A comprehensive checklist of the deciduous photinia genus *Pourthiaea* (Maleae, Rosaceae), with emphasis on their validity and typification

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Abstract

Due to the complicated evolutionary history in *Pourthiaea*, ninety-seven taxa have been described since 1784, and ninety-one of them are validly published taxa, five are naked names, and one is an invalid name. After a comprehensive and critical evaluation, 213 names have been published, including new combinations, new status, and new names; this may be due to the controversial taxonomic position of *Pourthiaea* in the apple tribe, Maleae. We herewith provide a taxonomic checklist of *Pourthiaea* for further taxonomic and evolutionary studies. We also lectotypify two taxa: *Photinia amphidoxa* var. *stylosa* and *P. glabra* var. *fokienensis*.

Keywords

Lectotype, nomenclature, *Photinia*, *Stranvaesia*, taxonomy, typification

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Introduction

Pourthiaea Decne. (Maleae, Rosaceae) is a small genus of deciduous shrubs or trees distributed from East to Southeast Asia (Kuan and Yu 1974; Gu and Spongberg 2003). The taxonomic identity of Pourthiaea has been controversial for decades, either as a section of Photinia Lindl. (Kuan and Yu 1974; Robertson et al. 1991; Gu and Spongberg 2003; Campbell et al. 2007; Potter et al. 2007), or a synonym of Aronia Medik. (Kalkman 2004), or a separate genus Pourthiaea (Iketani and Ohashi 1991; Guo et al. 2011; Liu et al. 2019, 2022). The controversial taxonomic status of Pourthiaea makes the published names unstable regarding generic membership. According to our comprehensive review in the present study, nearly 213 names, including new combinations, new statuses, and new names, exist in the literature, representing 91 validly published taxa. For example, a deciduous shrub species endemic to South China was described as Photinia benthamiana Hance in 1866. This taxon was then transferred either to Pourthiaea as P. benthamiana (Hance) Nakai in 1916 or to Stranvaesia as S. benthamiana (Hance) Merr. in 1917, as well as Pyrus as P. benthamiana (Hance) M.F. Fay & Christenh. in 1918.

Several recent phylogenetic studies have struggled to resolve the phylogenetic relationship between Pourthiaea and its closely related genera. Guo et al. (2011) firstly confirmed the monophyly of Pourthiaea using two plastid regions (trnL-trnF and psba-trnH) and nuclear ribosomal ITS sequences. Unfortunately, they did not resolve the phylogenetic relationships between Pourthiaea and its relatives due to limited informative sites and taxon sampling. Based on transcriptomic data, Xiang et al. (2017) recovered a sister relationship between Pourthiaea and a combined clade, including Chaenomeles Lindl., Cydonia Mill., and Pseudocydonia (C.K.Schneid.) C.K.Schneid. Furthermore, results from the whole plastome and/or plastid regions (Liu et al. 2019, 2020a, 2020b, 2022) supported a close relationship between Pourthiaea and part of Malus Mill., i.e., the Eastern North American and Mediterranean Europe clade (clade II of figure 5 in Liu et al. 2022). However, the nuclear phylogeny inferred from 785 single-copy nuclear genes in our recent study (Liu et al. 2022) supported a close relationship between Pourthiaea and a combined clade, Cydonia and Pseudocydonia, not including Chaenomeles, contradicting Xiang et al. (2017)'s result inferred from transcriptomic data. The discordant phylogenetic position between nuclear and plastid topologies indicated a possible chloroplast capture event in the evolutionary history of Pourthiaea (Liu et al. 2022). This series of phylogenetic and phylogenomic studies confidently resolved the monophyly and phylogenetic position of Pourthiaea. In addition, the monophyly of Pourthiaea was also supported by some morphological characters, such as deciduous leaves, warty peduncles and pedicels, Kribs’III-I heterogeneous rays in the wood, and clusters of stone cells surrounded by parenchymatous cells in the flesh of pomes (Iketani and Ohashi 1991; Lu et al. 1991; Zhang 1992).

Liu et al. (2019) provided a robust phylogeny of the Photinia complex using whole plastomes and entire nuclear ribosomal DNA (nrDNA) sequences with a comprehensive taxon sampling. They proposed a redefined generic circumscription of Pourthiaea, transferring two species and a variety of Stranvaesia Lindl. to Pourthiaea, i.e.,
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S. *amphidoxa* C.K.Schneid., *S. amphidoxa* var. *amphileia* (Hand.-Mazz.) T.T.Yu, and *S. tomentosa* T.T.Yu & T.C.Ku. Unfortunately, Guo et al. (2020) repeated these new taxonomic combinations, resulting in three illegitimate later homonyms. Recent systematic studies confidently resolved the generic circumscription of *Pourthiaea*, including all members of the previously recognized *Photinia* sect. *Pourthiaea* C.K.Schneid. and three newly transferred taxa from *Stranvaesia* (Guo et al. 2011, 2020; Liu et al. 2019, 2020a, 2020b, 2022). Furthermore, species delimitation within *Pourthiaea* has been controversial. Recent taxonomic treatments in *Pourthiaea* have been proposed solely from morphological evidence, either narrowly circumscribed (Kuan and Yu 1974; Gu and Spongberg 2003) or broadly circumscribed (Liu and Hong 2016a, 2016b, 2017). However, our recent phylogenomic evidence did not support these two proposals (unpublished data), indicating the need for an updated species delimitation in *Pourthiaea*. Hybridization, allopolyploidy, and apomixis have promoted the diversification of the apple tribe Maleae (Campbell et al. 1991; Robertson et al. 1991; Kalkman 2004; Liu et al. 2022). These complex evolutionary processes extensively diversified the genetic and morphological resources and greatly challenged the species delimitation in *Pourthiaea*. It is still premature to confidently delimit species in *Pourthiaea*.

Evaluating all the names published in *Pourthiaea* is the first step and will be helpful for further species delimitation. In this study, we made a comprehensive checklist of *Pourthiaea*. It should be noted that the checklist defined in this study is a summary of taxa (97) related to *Pourthiaea* rather than the species recognized currently in *Pourthiaea*, and these taxa have been described under *Crataegus* L., *Myrtus* L., *Photinia*, *Pourthiaea*, *Pyrus*, *Viburnum* L., and *Stranvaesia*. This checklist will provide a solid foundation for future taxonomic and evolutionary studies. In the genomic age, integrating hundreds of nuclear genes, plastomes and morphological characters make it possible to explore species delimitation in lineages with complicated evolutionary histories (Liu et al. 2021, 2022; Su et al. 2021).

**Materials and methods**

To comprehensively explore all the names published under *Pourthiaea* and other related genera, we took over nine years (2013–2021) for this taxonomic study. We reviewed all names in the online databases, such as Tropicos (https://www.tropicos.org), IPNI (https://www.ipni.org/), The Plant List (http://www.theplantlist.org/), as well as all the literature related to *Pourthiaea*. In addition, we evaluated the validity of all names based on the Shenzhen Code (Turland et al. 2018). A total of 568 type specimens were checked; they are from the following 54 herbaria: A, AU, BNU, BM, BO, CDBI, CSFI, E, GH, GXMI, GZAC, HBG, HENU, HGAS, HHBG, HIB, HIMC, HITBC, HTC, HUST, HX, HZU, IBK, IBSC, JF, JN, JXAU, K, KUN, KYO, L, LBG, M, N, NAS, NKU, NTUF, NY, P, PE, PH, QTPMB, SM, SNU, SYS, SZ, TAI, TI, U, UPS, US, WUK, ZJFC, and ZM, and the herbarium code followed the Index Herbariorum (http://sweetgum.nybg.org/science/ih/) hosted by New York Botanical Garden.
Results

We reviewed 213 names published in Pourthiaea and its related genera, and they belong to 91 validly published taxa, five naked names, and one invalid name. We also lectotypified two taxa, i.e., Photinia amphidoxa var. stylosa and P. glabra var. fokienensis. All these names in Pourthiaea have been arranged chronologically in the following text.

Taxonomic checklist


≡ Photinia villosa (Thunb.) DC. var. laevis (Thunb.) Dipp. ex C.K.Schneid., Ill. Handb. Laubholzk. i. 710. 1906.
≡ Pourthiaea villosa (Thunb.) Decne. var. laevis (Thunb.) Stapf, Bot. Mag. tab. 9275. 1929.

Type: JAPAN. s. loc., C.P. Thunberg s. n. (holotype: UPS [accession no. 11864]!).


Type: JAPAN. s. loc., C.P. Thunberg s. n. (holotype: UPS [accession no. 11881]!).


Type: JAPAN. s. loc., C.P. Thunberg s. n. (holotype: UPS [accession no. 11735]!).


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≡ *Pyrus arguta* (Lindl.) M.F. Fay & Christenh., Global Fl. 4: 95. 2018.


≡ *Photinia villosa* (Thunb.) DC. var. *coreana* (Decne.) Rehder, J. Arnold Arbor. 2: 45. 1920.


≡ *Photinia hookeri* (Decne.) Merr., Brittonia 4: 82. 1941.


≡ *Photinia lucida* (Decne.) C.K.Schneid., Ill. Handb. Laubholzk. i. 710. 1906.


**Type:** Bangladesh. “East Bengal” or India. [Khasia] Meghalaya: Khasi, *W. Griffith* 2099 (lectotype, designated by Vidal (1968: 51): P [barcode P02143251]!; isolecotype:


≡ *Photinia villosa* (Thunb.) DC. var. *zollingeri* (Decne.) C.K.Schneid., Ill. Handb. Laubholzk. i. 710. 1906.


