and transverse sections of seed characteristics of *Y. austro-orientalis* (I–K) and *Y. thomsonii* (M–O). I–K. from Chen 2009.

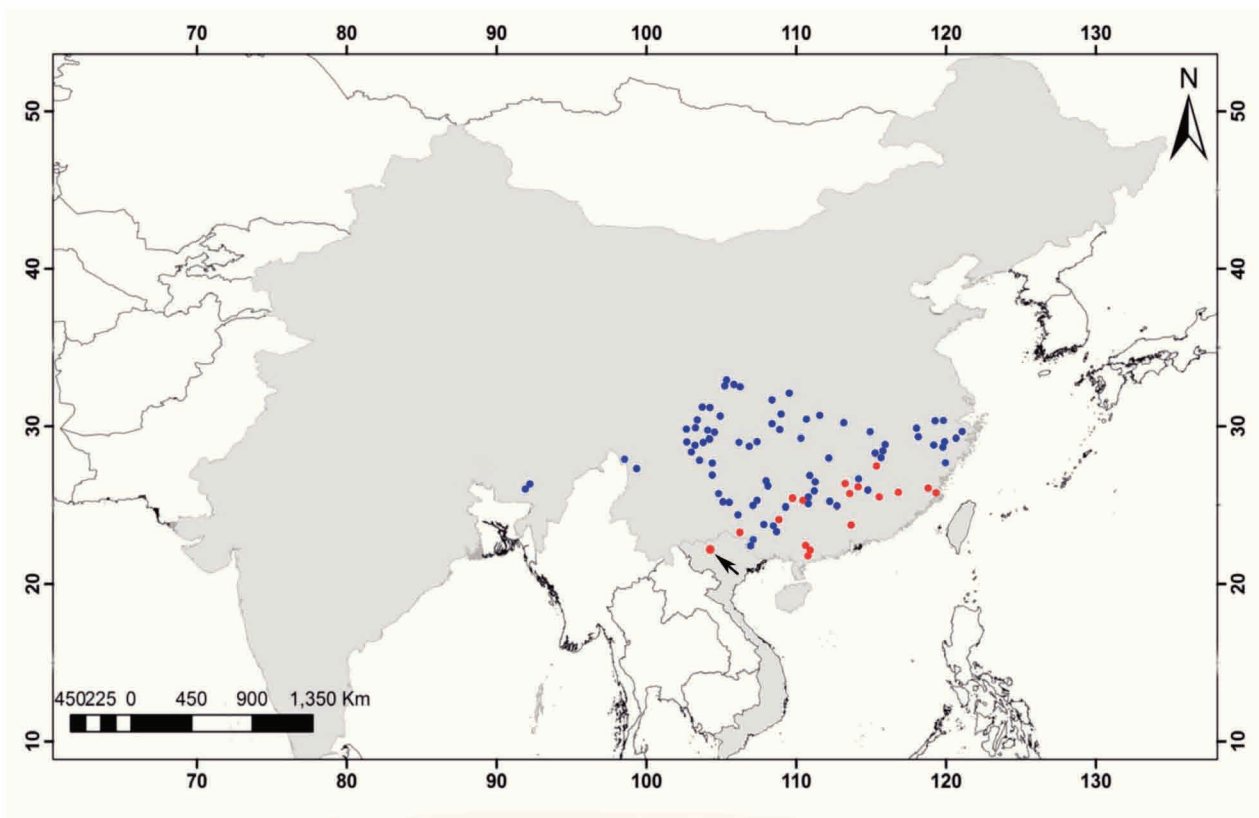


FIGURE 3. Distribution of *Y. austro-orientalis* (red dot) and *Y. thomsonii* (blue dot). An arrow indicates the locality of the new record from Vietnam.

Taxonomic treatment

Yua C.L. Li, (1990: 12). Type:—*Yua thomsonii* (M.A. Lawson) C.L. Li

Lianas, woody, hermaphroditic, with lenticels and white pith. *Stems* terete to slightly ridged, *tendrils* 2-branched. *Leaves* palmately pentafoliate. *Inflorescence* a compound dichasium, leaf-opposed. *Flowers* 5-merous; calyx cupular, entire; petals coherent in bud, opening at anthesis and falling off separately; stamens usually 5; disk inconspicuous; style conspicuous; stigma inconspicuously enlarged. *Berries* spherical, sweet and sour in taste. *Seeds* flat, pyriform, base rostrate, apex retuse, ventral infolds furrowed upward 2/3 from base; cross-section of endosperm M-shaped.