≡ *Photinia birmanensis* C.K.Schneid., Ill. Handb. Laubholzk. i. 709. 1906. replacement name.
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*Type*: not designated.


*Type*: not designated.


≡ *Pyrus fokienensis* (Finet & Franch.) M.F. Fay & Christenh., Global Fl. 4: 104. 2018.


A [barcode 00045590]!
E [barcode E00011320, E00285981]!
GH [barcode 00045587]!
P [barcode P02143151]!)


*Type:* China. W. Hupei [Hubei]: E.H. Wilson 359 (lectotype, designated by Liu and Hong (2017: 19): K [barcode K000758271, excluding the fruit branches]!; isolectotypes: A [barcode 00038570, excluding the fruit branches]!, E [barcode E00010995, excluding the fruit branches]!, P [barcode
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P02143174, excluding the fruit branches], US [barcode 00097501, excluding the fruit branches]). W. Hupei [Hubei], *E. H. Wilson 359* (syntypes: A [barcode 00038570, excl. the branch in flowering phase]!, E [barcode E0010995, excl. the branch in flowering phase]!, K [barcode K000758270, excl. the branch in flowering phase; K000758271, excl. the branch in flowering phase]!, P [barcode P02143174, excl. the branch in fruiting phase]!, US [barcode 00097501, excl. the branch in flowering phase]). (Image of lectotype available from https://plants.jstor.org/stable/10.5555/al.ap.specimen.k000758271).


**Type:** China. Taiwan: Taipei, Taihoku, 15 November 1896, *T. Makino* s. n. (holotype: T1 [barcode T00596]!).


**Type:** China. Western Hupeh [Hubei]: Changyang Hsien, 1300 m, 7 May 1907, *E.H. Wilson* 488 (holotype A [barcode 00038568, excluding the fruit branches]!; isotypes: E
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Note A: In the protologue, the specimen, J. Cavalerie & Fortunat 2533, was designated as the syntype of Photinia amphidoxa var. stylosa by Cardot (1914); however, Léveillé (1913) had designated it as the type of Pyrus feddei. Therefore, we exclude this specimen.
from the syntype of *Photinia amphidoxa* var. *stylosa*. Considering the better condition of the specimen *J. Cavalerie & Fortunat 1248*, we designated it as the lectotype herein.


(Note B)  


**Note B**: Léveillé (1915) designated the specimen (*J. Esquirol 2624*) as the type of *Cotoneaster esquirolii*; however, this specimen has been designated as the type of *Photinia arguta* var. *sinensis* by Cardot (1914). According to Article 52.1 & 52.2 in the International Code of Nomenclature for algae, fungi, and plants (Shenzhen Code) (Turland et al. 2018), *Cotoneaster esquirolii* definitely included the type of an earlier name, *Photinia arguta* var. *sinensis*, so the former name is illegitimate and nomenclaturally superfluous and is to be rejected.


**Type:** China. Fokien [Fujian]: Fuzhou, Mt. Kozan, November 1909, Nagasawa s. n. (holotype: TI!; isotypes: A [barcode 00038572, 00038573]!).


**Type:** China. Fokien [Fujian]: Foochow [Fuzhou], *W.R. Carles* 839 (holotype: K [barcode K000758285]!; isotypes: image A [barcode 00038559]! with fragments from K


**Type:** China. Taiwan: Mt. Rohon, 900 m, November 1932, *S. Hatusima* 793 (syntype FU).


Type: China. Yunnan: Shang-pa-hsien [Fugong County, Shangpa], 1500 m, 28 September 1933, *H.T. Tsai* 54959 (holotype: A [barcode 00045570]!; isotypes: IBSC [barcode 0004377]!, KUN [barcode 313254]!, NAS [barcode NAS00071263]!, PE [barcode 0020610, 0020612]!). Shangpa, 1,500 m, 2 September 1933, *H.T. Tsai* 54688 (paratypes: IBSC [barcode 0319885]!, KUN [barcode 0640795, specimen accession no. 0683743]!, NAS [barcode NAS00071262]!, PE [barcode 00337715, 00337717]!); ibidem, 2,000 m, 24 October 1934, *H.T. Tsai* 58945 (paratypes: IBSC
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≡ *Photinia pirocarpa* J.E.Vidal, Notul. Syst. (Paris) 13(4): 300. 1948. nom. illeg. superfl. (referring to the Note 15 in Liu and Hong (2017)).


**Type:** China. Fujian: Liancheng, Luodi, 24 October 1932, Y. Ling 4167 (holotype: PE [barcode 00004605]); isotypes: AU [barcode 010148], PE [barcode 00004604]).


**Type:** China. Guizhou: Anlong County, Longshan, Qiaoling, 1,200 m, 9 June 1960, Z.S. Zhang & Y.T. Zhang 4035 (holotype: PE [barcode 00934236]); isotypes: IBSC [barcode 0335502], KUN [barcode 607037]).


**Type:** China. Guizhou: Luodian, Bamao, Dating, Hongshui River, 200 m, 8 April 1959, Qiannan Expedition 408 (lectotype, designated by Liu and Hong (2016b: 225): PE [barcode 00004600]); isolectotypes: HGAS [barcode 021090], KUN [barcode 606957, 747408], PE [barcode 00020608, 01498393, 01498394]). Hongshui River, riverside, 8 April 1959, Qiannan Expedition 709 (paratypes: HGAS [barcode 021089], KUN [barcode 606956], NAS [barcode 00071260], PE [barcode 00337090, 00337091, 01651162]). Guangxi: Baise City, Yangxu Zhen, 280 m, 25 December 1955, Base Expedition 1534 (paratypes: IBK [barcode IBK-00190813], IBSC [barcode 0004370], KUN [barcode 606955], NAS [barcode 00071259], PE [barcode 00337094]). Petseu, 1914, J. Cavalerie 4283 (paratype: P [barcode P03342555]). ibidem, 1900–1920, J. Cavalerie 4498 (paratypes: K [barcode K000758287], P [barcode P03373739]). Longlin County, Gebu Xiang, Wuchong Village, on the rocks by river, 13 May 1957, C.F. Liang 32325 (paratypes: IBK [barcode IBK00190814], IBSC [barcode 0004369]). Tian’e County, Baiyang Zhen, Hongshui River, riversides, 150 m, 27 March 1960, Guizhou Expedition 14 (paratypes: IBK [barcode 00062433], IBSC [barcode 0319277], NAS [barcode 00071258], PE [barcode 00337093]). Liupai Zhen, 21 May 1957, Z. Huang 43389 (paratypes: IBK [barcode IBK00190812], IBSC [barcode 0319273], KUN [barcode 606954]). Tianlin County, on the way from Leli Xiang to Lizhou Xiang, on the rocks in valley, 22 November 1957, Z.Q. Zhang 10921 (paratypes: IBK [barcode IBK00062427], IBSC [barcode 0319272]).


**Type:** China. Taiwan: Hualien, Mt. Chingshui, 600–1400 m, 29 March 1961, T. Shimizu & M.T. Kao 11749 (holotype: TAI [barcode 055602]!; isotypes: KYO [barcode KYO00022343]!, SHIN [barcode 155840]!, TI [barcode TI00031789]!).


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**Type:** China. Zhejiang: Jingning County, Gulou, 13 November 1958, *S.Y. Zhang* 4505 (holotype: HHBG [specimen accession no. 10236]!, isotypes: KUN [barcode 0642805, 0642806]!, PE [barcode 00020624, 00020625]!). Jingning, Yingchuan, 9 May 1959,


**Type:** China. Anhui: Jinzhai County, Baimazhai Forest Farm, 1,100 m, 17 May 1984, *M.B. Deng 81741* (lectotype, designated by Liu and Hong (2017: 19): NAS [barcode NAS00072797]!; isolecotype: NAS [barcode NAS00072798]!). Baimazhai Forest Farm, Zaoqian’ao, 1,500 m, 18 May 1984, *G. Yao 8988* (paratypes: NAS [barcode NAS00354378, NAS00354379]!).


Type: China. Hunan: Zhijiang County, Dashu’ao Xiang, Zhupo village, 600 m, 17 October 1988, Wulingshan Expedition 2302 (holotype: PE [barcode 01896033]); isotype: IBSC [barcode 0344337]). nom. illeg. (referring to Liu and Hong (2017)).


Type: China. Jiangxi: Shangyou, Wuzhifeng, 1 May 1972, Jiangxi Expedition Team 1002 (holotype: PE [barcode 00337886]); isotype: PE [barcode 01641097]); Anfu, Wugong Shan, Kenzhichang, Yantian, the foot of the mountain, 10 August 1959, S.S. Lai 1765 (paratypes: KUN [barcode 608499], LBG [barcode 00010381], PE [barcode 00337906]); Ji’an, Donggu, Yingxu, Yangtian Shan, the forest edge, 16 May 1970, s. coll. 272 (paratype: PE [barcode 00337923]); Jinggangshan, along road between Xiaojing and Ciping, on the slope, 860 m, 13 October 1971, Jiangxi Expedition 894 (paratypes: PE [barcode 00337912, 00337913]); Nanfeng, Qia Cun, roadsides in the bushes, 23 April 1958, M.X. Nie 2265 (paratypes: LBG [barcode 00010363], LBG [barcode 00014991], PE [barcode 00337934]); ibidem, roadsides in the bushes, 25 April 1958, M.X. Nie & S.S. Lai 2350 (paratypes: KUN [barcode 608524], LBG [barcode 00014974, 00014975], PE [barcode 00337933]); Pingxiang, Xindian, sunny slope on the forest edge of Camellia oleifera plantation, 300 m, 28 April 1954, W.T. Wang 28 (paratype: PE [barcode 00337915]); ibidem, sunny slope on the forest edge of Camellia oleifera plantation, 300 m, 28 April 1954, W.T. Wang 29 (paratype: PE [barcode 00337914]); Ruijin: Liangtang, longwangting, roadsides in the woods, 9 August 1958, Q.M. Hu 4148 (paratypes: IBSC [barcode 0335603], KUN [barcode 608607], KUN [barcode 608539], LBG [barcode 00010431], PE [barcode 00337929]); Xunwu, along road between Zhonghe and Guizhumao, 500 m, 1958, Q.M. Hu 1252 (paratypes: IBSC [barcode 0335623], KUN [barcode 608525], LBG [barcode 00014988], PE [barcode 00337918]); Xunwu, the valley in the east of Guizhumao, 700 m, 1 May 1958, Q.M. Hu 1462 (paratypes: IBSC [barcode 0319949], KUN [barcode 608518], LBG [barcode 00010412], PE [barcode 00337931]); Xunwu, vicinity of Guizhumao Forest Farm, 700 m, 3 May 1958, Q.M. Hu 1584 (paratypes: KUN [barcode 608536, 608517], LBG [barcode 00010386], PE [barcode 00337930, 00337932]); Guangxi: Lingui, Wantian, 120 m, 19 April 1955, C.F. Liang 31703 (paratypes: IBK [barcode IBK00062287], IBSC [barcode 0319934], PE [barcode 00337965], SZ [barcode 00197053]); Xing’an, Simen, May 1953, Guangxi Team 4 (paratypes: PE [barcode 00337963, 00337964, 00337966, 01641095]); Huajiang, 27 May 1953, Guangxi Team 841 (paratype: PE [barcode 00337968]). Guizhou:
Leishan, vicinity of Wudong, 950 m, 6 May 1959, South Guizhou Expedition 1310 (paratypes: KUN [barcode 608544!], NAS [barcode NAS00354188, NAS00354321]!, PE [barcode 00337961, 01641101]!); Leishan, Xijiang, Leigongping, in the bushes on the slope, 1,100 m, 22 May 1959, South Guizhou Expedition 2107 (paratypes: HGAS [barcode 021267]!, PE [barcode 00337869, 00337955]!); Leishan, Taoyao, Jieli, in the bushes on the slope, 108°8'20"E, 26°22'30"N, 950 m, 21 May 1965, Z.B. Jian et al. 50082 (paratypes: HGAS [barcode 021282], KUN [barcode 608543], PE [barcode 00337958, 01498535]); Leishan, Wudong, Xiaoshuiyan, in the woods on the slope, 26°21'30"N, 108°9'E, 1,140 m, 22 May 1965, Z.B. Jian et al. 50167 (paratypes: KUN [barcode 608541]!, PE [barcode 00337962, 01498532]!); Rongjiang, Bakai, Jihua, Baila, vicinity of Shangbaila, on the slope, 900 m, 25°39'30"N, 108°14'20"E, 8 August 1965, Z.B. Jian et al. 51682 (paratypes: HGAS [barcode 021277]!, KUN [barcode 608655]!, PE [barcode 00337957, 00337947]!); Tianzhu, 15 June 1937, B.Q. Zhong 1090 (paratypes: PE [barcode 00337956, 00337959]!). Hunan: Hongjiang, Qianyang, District One or Two, 18 April 1953, Anjiang Agricultural School 182 (paratypes: IBSC [barcode 0335715]!, PE [barcode 00337947]!); ibidem, 12 August 1953, Anjiang Agricultural School 645 (paratypes: IBSC [barcode 0319171]!, PE [barcode 00337943, 00337944]!). Jiangsu: Lianyungang, Yuntai Shan, Liuhe, 80 m, 27 August 1958, EX. Liu et al. 10848 (paratypes: IBSC [barcode 0335666, 0335668]!, NAS [barcode NAS00116611], PE [barcode 00337887, 00337888, 00337890, 00337891]!); Qiaya, Shendongcun, 260 m, 21 June 1956, EX. Liu et al. 2171 (paratypes: HHBG [barcode HZ016566]!, IBSC [barcode 0335662]!, NAS [barcode NAS00116596]!, PE [barcode 00337889]!). Zhejiang: Lin’an, Changhua, the tea plantation of Longtang Shan, in the stone crevices of the valley, 217 m, 2 October 1957, X.Y. He 29819 (paratypes: HHBG [barcode HZ016611]!, NAS [barcode NAS00354049]!, PE [barcode 00337896]!); Ningbo, s. coll. 1536 (paratype: PE); Yinxian, G.R. Chen 2265 (paratypes: PE [barcode 00337893, 00337897]!).


**Type:** China. Hunan: Xinhuang County, Tianlei Shan Forest Farm, 760 m, 23 May 2008, W. Guo & R.J. Shen 840 (holotype: SYS [barcode SYS00164356]!; isotypes: IBSC, SYS [barcode SYS00164354, SYS00164355]!). ibidem, 760 m, 10 May 2008, W. Guo & R.J. Shen 841 (paratypes: IBSC, SYS); Mibe, Shiyangdong, Gualoupo, 900 m, 17 July 1988, Wuling Expedition 909 (paratypes: IBSC [barcode 0335431]!, PE [barcode 01364106]!). Zhijiang: Longping, Baishuidong, 28 May 1959, PX. Tan 60949 (paratypes: IBK [barcode IBK00062671]!, IBSC [barcode 0317981]!).

**Naked names:**

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Invalid names:


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A new species of *Cinnamomum* (Lauraceae) from southwestern China

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Abstract

Field investigations in Guizhou, China, in 2020 resulted in the discovery of an unknown species of Lauraceae. Morphological studies revealed that it is a new species of *Cinnamomum* Schaeff. sect. *Camphora* Meisn., based on the large terminal buds, and alternate leaves with pinnate veins. It is distinguished from other species of sect. *Camphora* by the rather large perulate terminal buds with numerous bracts, larger flowers, oblong-elliptic linear tepals twice as long as the stamens, and the deep cup-shaped fruiting cupule. It is here described and illustrated as a new species, *Cinnamomum guizhouense* C.Y.Deng, Zhi Yang et Y.Yang. A key to distinguish it from related species in the same area is provided. In addition, we list the new species as Critically Endangered (CR), and suggest to conduct *ex situ* conservation, collect seeds and plant the species in botanic gardens.

Keywords

Guizhou, morphology, sect. *Camphora*, taxonomy
Introduction

*Cinnamomum* Schaeff. (Schaeffer 1760: 74; Lauraceae) is known for the spice, cinnamon, derived from the bark of *Cinnamomum aromaticum* Nees (Nees von Esenbeck 1831: 74), which is well known worldwide (Rohwer 1993). For a long time, the genus was circumscribed to contain and ca. 350 species and to have a pan-Pacific distribution (Rohwer 1993; Lorea-Hernández 1996; van der Werff 2001). Recent phylogenetic and taxonomic studies have transferred the Neotropical species of *Cinnamomum* to other genera so that *Cinnamomum* is now treated as being restricted to Tropical/Subtropical Asia and Oceania (Huang et al. 2016; Rohde et al. 2017; Zeng et al. 2021). Two sections have been recognized in *Cinnamomum*, sect. *Camphora* Meisn. (Meissner 1864: 24) and sect. *Cinnamomum*. Sect. *Camphora* differs from sect. *Cinnamomum* in having perulate terminal buds (vs. naked terminal buds), pinnately veined alternate leaves (vs. tripliveined opposite/subopposite leaves), and domatia usually present in the axils of the lateral leaf veins (vs. lacking domatia in the axils of the lateral leaf veins) (van der Werff 2001; Huang et al. 2016). Sect. *Camphora* is restricted to the northern hemisphere while sect. *Cinnamomum* is distributed from eastern Asia to Oceania (Soh 2011). Interestingly, Trofimov and Rohwer (2020) suggest that *Cinnamomum* is polyphyletic with sect. *Camphora* being sister to *Sassafras* J.Presl (Presl 1825: 230) and sect. *Cinnamomum* being sister to *Kuloa* Trofimov & Rohwer (2020: 527). Until there is a modern taxonomic treatment, we accept species of *Cinnamomum* as belonging to a single genus.

Recent botanical investigations to Wangmo County of Guizhou Province, one of the most botanical diverse regions of China, resulted in the discovery of a *Cinnamomum* species with unusual morphology, which led us to conclude that it is a new species for science. We conducted field investigations, estimated the population size and extent/area of occupancy, and collected several flowers and fruits of the plant. Specifically, we carried out morphological studies to answer the following questions: 1) what are the morphological affinities of the new species; and 2) what is the conservation status of the new species?

Material and methods

Field investigations were conducted and observations were made during February of 2020 and February of 2022. Specimens were collected, and flowers were fixed in FAA. Fresh and pickled flowers were dissected, observed and measured under a light microscope (GP-M101). Photographs were taken using a Nikon D7100 and a Sony A7M3 camera. We assessed the conservation status of the species by observing the population size and estimating the extent of occurrence (EOO) and the area of occupancy (AOO) and applying IUCN red list categories and criteria and guidelines (IUCN 2012, 2022). Line drawings were prepared manually with a pen and black ink. Line drawings and figures were edited, arranged, and merged using Adobe Photoshop CS2 ver. 9.0 and Adobe Illustrator. The distribution map was generated with ArcGis ver. 10.0.
A Cinnamomum new species from China

Results

Taxonomy

Cinnamomum guizhouense C.Y. Deng, Zhi Yang & Y. Yang, sp. nov.
urn:lsid:ipni.org:names:77302159-1
Figs 1–2


Diagnosis. Cinnamomum guizhouense is close to C. foveolatum (Merr.) H. W. Li et J. Li (Li et al. 2008: 170) in having leaves that lack domatia in the axils of the lateral leaf veins and in the long fruiting cupule, but differs from the latter by the longer leaves (12–21 cm vs. 9–15 cm in C. foveolatum), longer petioles 2–4 cm long (vs. 1–1.3 cm in C. foveolatum), longer tepals (3–4 mm long vs. 1.7–2 mm long in C. foveolatum), and shorter campanulate or cup-shaped cupules ca. 15 mm long (vs. cupules up to 20 mm long in C. foveolatum).