Yua austro-orientalis (F.P. Metcalf) C.L. Li (1990: 7). *Parthenocissus austro-orientalis* F.P. Metcalf (1948: 132, Fig. 1). Type:—CHINA, Guangdong, Lung T'au Shan, Iu, 5 June 1924, *To & Tsang* 12378 (holotype A! (barcode A00051628)).

Deciduous woody climbers. *Stems* terete, branchlets brownish or gray-brownish, with many lenticels, glabrous; *tendrils* bifurcate, without adhesive discs. *Leaves* compound, palmately 5-foliolate; petiole 3–5 cm long; leaflets subleathery, terminal petiolules 0.2–1 cm, glabrous, longer than lateral ones; terminal leaflet obovate-lanceolate or obovate-elliptic, 4.5–9 × 2–5 cm, glabrous, abaxially usually glaucous, base cuneate, margin 2–5-toothed on each side, rarely teeth inconspicuous, apex acute, shortly acuminate, or obtuse; petiolule of lateral leaflet inconspicuous, lateral leaflet blade obovate-elliptic, 2–5 × 1.5–2 cm, base narrow cuneate, margin and apex as terminal leaflet; veinlets conspicuously raised when dry, lateral veins 6–9 pairs. *Inflorescences* a compound dichasium, leaf-opposed; peduncles 1.5–2 cm. *Flowers* bud elliptic, 2–3.5 mm; pedicels 3–6 mm; calyx cupular, entire or wavy at the margin; petals 5, ca. 3 mm long, filaments 3–3.8 mm, anthers yellow, elliptic, ca. 2 mm long; pistil 2–2.5 mm long, style attenuate. *Berries* 1.5–2.5 cm in diam., amaranthine, sweet and sour in taste, 1–4 seeded. *Seeds* slightly flattened, 6–8 × ca. 5 mm, rugose.

Distribution:—China and Vietnam.

Distribution in Vietnam:—Lao Cai, Sapa. The voucher specimens have been incorporated into the Herbarium of the Institute of Botany (PE), Chinese Academy of Sciences, Beijing, China.

Ecology:—Forests or shrublands in valleys; 100–900 m.

Phenology:—Flowering in May–July; fruiting in October–December.

Specimens examined:—VIETNAM. Lao Cai: Sapa, 4 August 2013, *Z.D. Chen, L.M. Lu & J.B. Zhang VN0150* (PE). CHINA. Guangxi: 25 June 1956, *C.S. Qing 9528* fr. (PE, IBK); 20 September 2000, *Q.Z. Li 370* fr. (IBK); 28 June 2008, *Z.L. Zhong 1655* (IBK); 14 August 2008, *Z.L. Zhong 3178* (IBK); 4 July 2011, *LZ397* fr. (IBK); 18 October 2011, *D3277* fr. (IBK); 1 September 1930, *X.P. Gao 50800* (PE, IBK); 25 May 1932, *W.T. Tsang 20560* fr. (PE); 30 June 1957, *C. Huang 163075* fl. (KUN); 14 October 1958, *P.X. Tan 59851* fr. (PE, IBK); 27 July 1959, *P.C. Zhou 10482* (PE); Hunan: 1 September 1958, *Y.K. Li 401307* (IBK); Fujian: 20 October 1932, *Y. Ling 4204* (PE); Jiangxi: 28 September 1954, *Jiangxi expedition 1631* (PE); 28 June 1970, *W.Z. Ren 1108* (PE).

Typification:—Metcalf (1948: 132, 134) cited ‘Kwangtung: Lung T’au Shan, Iu Village, LU 12378* (To & Tsang), type, May 27, 1924, in forested ravine, vine, 15 m. “Pui-tai-t’ang; Kat-ts’ing-t’ang; and Sai-me-tai-t’ang” (CCC)’. This is a clear designation of a single type specimen. ‘CCC’ appears to represent the ‘Chinese Cultural Collection’, with the cited specimen held at A. The collection *W.T. Tsang 20560* (PE, 2 sheets) labeled ‘paratypus’ is original material, but not type material.