Description. Trees, evergreen, 11–13 m tall, D.B.H. ca. 36 cm (Fig. 1a); crown columnar to pyramid shaped, ca. 3 m in diam. Trunk straight; bark gray, longitudinally fissured. Twigs angular, glabrous, with multiple circular scale scars at base of twigs. Terminal buds prominent, to 2.5 cm long, 1.5 cm in diam. (Fig. 1b); bracts many (to 15), obovate to oblanceolate, apex obtuse, acute to cuspidate, abaxially pubescent, adaxially glabrous, margin ciliate. Leaves alternate; petioles glabrous, channelled abaxial, 2–4 cm long (Figs. 1c–e, 2a); blade coriaceous, elliptic to obovate-elliptic, 6–9×12–21 cm, base acute to cuneate, more or less decurrent, apex acuminate, pinnately veined, secondary veins 5–7 pairs, midrib and secondary veins immersed or slightly raised on adaxial surface, elevated on abaxial surface; adaxially green, abaxially glabrous and glaucous. Panicles terminal (Figs. 1c, 1f, 2a), 7–10 cm long, peduncles, pedicels and tepals pubescent, lateral flowers of ultimate cymes opposite, pedicels 4–6 mm long. Flowers bisexual, receptacle prominent, obconic, ca. 1 mm long, 1 mm in diam.; perianth in two whorls, tepals 6–8, subequal, oblanceolate to linear, 3–4 mm long, 1 mm wide, both surfaces pubescent, margin ciliate (Figs. 1g, 1h); stamens in three whorls, 3 or 4 in each whorl, 1.5–2 mm long, filaments subequalling anthers, glabrous, each stamen of third whorl with two globose glands at base; anthers yellow, 4-locular, those of outer two whorls introrse, those of third whorl extrorse (Figs. 1i–1k, 2d–2e); staminodes of fourth whorl sagittate, filaments pubescent (Fig. 2f); pistil glabrous, ovary ovoid to ellipsoid, 1.2 mm long, ca. 0.8 mm in diam., style glabrous, ca. 1 mm long, stigma peltate when fresh, inconspicuous when dry (Figs. 1l, 2g). Infructescences 6–15 cm long. Young fruit together with cupules obovoid-ellipsoid, 15–20 mm long, 13–17 mm in diam., 3/4 or more of fruit enclosed in cupule (Fig. 1m). Fruit black when mature, cupulate, cupules campanulate to cup-shaped, ca. 1.5 cm long, 1.5 cm in diam. (Fig. 1n, 2i); pedicels
thickened, 4–6 mm in diam.; seeds ellipsoid to subglobose (Fig. 2J), ca. 1 cm long, 8 mm in diam., yellowish-brown, longitudinally ridged. Flowering February; fruiting September and October.

**Etymology.** The species is named after the province, Guizhou, where it occurs.

**Distribution.** *Cinnamomum guizhouense* is known only from Wangmo Xian, Guizhou Province, southwestern China (Fig. 3).

**Ecology and habitat.** The new species lives in bamboo (*Phyllostachys* sp.) colonies in acidic soil with mean annual temperature 13–15 °C, annual precipitation 1000–
Figure 2. Illustration of morphological characters of *Cinnamomum guizhouense* C.Y. Deng, Zhi Yang & Y. Yang, sp. nov. A leafy flowering branch with alternate, elliptic and obovate leaves, large terminal buds and inflorescences B, C variation in floral merosity B tetramerous flower C trimerous flower D stamen of first and second whorl E stamen of third whorl F staminode of fourth whorl G pistil H longitudinal section of young fruit with pedicel and cupule partially enclosing inner fruit I mature infructescence with peduncle and pedicel and deep cup-shaped cupule J subglobose seed.
1200 mm. It is heliophilous and lives on western slopes. The species lives near a village road with human disturbance, and the disturbance will not stop unless a new nature reserve is established to conserve the species. The species has an extremely small population, and only two individuals were found in the region. The living individuals occupy an area (EOO, ≈ AOO) ca. 100 m².

Conservation. On four instances of field investigations in the area, we found only two mature plants living within ca. 100 m². We thus designate the species to be Critically Endangered (CR B1+2ab(iii); C1+2a(i); D) according to the IUCN red list categories and criteria (IUCN 2012, 2022), but we acknowledge that further assessments are necessary as new populations are found.

Vernacular name. The local people refer to *C. guizhouense* as Da Mu Jiang Zi (big *Litsea*), which is not in accordance with its formal taxonomic position. Here we name it Guizhou Cinnamon.

Discussion

Recent phylogenetic studies have suggested that *Cinnamomum* comprises two groups that largely, but not strictly, correspond to two sections of the genus (Huang et al. 2016; Liu et al. 2021; Zeng et al. 2021). Huang et al. (2016) reported that *C. saxatile* H.W.Li (Li 1975: 44) and *C. longipetiolatum* H.W.Li (Li 1975: 47) and an unidentified species *C.* sp. C684 actually belong to sect. *Cinnamomum* and not to sect. *Camphora* as traditionally circumscribed. *Cinnamomum guizhouense* belongs to sect. *Camphora* according to our plastome phylogeny (unpubl. data). This finding was corroborated by the large perulate buds and pinnately veined, alternate leaves of *C. guizhouense*.

*Cinnamomum guizhouense* is characterized by the large perulate terminal buds, flowers with tepals twice as long as the stamens, and deep fruiting cupules. This unique combination of morphological characteristics distinguishes *C. guizhouense* from all other species of sect. *Camphora* (Li et al. 1982, 2008). We made a morphological comparison of *C. guizhouense* with other species of sect. *Camphora* in Guizhou (Table 1). *Cinnamomum guizhouense* is similar to *C. foveolatum* in the deep fruiting cupules, but differs from the latter in the longer leaves 12–21 cm (vs. leaves 9–15 cm long in *C. foveolatum*), oblong-elliptic to linear tepals 3–4 mm long (vs. ovate to broadly ovate tepals 1.7–2 mm long in *C. foveolatum*), longer stamens 1.5–2 mm long (vs. stamens 1.2–1.4 mm long in *C. foveolatum*) and shorter fruiting cupules ca. 15 mm (vs. fruiting cupules ca. 20 mm

### Table 1. Morphological comparison of species of *Cinnamomum* sect. *Camphora* from Guizhou, China.

<table>
<thead>
<tr>
<th>Species</th>
<th>Leaf size (cm)</th>
<th>Lateral veins</th>
<th>Petiole length (cm)</th>
<th>Inflorescence pubescence</th>
<th>Tepal shape</th>
<th>Tepal length (mm)</th>
<th>Stamen length (mm)</th>
<th>Cupule length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>C. bodinieri</em></td>
<td>8–17 × 3−10</td>
<td>4−6</td>
<td>2−3</td>
<td>glabrous</td>
<td>ovate</td>
<td>1.2</td>
<td>1 or a little longer</td>
<td>/</td>
</tr>
<tr>
<td><em>C. camphora</em></td>
<td>6–12 × 2.5−5.5</td>
<td>1−5(−7)</td>
<td>2−3</td>
<td>glabrous or gray- to yellow-brown puberulent</td>
<td>elliptic</td>
<td>2</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td><em>C. foveolatum</em></td>
<td>9–15 × 3−5.5</td>
<td>6−8</td>
<td>1−1.3</td>
<td>sparsely villous</td>
<td>outer ones ovate, inner ones broadly ovate</td>
<td>2 × 1.7</td>
<td>1.2–1.4</td>
<td>20</td>
</tr>
<tr>
<td><em>C. glanduliferum</em></td>
<td>6–15 × 4–6.5</td>
<td>4 or 5</td>
<td>1.5–3.5</td>
<td>glabrous</td>
<td>broadly ovate</td>
<td>2 × 1.7</td>
<td>1.4–1.6</td>
<td>10</td>
</tr>
<tr>
<td><em>C. guizhouense</em></td>
<td>12–21 × 6−9</td>
<td>5–7</td>
<td>2−4</td>
<td>pubescent</td>
<td>oblong-elliptic to linear narrowly ovate</td>
<td>3−4</td>
<td>1.5–2</td>
<td>15</td>
</tr>
<tr>
<td><em>C. micranthum</em></td>
<td>7.5–10 × 4–6</td>
<td>4 or 5</td>
<td>2−3</td>
<td>subglabrous or slightly puberulent</td>
<td>narrowly elliptic</td>
<td>1.3</td>
<td>1</td>
<td>9</td>
</tr>
<tr>
<td><em>C. migao</em></td>
<td>4.5–16 × 2.5–7</td>
<td>4 or 5</td>
<td>1.3−3</td>
<td>pubescent</td>
<td>glabrous</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td><em>C. parthenoxylon</em></td>
<td>6–12 × 3−6</td>
<td>4 or 5</td>
<td>1.5–3</td>
<td>pubescent</td>
<td>slightly puberulent</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td><em>C. rufotomentosum</em></td>
<td>15–16.5 × 4–5</td>
<td>4–6</td>
<td>2–2.9</td>
<td>reddish brown tomentose</td>
<td>brownish</td>
<td>/</td>
<td>/</td>
<td>/</td>
</tr>
<tr>
<td><em>C. saxatile</em></td>
<td>5–13 × 2−5</td>
<td>5–7</td>
<td>0.5–1.5</td>
<td>brownish puberulent</td>
<td>ovate</td>
<td>3</td>
<td>4–4.5</td>
<td>shallow</td>
</tr>
</tbody>
</table>