Yua thomsonii (M.A. Lawson) C.L. Li (1990: 2). *Vitis thomsonii* M.A. Lawson in Hook. f. (1875: 657–658, as *Thomsoni*). *Parthenocissus thomsonii* (M.A. Lawson) Planch. in DC. (1887: 453). *Cissus thomsonii* (M.A. Lawson) Planch. in DC. (1887: 565). *Cayratia thomsonii* (M.A. Lawson) E. Reid & M. Chandler (1933: 388). *Pseodera thomsonii* (M.A. Lawson) Stuntz in Taylor (1915: 35). Type citation:—‘Khasia Mts., alt. 4–6000 ft., *H. f. & T.*’ in M.A. Lawson (1875: 658).

Type:—INDIA, Assam Nunklow, Khasia, alt. 4–6000 ft., 10 July 1850, *J.D. Hooker & T. Thomson 1585* (Lectotype (designated here) K! (barcode K000736314); isolectotype K! (barcode K000736313)).

Residual Syntypes:—Assam Boga Panee, Khasia, 4–6000 feet, 29 June 1850, *J.D. Hooker & T. Thomson 1371* syntype K! (barcode K000736311). Assam [Nunklow], Assam Khasia, Sikkim, 4–6000 ft., 29 July 1850, *J.D. Hooker & T. Thomson s.n.* (syntypes GH! (barcode GH-HUH00051639), K! (barcode K000736312), K! (barcode K000736315), P! (barcode P00697602)).

Yua thomsonii (M.A. Lawson) C.L. Li var. *glaucescens* (Diels & Gilg) C.L. Li (1990: 6). *Parthenocissus henryana* (Hemsl.) Graebn. ex Diels & Gilg var. *glaucescens* Diels & Gilg (Gilg & Diels 1901: 464). Type:—Szechuan, *Bock & Rosthorn 226* (holotype?B, ?destroyed, photo at A, *n.v.*; isotype O, *n.v.*).

Yua chinensis C.L. Li (1996: 47). Type:—Sichuan, Qingcheng, alt. 1000 m, 13 June 1963, *X.Q. Li 177* (holotype CDBI! (barcode CDBI0172485)).

Specimens examined:—CHINA. Anhui: 23 June 1959, *2369* fr. (PE); Chongqing: 21 June 1956, *Chuanqian expedition 712* fr. (PE); 18 July 1959, *P.Y. Li 6558* fl. (PE); 9 July 1964, *K.J. Guan, J.W. Wang & C.L. Li 1284* (PE); 11 July 1964, *H.F. Zhou & H.Y. Su 109348* (PE); 22 June 1988, *F.D. Pu & Y.L. Cao 0093* fl. (PE); Gansu: 6 June 2006, *S.J. Bai 1237* (PE); Guangxi: 9 June 1928, *R.C. Qin 5886* (PE); 11 July 1937, *X.Q. Liu 28584* (PE); 17 August 1953, *Guangxi expedition 3399* fl. (PE); 20 June 1955, *Guangxi expedition 414* fr. (PE); 2 June 1957, *Y.K. Li P01338* fl. (PE, IBK); 21 July 1958, *Z.Z. Chen 51221* fr. (KUN, IBK); May 1981, *H.N. Tan 00163* fl. (PE); 9 September 2010, *LYJX0038* (IBK); 24 June 2012, *Y1580* fr. (IBK); Guizhou: 27 June 1930, *Y. Jiang 5414* fr. (PE); 7 July 1959, *Libo expedition 1006* (PE, KUN); 13 July 1959, *Qiannan expedition 2758* fr. (PE, KUN); 22 August 1959, *Anshun expedition 937* (PE, KUN); 20 May 1960, *Z.S. Zhang & Y.T. Zhang 3643* fl. (PE); 8 July 1960, *Z.S. Zhang & Y.T. Zhang 6751* fl. (PE); Hunan: 07 August 1942, *S.Q. Chen 2035* fl. (IBK); 24 July 1948, *Y. Liu 00194* fr. (PE); 31 August 1953, *Z. An & X. Nong 1251* fr. (PE); 12 July 1959, *P.X. Tan 62461* (PE, IBK); 24 June 1987, *P.S. Hu 632* fl. (PE); 18 August 2009, *J.H. Fan, H.L. Li, T. Yang & L.M. Lu 090818-05* fr. (PE); Jiangxi: 8 May 1963, *S.K. Lai 2043* fl. (PE, KUN); 24 May 1963, *S.L. Liu 1410* fl. (PE); 29 August 1963, *M.X. Nie 07670* fr. (PE); 14 August 1964, *W.H. Wan 1809* (PE); 28 April 1970, *(70)148* (PE); Hubei: 22 May 1958, *W.B. Lin 221* fl. (PE); 30 June 1958, *H.J. Li 3273* fl. (PE); 16 June 1959, *Y.L. Qiao 1426* fl. (KUN); Sichuan: 22 June 1936, *6024* (PE); 4 August 1938, *C.W. Yao 2666* fr. (PE); 12 July 1939, *C.W. Yao 4126* fr. (PE); 8 July 1952, *X.L. Jiang & X.S. Zhang 31564* (PE); 1954, *Z.P. Song 39413* fr. (PE, KUN); 1955, *C.J. Xie 40522* fl. (PE); 29 April 1958, *10142* fl. (PE); 27 August 1958, *X.L. Jiang 11044* fr. (PE); 10 May 1959, *J.M. Chuan 3067* fl.

(KUN); 27 May 1959, 8848 (PE); 1 June 1959, *J.Z. Chuan 0802* fl. (PE, KUN); 3 July 1959, *J.Z. Chuan 3598* fl. (PE, KUN); 29 August 1959, *Z.T. Guan 6646* fr. (PE); 12 August 1961, *J.S. Ying 10011* (PE); 20 August 1963, *K.J. Guan & W.C. Wang 1730* (PE); 2 September 1963, *K.J. Guan & W.C. Wang 2193* fr. (PE); 26 July 1976, *C.S. Ke & Z.B. Zu 13537* fl. (PE); 17 July 2002, *T.S. Yi 2042* fr. (KUN); Yunnan: 10 August 1947, *K.M. Feng 11029* fl. (PE); 13 June 1973, *B.X. Sun 590* fl. (KUN); 17 July 1982, *Qingzang expedition 7970* fl. (KUN); Zhejiang: 1927, *Y.L. Keng 537* (PE); 17 July 1957, *X.Y. He 23964* fr. (PE); 3 July 1958, *0609* (PE); 13 June 1959, *S.Y. Zhang 5745* fl. (PE, KUN); 28 July 1959, *S.Y. Zhang 6025* fr. (PE, KUN).

Typification:—The diagnostic characteristics for the genus (two-branched tendrils and leaf-opposed inflorescence forming a compound dichasium) are only both present on the sheet selected as lectotype of *Y. thomsonii*. It is also one of only two sheets bearing fruit, important for recognition of the species.

Key to the genera of Vitaceae in Vietnam

1. Petals united at apex, shed as a cap-like calyptra; inflorescence a compact, paniculate thyrs; bark on older twigs usually loose, peeling off in stripes *Vitis*
- Petals free; inflorescence a loose thyrs, panicle, dichasium, corymbose cyme, or umbel; bark intact, not peeling off in stripes ...2
2. Inflorescence a loose thyrs or panicle, base subtended by a tendril *Ampelocissus*
- Inflorescence a loose dichasium, corymbose cyme, or umbel, base without tendrils3
3. Petals 54
- Petals 46
4. Tendrils 4–12-branched, tips usually with adhesive discs *Parthenocissus*
- Tendrils usually 2(–3)-branched or unbranched, tips without adhesive discs5
5. Disk inconspicuous; inflorescence a compound dichasium, without reduced inflorescences appearing on tendrils *Yua*
- Disk well developed, 5-lobed; inflorescence a corymbose cyme, reduced inflorescence often appearing at tips of tendrils *Ampelopsis*
6. Inflorescence leaf-opposed; seeds with an encircling raphe near base; leaves simple *Cissus*
- Inflorescence usually axillary or pseudo-axillary, rarely leaf-opposed; seeds with 1 or 2 conspicuous ventral cavities nearly as long as seeds; leaves compound7
7. Style conspicuous, stigma undivided, slightly expanded *Cayratia*
- Style inconspicuous or short, stigma usually 4-divided, rarely irregularly divided *Tetrastigma*

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