*Morphological data was extracted from Flora of China (Li et al. 2008).*
in *C. foveolatum*). *Cinnamomum guizhouense* resembles *C. saxatile* in the tepals 3–4 mm long (Li et al. 1982, 2008), but differs in having shorter stamens 1.5–2 mm (vs. tepals subequalling stamens, ca. 4 mm in *C. saxatile*). *Cinnamomum saxatile* was ascribed to sect. *Camphora* because of its alternate, pinnately veined leaves (Li et al. 1982, 2008), but has been demonstrated to belong to sect. *Cinnamomum* according to the leaf anatomy and phylogenetic evidence (Huang et al. 2016; Zeng et al. 2021). *Cinnamomum guizhouense* was close to *C. camphora* (L.) J.Presl (Presl 1825: 47) and *C. bodinieri* H.Lév. (Léveillé 1912: 369) in sect. *Camphora* in our plastome phylogeny (unpubl. data), but differed from *C. camphora* and *C. bodinieri* in the absence of domatia in the axils of the leaves, much longer tepals (3–4 mm vs. 1.5–2 mm in *C. camphora* and *C. bodinieri*), and the deep, cup-shaped fruiting cupules (vs. flat cupules in *C. camphora* and *C. bodinieri*).

A key to these closely related species is provided. Moreover, we found that floral merosity of our new species is variable. Variation of floral merosity, including tetramerous flowers, has also been recorded in *Beilschmiedia appendiculata* (C.K.Allen) S.K.Lee & Y.T .Wei (Li et al. 1979: 65) and *Syndiclis* spp (Zeng et al. 2017, 2021), and also in *Caryodaphnopsis* sp. (pers. observ.). The variable merosity of flowers in the family may have been caused by change of selection pressure. Further studies are necessary to figure out what kind of selection pressure works on the change of floral merosity. Our finding not only increases species diversity of *Cinnamomum* in Guizhou and China but also expands our knowledge of the morphological diversity of *Cinnamomum*.

We conducted field investigations on *C. guizhouense* on four occasions and found only two individuals in the area, suggesting that the species has an extremely small population. In addition, the new species lives near a village with human disturbance, the living habitat of *C. guizhouense* has not been improved and deterioration continues. We thus suggest to plan an *ex situ* conservation strategy for the new species, collect seeds and plant the species in botanic gardens.

**Key to similar species in the same region**

1a Tepals of flowers short, 1–2 mm long .................................................................2
1b Tepals of flowers 3–4 mm long ........................................................................ 4
2a Fruiting cupule up to 20 mm long .................................................. *C. foveolatum*
2b Fruiting cupule ca. 5 mm long .......................................................... 3
3a Leaves 8–17 cm long; tepals ovate, 1.2 mm long; stamens 1 mm long........
........................................................................................................... *C. bodinieri*
3b Leaves 6–12 cm long; tepals elliptic, 2 mm long; stamens 2 mm long........
............................................................................................................... *C. camphora*
4a Buds 2–5 mm long; domatia present in the axils of lateral leaf veins; panicles 3–6 cm long; stamens 4–4.5 mm long; fruiting cupule shallow, 5–6.5 mm in diam .......................................................... *C. saxatile*
4b Buds to 25 mm long; domatia absent in the axils of lateral leaf veins; panicles 7–10 cm long; stamens 1.5–2 mm long; fruiting cupule deep to 15 mm in diam .......................................................... *C. guizhouense*
Acknowledgements

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**Chrysanthemum dabieshanense**, a new name for *Chrysanthemum vestitum* var. *latifolium* (Asteraceae, Anthemideae)

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**Abstract**

Recent phylogenetic analyses have revealed that *Chrysanthemum vestitum* var. *latifolium* and *C. vestitum* var. *vestitum* were placed in different clades based on their chloroplast genomes and nuclear LFAFY gene sequences. Accordingly, based on previous morphological analysis, molecular phylogenetic results, fieldwork, and herbarium studies, *Chrysanthemum vestitum* var. *latifolium* should be raised to the species level. Considering the condition of the material found and Articles 6.9, 6.11, 41.2, 58.1 of the International Code of Nomenclature for Algae, Fungi, and Plants (*Shenzhen Code*) that is currently in force, *Chrysanthemum dabieshanense* Z.X.Fu, A.G.Zhen, & Y.P.Ma, **nom. nov.**, is proposed as the new name for *Chrysanthemum vestitum* var. *latifolium* J.Zhou & Jun Y.Chen. The detailed emended description, distribution map, insights into its habitat, and an updated comparative morphological study are presented in this study.

**Keywords**

Asteraceae, China, *Chrysanthemum* endemism, taxonomy

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Introduction

Chrysanthemum L. is a genus of the tribe Anthemideae that contains approximately 40 species. This genus is mainly distributed in temperate Asia (Oberprieler et al. 2007), with approximately 23 species in China (Shih et al. 2011; Meng et al. 2020). The genus is characterized by subshrubs or perennial herbs with pinnately or palmately divided alternate leaves, female ray florets, white or red apical appendages of anthers, and faintly 5–8-ribbed achenes (Shih et al. 2011). Furthermore, recent molecular phylogenetic studies have demonstrated that Chinese Chrysanthemum should be divided into two groups: the Chrysanthemum zawadskii group, which is distributed in northern China and has erect stems and large capitula with white or purple ray florets, and the Chrysanthemum indicum group, which is distributed from north to south China and has creeping stems and capitula with yellow or white ray florets (Liu et al. 2012; Li et al. 2014; Ma et al. 2020).

According to the phylogenetic study of chloroplast genomes and the nuclear LFAFY gene by Ma et al. (2020), Chrysanthemum vestitum var. vestitum from the Funiu Mountain in Henan Province and C. vestitum var. latifolium from the Tianzhu Mountain in Anhui Province represent two distinct clades. Morphologically, C. vestitum var. latifolium is not similar to other species of Clade I (Shih et al. 2011). Accordingly, based on the morphological and molecular results, we propose that the variety Chrysanthemum vestitum var. latifolium should be raised to the species level.

This evidence of phylogenetic results seems to be sufficient for a new taxonomic decision. This study aimed to describe one of the species of Chrysanthemum and investigate its phylogenetic affinities based on molecular and morphological data. Combined with previous morphological and field studies, we also provide a distribution map and information on the taxonomy of Chrysanthemum dabieshanense.

Materials and methods

We employed standard techniques for morphological studies of herbarium specimens and digital images of the most closely related species from the herbaria CSH, HIB, K, KUN, PE, WUK; acronyms follow Thiers (2022), including the holotype specimens of Chrysanthemum vestitum (Hemsl.) Stapf (Fig. 1A) (K, images seen). Dr Z.X. Fu visited the PE herbarium (Institute of Botany, Chinese Academy of Sciences) in June 2021 and compared and checked the holotype specimen of Chrysanthemum vestitum (Hemsl.) Stapf. var. latifolium J.Zhou et J.Y.Chen (East China Station Inst. Bot. 6935, Fig. 1B, PE). We also verified that morphological characteristics of voucher specimen MYP-20160826 (Fig 2, Ma et al. 2020, photo from Y.P. Ma) are identical to those of the type specimen of C. vestitum var. latifolium.

The morphological characteristics of C. vestitum var. latifolium and its related species were examined for comparative research based on measurements of herbarium
The new name, *Chrysanthemum dabieshanense*

specimens (Table 1), supplemented by photos of mature living plants collected from the field (photos from A.G. Zhen and X.X. Zhu). The localities were sorted according to county-level administrative divisions of the People’s Republic of China.

**Results and discussion**

Zhou and Chen (2010) reported a new variety: *Chrysanthemum vestitum* (Hemsl.) Stapf. var. *latifolium* J.Zhou et J.Y.Chen from China (Fig. 1B). In their study, the holotype specimen of *Chrysanthemum vestitum* var. *latifolium* was collected from the Tianzhu Mountain (Anhui Province, Fig. 1B). The variety *Chrysanthemum vestitum* var. *latifolium* is mainly distributed on the western slopes of the Dabie Mountains, throughout the Anhui and Hubei provinces (Qi et al. 2021). It has long been treated as a variety of *Chrysanthemum vestitum* (Fig. 1A). Based on a recent study by Meng et al. (2020), principal component analysis of leaf length (L), leaf width (W), petiole length (P), and relative petiole length (B = P/L) between *C. vestitum* and *C. vestitum*
var. latifolium was conducted, and the two varieties of C. vestitum differed slightly. The difference between the new variety and the original species is that the new variety is less branched and has orbicular and ovoid leaves that are 4–7 cm long and 3–5 cm wide, and the diameter of its capitula is larger, reaching 4.5–5.0 cm (Table 1). The morphology of C. vestitum var. latifolium is distinct from other species in the same clade in terms of the leaf shape and length of capitula (Shih et al. 2011; Ma et al. 2020) (Table 1).

Based on a phylogenetic study of whole chloroplast genomes (Ma et al. 2020), two distinct clades were recognized in the genus Chrysanthemum. Clade I comprised C. chanetii, C. indicum, C. lavandulifolium, C. nankingense, C. zawadskii, C. dichrum, C. mongolicum, C. oreastrum, C. glabriusculum, C. boreale, and C. vestitum var. latifolium from Tianzhu Mountain in the Dabieshan Mountain area (the Chrysanthemum zawadskii group). Clade II consisted of C. rhombifolium, C. indicum var. aromaticum, C. potentilloides, C. hypargyrum, C. argyrophyllum, and C. vestitum var. vestitum (Fig. 3 A, C) (the Chrysanthemum indicum group). Based on the nuclear LFAFY gene, Chrysanthemum vestitum var. latifolium and C. vestitum var. vestitum were treated as two distinct species in different clades (Ma et al. 2020). Accordingly, based on the morphology and molecular results, we propose that the variety Chrysanthemum vestitum var. latifolium should be raised to the species level.

Figure 2. A plant of Chrysanthemum vestitum (Hemsl.) Stapf var. latifolium collected at Tianzhu Mountain, Dabieshan mountains (The voucher no. MYP-20160826, WUK, Ma et al. 2020) A plant growing in natural habitat B the adaxial side of leaf C the abaxial side of leaf. Scale bar: 2 cm (B, C). Photographed by Yue-ping Ma.
Table 1. Comparative measurements in Chrysanthemum dabieshanense (= C. vestitum var. latifolium) and its related species (based on Shih et al. 2011 and additional specimens at the herbaria visited).

<table>
<thead>
<tr>
<th>Species</th>
<th>C. dabieshanense</th>
<th>C. vestitum var. latifolium</th>
<th>C. mongolicum (Clade I)</th>
<th>C. indicum (Clade I)</th>
<th>C. zawadskii (Clade I)</th>
<th>C. lavandulifolium (Clade I)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Leaf blades</strong></td>
<td>orbicular or</td>
<td>ovate, broadly ovate,</td>
<td>broadly ovate or</td>
<td>ovate, long,</td>
<td>ovate, broadly ovate,</td>
<td>ovate, broadly ovate,</td>
</tr>
<tr>
<td></td>
<td>ovate-orbicular,</td>
<td>ovate, oblong, 3.5–7 cm × 2–4 cm, margin repand-dentate</td>
<td>elliptic 1–2 cm × 1.5–1.8 cm</td>
<td>ovate, or elliptic-ovate, 3–7 cm × 2–4 cm, bipinnatisect</td>
<td>1.4–4 × 1–3.5 cm, bipinnatisect</td>
<td>ovate, elliptic-ovate, narrowly elliptic, 2–7 × 1.5–4.5 cm, bipinnatisect</td>
</tr>
<tr>
<td></td>
<td>4–7 × 3–5 cm, 3-loded</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td><strong>Phyllaries</strong></td>
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<td><strong>Capitula</strong></td>
<td>4.5–5 cm in dia.</td>
<td>2–3 cm in diam.</td>
<td>3–4.5 cm in diam.</td>
<td>2.5–4 cm in diam.</td>
<td>1.5–4.5 cm in diam.</td>
<td>1–1.5 cm in diam.</td>
</tr>
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</table>

**Note.** According to International Code of Nomenclature for algae, fungi, and plants (ICN) Articles 6.9, 6.11, 41.2, and 58.1 (Turland et al. 2018), Chrysanthemum dabieshanense Z.X.Fu, A.G.Zhen, & Y.P.Ma, nom. nov. is proposed here as an explicit substitute for the legitimate name Chrysanthemum vestitum var. latifolium, because the epithet latifolium cannot be used for the present combination because of the existence of the name Chrysanthemum latifolium (DC.) Baksay, Ann. Hist. Nat. Mus. Natl. Hung. 8: 161, 1957 (online resource from https://www.tropicos.org/name/50268974). The specific epithet “dabieshanense” refers to the name of the Dabieshan (= Ta-pieh) mountain area, located at the border of the Anhui, Hubei, and Henan Provinces, where the species occurs. Chrysanthemum dabieshanense is endemic and restricted to the Dabieshan Mountain area (Hubei and Anhui provinces). Therefore, we accept Chrysanthemum dabieshanense as a replacement name for Chrysanthemum vestitum var. latifolium. A taxonomic treatment is presented.

**Type.** China. Anhui Prov. Yuexi County, Baojia River, shady slope at the top of the hill, alt. 1500 m, 24 Sep 1953, East China Station Inst. Bot. 6935 (holotype, PE 00544099!, isotype NAS 00486826 photo seen) (Fig. 1B)

**Description.** Perennial rhizomatous herbs, 60–100 cm tall. Stems sprawling, not much branched. Lower stem leaves withered at anthesis. Middle stem leaf blades orbicular or ovate-orbicular, 4–7 cm × 3–5 cm, grayish-green adaxially, grayish-white abaxially, margin above middle obtusely repand-dentate, distal stem leaves sessile or subsessile, capitula 3–10, 4.5–5 cm in diameter. Involucre cup-shaped; phyllaries in 4 rows, abaxially densely pubescent, scarious margin brown, outer phyllaries triangular or triangular-ovate, 3.5–4.5 mm, middle phyllaries lanceolate-ovate, ca. 6.5 mm, inner phyllaries obovate or oblanceolate-elliptic, 6–7 mm long. Ray floret lamina white, 1.2–2 cm long. Achenes ca. 1.5 mm long (Fig. 2, Fig. 3 B, D).
Figure 3. The images of *Chrysanthemum vestitum* and *Chrysanthemum dabieshanense* A, B plants growing in natural habitat C, D adaxial side of leaf (A, C *Chrysanthemum vestitum*, voucher Z.X. Fu 610, PE, Lushi county, Henan province, China, Photographs by Zhixi Fu). (B, D *Chrysanthemum dabieshanense*, voucher X.X.Zhu 089 CSH, Yingshan county, Hubei province, China. Photographs by Xinxin Zhu).

Figure 4. Distribution map of *Chrysanthemum dabieshanense* (black circles) in Anhui and Hubei provinces, China, based on the voucher specimen information.
The new name, *Chrysanthemum dabieshanense*

**Specimens examined.** China – Anhui Prov. Jinzhai County, [without exact locality], M.B. Deng & H.T. Wei 81350, 81196 (NAS); ibidem, B. Chen CB07550 (CSH), Qianshan City, S. J. Yang *et al.* 7193 (NAS), Y.P. Ma MYP-20160826 (WUK); Hubei Prov. Yingshan County, Wujiashan Forest Farm, X.X. Zhu 089 (KUN, CSH); Luotian County, Tiantangzai, A.G. Zhen DBSYS708 (HIB); X.X. Zhu 211858 (KUN).

**Distribution and habitat.** Endemic to the Dabieshan mountain area (Anhui and Hubei Provinces, China, Fig. 4). It grows on shaded slopes, hills, and streamsides, at alt. 800–1600 m.

**Phenology.** Flowering and fruiting are observed in October.

**Chinese name.** Da-Bie-Shan-Ju (大别山菊).

**Acknowledgements**

The authors thank curators and relevant staff of the CSH, HIB, K, KUN, PE, WUK herbaria who granted access to their collections and images. We also thank Dr. Caifei Zhang (Wuhan Botanical Garden, the Chinese Academy of Sciences), Dr. Guojin Zhang (Pennsylvania State University), Dr. Shuai Liao (East China Normal University) and Dr. Peiliang Liu (Northwest University), Associate Prof. Longfei Fu (Guangxi Institute of Botany, Guangxi Zhuang Autonomous Region and Chinese Academy of Sciences) for their critical comments and great help, Mr. Xingyong Cui (Beijing Forestry University) for drawing distribution map. We also thank the anonymous reviewers and editor for constructive criticism of the original manuscript. This study was financially supported by the National Natural Science Foundation of China (No. 32000158, 31872710, 31970225), the National Science & Technology Fundamental Resources Investigation Program of China (No. 2019FY101809, 2021XJJK0702) and the Foundation of Sustainable Development Research Center of Resources and Environment of Western Sichuan, Sichuan Normal University (No. 2020CXZYHJZX03).

**Reference**


Nomenclatural notes of *Sabina convallium* var. *microsperma* (Cupressaceae)

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Abstract
The name *Sabina convallium* var. *microsperma* W.C.Cheng & W.T.Wang was not validly published when it was first described in 1975, but was validated in 1978 at the same time as the specific combination *Sabina convallium* (Rehder & E.H.Wilson) W.C.Cheng & W.T.Wang was validly published in *Flora Reipublicae Popularis Sinicae*. Under Art. 41.6 of the Shenzhen Code, other names based on *Sabina convallium* var. *microsperma* were valid, including *Sabina microsperma* (W.C.Cheng & L.K.Fu) W.C.Cheng & L.K.Fu, *Juniperus convallium* var. *microsperma* (W.C.Cheng & L.K.Fu) Silba, *Juniperus microsperma* (W.C.Cheng & L.K.Fu) R.P.Adams, despite the reference of the basionym being erroneously cited when these authors made the new combinations.

Keywords
Conifer, Cupressaceae, nomenclature, *Sabina convallium* var. *microsperma*
Introduction

When working on an updated catalogue of gymnosperms, we noticed that the small-seeded juniper has nomenclatural problems. The small-seeded juniper was treated either as a species, e.g., *Juniperus microsperma* (W.C.Cheng & L.K.Fu) R.P.Adams (Adams 2008, 2014; Shang et al. 2015), *Sabina microsperma* (W.C.Cheng & L.K.Fu) W.C.Cheng & L.K.Fu (Fu 1983, in Fl. Xizang. 1: 390), or a variety, e.g., *Sabina convallium* var. *microsperma* W.C.Cheng & L.K.Fu (Cheng et al. 1975; Wang et al. 1978), *Juniperus convallium* var. *microsperma* (W.C.Cheng & L.K.Fu) Silba (Silba 1984; Fu et al. 1999; Farjon 2010). However, it remained ambiguous whether these scientific names used in previous taxonomic works were validly published.

*Sabina convallium* var. *microsperma* W.C.Cheng & L.K.Fu was first recognized and described in Cheng et al. (1975, Acta Phytotax. Sin. 13: 86), but was not validly published in that work under Art. 35.1 of the Shenzhen Code (Turland et al. 2018), because the specific name *Sabina convallium* (Rehder & E.H.Wilson) W.C.Cheng & W.T.Wang was not validly published at that time. W.C.Cheng & W.T.Wang made the new combination *Sabina convallium* (Rehder & E.H.Wilson) W.C.Cheng & W.T.Wang (Cheng 1961, in Trees of China, 1: 257), but they did not validly publish the combination under Art. 41.5 because this combination was made after Jan. 1st of 1953 and the authors cited only the basionym but without the reference citation. W.C.Cheng & W.T.Wang unintentionally but validly published the specific combination in Flora Reipublicae Popularis Sinicae (Wang et al. 1978, 7: 372) where they correctly cited the basionym and its reference. In the same work, the varietal name *Sabina convallium* var. *microsperma* W.C.Cheng & L.K.Fu was validated by citing the reference of the protologue (Wang et al. 1978, 7: 373).


Adams (2008, 2014) divided *Juniperus* into three sections, viz. sect. *Caryocedrus* Endl., sect. *Juniperus*, and sect. *Sabina* (Mill.) Spach, and indicated that the three sections can be distinguished using morphological characters, e.g. leaves decurrent or not (decurrent in sect. *Sabina* vs. jointed in sect. *Caryocedrus* and *Juniperus*), leaf shape (acicular in sect. *Caryocedrus* and *Juniperus* vs. scale-like in sect. *Sabina*), seed cones size
(8–25 mm in sect. *Caryocedrus* vs. 6–18 mm in sect. *Juniperus* and *Sabina*), seeds fusion (fused in sect. *Caryocedrus* vs. free in sect. *Juniperus* and *Sabina*). Mao et al. (2010) suggested that all of the three sections are monophyletic. Yang et al. (2022) treated *Sabina* as a separate genus from *Juniperus* considering phylogeny, morphology, and utilization purposes. Based on the phylogeny of nuclear markers, Shang et al. (2015) suggested that *Juniperus microsperma* is not closely related to *J. convallium*, but sister to a small clade including *J. semiglobosa* and *J. sabina*. Therefore, we treated the generic name *Sabina* and the specific name *Sabina microsperma* as accepted.

**Nomenclature**


**Type.** China (中国). Sichuan (四川), arid places, alt. 2500 m, Aug. 1904, Veitch Exped. 3010 (holotype: A00056809, Fig. 1; isotypes: BM000959921, K001090508, K001090509, K000089628, P00748989, S-C-6511, SYS00001562).

**Note.** Rehder and Wilson (1914) cited one single collection (Veitch Exped. 3010) in the protologue which should be considered as the type specimen. Adams (2008, 2014) and Farjon (2010) indicated that the specimen in A is the holotype and the isotypes are in BM and K. We found five additional isotypes in international herbaria.


**Type.** China (中国). Xizang (西藏), Qamdu (昌都), Sumzom (松宗), 26 Oct. 1961, Forestry Exped. (森林调查队) 10019 (holotype: PE00002535, Fig. 2).
Figure 1. Holotype of *Juniperus convallium* Rehder & E.H. Wilson: Vietch Exped. 3010 (A00056809).
Figure 2. Holotype of *Sabina convallium* var. *microsperma* W.C. Cheng & L.K. Fu: Forestry Exped. 10019 (PE00002535).
Acknowledgements

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References


A new classification of C4-Atriplex species in Russia, with the first alien record of *Atriplex flabellum* (Chenopodiaceae, Amaranthaceae) from North Siberia

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Abstract

For a long time, the systematics of *Atriplex* was based solely on morphological characters and leaf anatomy. The latest worldwide phylogenetic study of *Atriplex* significantly improved our knowledge about the relationships within the genus, but a new classification has not been put forward thus far. Here we re-evaluate the taxonomy of C₄-species of *Atriplex* that are native to Russia. Seven species are classified into two sections, *A*. sect. *Obione* (incl. *A*. sect. *Sclerocalymma*, syn. nov.) (*A. altaica*, *A. centralasiatica*, *A. rosea*, *A. sibirica*, and *A. sphaeromorpha*), and *A*. sect. *Obionopsis* (incl. *A*. sect. *Psammophila*, syn. nov.) (*A. fominii* and *A. tatarica*). Although the majority of Eurasian C₄-species have similar morphology, leafy inflorescence is a typical character for *A*. sect. *Obione*. The members of *A*. sect. *Obionopsis* are characterised mostly by aphyllous inflorescences, but some species (*A. laciniata*, *A. pratovii*, and *A. tornabenei*) have leafy inflorescences. Geographically, almost all members of *A*. sect. *Obione* are confined to Central Asia, although *A. rosea* is a typical Mediterranean element and *A. argentea* occurs in North America. The representatives of *A*. sect. *Obionopsis* are distributed mostly in the Mediterranean and the Irano-Turanian floristic region. The alien status of *A. rosea*, *A. sibirica* and *A. tatarica* is discussed. *Atriplex flabellum*, a desert species from the Irano-Turanian region, is reported for the first time from Russia (Yamalo-Nenets Autonomous District, North Siberia) as a casual alien. This species occupies a phylogenetic position distant from both aforementioned sections. An identification key to all C₄-species of the genus growing in Russia is given, and a sectional checklist with updated nomenclature and revised synonymy is provided.
Keywords
Alien species, Atriplex flabellum, distribution, Russia, systematics, taxonomy

Introduction

Atriplex L. is the largest genus in the subfamily Chenopodioideae (Amaranthaceae sensu APG IV 2016), after Chenopodium L. s.l. has been disassembled into several genera of different taxonomic placement within the subfamily (Fuentes-Bazan et al. 2012). It encompasses ca. 260 species distributed worldwide (Žerdoner Čalasan et al. 2022). In Eurasia, many species of Atriplex are found in deserts, especially in the Irano-Turanian floristic region, and it was suggested that the genus originated in continental Asia (Žerdoner Čalasan et al. 2022).

The classification system of Atriplex had been at first based on morphological characters (e.g., Aellen 1939; Wilson 1984); additionally, leaf anatomy was used as an important character for the delimitation of Atriplex species. The genus was divided into two physiological groups: with non-Kranz (C₃) and Kranz (C₄) anatomy (Moser 1934; Carolin et al. 1975; Welsh 2001; Sukhorukov 2006). In the latest treatment for Russia and adjacent countries (Sukhorukov 2006), Atriplex was divided into two subgenera based on the fusion of the perianth segments (valves) in the female flowers: A. subgen. Atriplex with marginally connate valves and A. subgen. Pterotheca (Aellen) Sukhor. with ventrally fused valves. The valves imitate bracteoles and pairs of them form bract-like covers enclosing each female flower. The type subgenus comprised several sections, characterised by the degree of valve fusion and their sclerification, leaf anatomy, the type of diurnal leaf movements, as well as their fruit and seed characters.

Molecular phylogenetic studies (Kadereit et al. 2010; Žerdoner Čalasan et al. 2022) confirmed a close relationship of many Eurasian C₃-species, especially those of A. sect. Atriplex and A. sect. Teutliopsis Dumort. emend. Sukhor. (excl. A. oblongifolia Waldst. & Kit.), as well as a distant position of A. cana C.A.Mey. from other members proposed by Sukhorukov (2006). All C₄-species of the genus comprise a monophyletic clade (Kadereit et al. 2010; Žerdoner Čalasan et al. 2022) with ca. 180 members distributed in the arid and mountainous regions around the world (Sage 2016).

Nearly all of the aforementioned species (except *A. belangeri* and *A. tianschanica*) were included in the latest molecular phylogenetic study of the genus, and they fell into two phylogenetic lineages with different positions on the tree within the large C_4_ group (Žerdoner Čalasan et al. 2022). The previous morphology-based classification (Sukhorukov 2006, 2014) only partly agrees with the phylogenetic relationships. Thus, the systematics of *Atriplex* needs to be revised, with the re-evaluation of its section-level taxonomy.

The present article is dedicated to a new sectional subdivision of the C_4_-species of *Atriplex* growing in Russia as the first step towards a new taxonomic classification of *Atriplex* worldwide. It summarises the distributional data for all its members including new, unexpected alien occurrences, with further notes on geographical patterns revealed in the new classification.

**Materials and methods**

Our new classification of C_4_-*Atriplex* taxa occurring in Russia is based on the most recent phylogenetic study (Žerdoner Čalasan et al. 2022) and follows the principle of strict monophyly.

Historical taxonomic literature was examined for infrageneric classifications in *Atriplex*. A section-level taxonomic and nomenclatural checklist was compiled in order to evaluate the infrageneric names used to classify the species under study. Taxonomic literature was screened for protologues, which were evaluated according to the current rules of botanical nomenclature (Turland et al. 2018).

We used the distribution data for each species given by Hedge (1997) and Sukhorukov (2006, 2014), which were complemented by our recent field and herbarium studies. Herbarium collections from LE, LECB, MHA, MW, MSK, MSKU, MWG, NS and NSK were critically revised for taxonomic identifications and screened for new records.

Distribution maps were prepared using SimpleMappr online tool (http://www.simplemappr.net) based on the literature data and the examined specimens. The results were generalised and schematically presented over the basemap of first-level administrative subdivisions of Russia. Distribution areas were evaluated for their native core and secondary dispersal based on herbarium specimens and our personal observations in the field, thus separating the territories where the species occur in their natural habitats from those where the species are confined exclusively to ruderal or other man-made habitats.

**Results and discussion**

**Taxonomy of the native species**

The C_4_-species of *Atriplex* native to Russia are here classified into two sections, *A. sect. Obione* (Gaertn.) Reichenb. and *A. sect. Obionopsis* (Lange) Dumort., according to their phylogenetic position (Žerdoner Čalasan et al. 2022). The latter sectional
name had been forgotten for a long time but is resurrected here as the earliest name applicable to the group that includes its type species *A. laciniata* and related taxa. In the checklist, previously overlooked protologues are cited for accepted names together with second references (other than protologues) that indicate the works previously considered as places of valid publication.


≡ *Obione* Gaertn., De Fruct. 2: 198 (1791).
≡ *Atriplex* [unranked] *Argenteae* Standl. in Britton, N. Amer. Fl. 21: 46 (1916), syn. nov.

**Description.** Annuals; inflorescences leafy; glomerules loosely arranged.

**Native distribution and species.** Members of the section occur in steppes, semi-deserts and mountains of Central Asia (e.g. *A. altaica, A. centralasiatica, A. pamirica, A. sibirica*), in the Aralo-Caspian floristic region (*A. sphaeromorpha*), in the Mediterranean (*A. rosea*), and in North America (*A. argentea* Nutt.). Five species are native to Russia (*A. altaica, A. centralasiatica, A. sibirica, A. sphaeromorpha*, and *A. rosea*). The Central Asian species (*A. altaica, A. centralasiatica, A. sibirica*) are mostly confined to mountain steppes and scree in South Siberia, but *A. centralasiatica* and *A. sibirica* can be found also in saline and ruderal habitats. *Atriplex rosea* and *A. sphaeromorpha* are typical lowland species with similar morphology but different distribution patterns. The first species, with predominantly Mediterranean distribution, was considered native in the southern part of Eastern Europe (Medvedeva 1996), whereas we treat it as native only in Krasnodarsky Kray, where it occurs near the shore of the Black Sea and in ruderal places further inland (Sukhorukov 2006; Zernov 2006). *Atriplex sphaeromorpha* is
mainly distributed in steppes and semi-deserts of Kazakhstan, with very scattered records in Orenburg and Saratov Oblast, as well as in the North Caucasus (Sukhorukov 1999, 2006). In these regions, *A. sphaeromorpha* could potentially require conservation action according to the IUCN guidelines (IUCN 2022) because of a high level of anthropogenic disturbance to Eurasian grasslands. The native and alien ranges of all Russian species of *A.* sect. *Obione* are displayed in Fig. 1A–E.

**Taxonomic notes.** The synonymisation of *Atriplex* sect. *Obione* with *A.* sect. *Sclerocalymma* and *A.* subsect. *Argenteae* is undertaken here for the first time. *Atriplex powellii* S.Watson, previously considered as a close relative of *A. argentea* (Standley 1916; Welsh 2001), occupies a distant phylogenetic position (Žerdoner Čalasan et al. 2022).

**Nomenclatural notes.** The name *A.* sect. *Obione* has usually been credited to Meyer (1833), who accepted this subdivision in ‘Flora Altaica’. However, the first author who segregated this section within *Atriplex* was Reichenbach (1828). He accepted the name and provided an indirect reference to the basionym as “Obione. G.” The

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**Figure 1.** Schematic distribution areas of C₄-species of *Atriplex* native to Russia. **A**. *A. altaica* **B**. *A. centralasiatica* **C**. *A. rosea* **D**. *A. sibirica* **E**. *A. sphaeromorpha* **F**. *A. tatarica*. Green – native distribution range, yellow – alien distribution not confirmed after 1930s, orange – alien distribution confirmed after 1930s.
infrageneric taxa accepted by Reichenbach (1828) were explicitly ranked as sections, as evidenced by a footnote on page 184 in this work. Similarly, Hooker (1870) was the first to accept *A.* subgen. *Obione*, which was explicitly ranked by him. On the contrary, Ascherson (1864) developed complex infrageneric systems that included at least three ranks, with names at all of these ranks, and made no note of their ranking; such classifications are to be treated as unranked (Art. 37.3).


   Type species: *Atriplex arenaria* J.Woods 1849, non Nuttall 1818 (= *Atriplex laciniata* L.).
   syn. nov. Type species: *Atriplex dimorphostegia* Kar. & Kir.

**Description.** Annuals; inflorescences aphyllous or bracteate, rarely leafy in the lower and middle parts; glomerules loosely or densely arranged.


**Native distribution.** Members of this section are distributed mostly in the Irano-Turanian floristic region, with extensions into the Mediterranean and Western Europe. *Atriplex paradoxa* is the only species native to Central Asia (Tian-Shan Mountains). Two species are present in Russia: *A. fominii* (not shown on the map), which is restricted to the western shore of the Caspian Sea in Dagestan and Azerbaijan (Iljin 1936; Sukhorukov 2006), and the widely distributed *A. tatarica* (Fig. 1F). In the steppe and desert zones of Russia, *A. tatarica* is considered native based on its presence in natural landscapes (mostly on saline soils).

**Nomenclatural notes.** Lange (1859) used unranked infrageneric categories in his classification, whereas Du Mortier (1873) was apparently the first to explicitly rank *Obionopsis* as a section of *Atriplex*, but the nomenclatural significance of Du Mortier’s publication was overlooked.

The second edition of Lange’s ‘Haandbog i den Danske Flora’ was published in 7 parts during 1856–1859 (Stafleu and Cowan 1979). These parts were distributed separately by commercial publishers and are therefore effectively published, and the nomenclatural novelties in this work should be cited as published in its parts. The complete book bears no note on the parts and their dates, and no information on the book’s structure and dates is publicly available. According to contemporary announcements of book sales, the concluding part 7 of Lange’s book (with the treatment of Chenopodiaceae) was published in 1859 and consisted of 172 pages, which agrees with the printer’s signatures.
Morphological notes on the members of *Atriplex* sect. *Obione* and *A*. sect. *Obionopsis*

Considering the latest phylogenetic results, many morphological characters like annual life form, ± significant fusion of the valves enclosing the female flowers, indurated lower part of the bract-like cover and heteromorphic seeds, which have been traditionally used in sectional delimitation (e.g., Aellen 1939; Sukhorukov 2006), should be considered as convergent and thus unreliable for the delimitation of *Atriplex* sect. *Obione* and *A*. sect. *Obionopsis*.

The fusion of the valves of the female flowers can vary considerably within a single species as observed, e.g., in *A. centralasiatica* (Grubov 1966). This species is characterised by dimorphic bract-like and smooth covers (with and without dorsal outgrowths), with the latter ones being less fused. The valve fusion was examined in other annual species of both sections (Sukhorukov 2006). In *A*. sect. *Obione*, the valves are connate to 1/3–1/2 of their length in most species, but to 2/3 or higher in *A. sibirica*. In *A*. sect. *Obionopsis* the valves are usually fused to 1/3–1/2 of their length, but in *A. dimorphostegia* and *A. ornata* they are free (except the stalks, which are always fused), herbaceous and not inflated.

Seeds are usually dimorphic, red and brown in most members of both sections (Sukhorukov 2006). In light of the recent phylogenetic results (Žerdoner Čalasan et al. 2022), the trimorphic (black, red and brown) seeds mentioned by Sukhorukov (2006) as a key character for *A*. sect. *Psammophila* (now included in *A*. sect. *Obionopsis*) as well as the stalked and herbaceous valves should be re-evaluated as rare synapomorphies among the C₄-species of the genus.

Leafy inflorescences, which were considered characteristic of *A*. sect. *Obione* (Sukhorukov 2006), are also present in several species of *A*. sect. *Obionopsis* (*A. dimorphostegia, A. laciniata, A. ornata, A. pratovii*). We conclude that there are no specific morphological traits that can distinguish both sections.

Notes on alien status of the species under consideration

From all the C₄-species of *Atriplex* growing in Russia, only *A. tatarica* (Fig. 2A) seems to be able to spread continuously to the north reaching the forest zone (Fig. 1F). It is found in almost all regions of European Russia and Siberia up to 60°–65°N (e.g., Lomonosova 1992; Medvedeva 1996; Uotila 2011), with potential outposts in the Russian Far East (Ignatov 1988). In the forest zone, *A. tatarica* is usually found along the railway tracks on gravelly soil, where it can be classified as a typical “railway-wandering plant” (terminology after Kornaš et al. 1959). Nevertheless, sometimes it can also be encountered in towns as a ruderal plant (Sukhorukov 2014). In the northern part of Central Russia, it is a neophyte (Vinogradova et al. 2009) rather than a native species or an archeophyte as proposed by Uotila (2011). *Atriplex tatarica* was included in the “Black Book [Invasive and naturalized alien plants] of the flora of Middle Russia” (Vinogradova et al. 2009), but its invasive status was apparently exaggerated,
at least for the provinces situated in the forest zone, due to a limited number of suitable habitats in this area. In steppes of European Russia, *A. tatarica* seems to be native (but allochthonous) and can be found in a wide range of habitats including saline soils, same as in more southern regions of temperate Eurasia.

*Atropin distincta* is native to Central Asia and South Siberia (Sukhorukov 2006) where it grows in steppes, on loamy or stony soils, or as a ruderal plant. Surprisingly, this species is rarely found as an alien taxon in other regions despite the presence of suitable habitats, and almost all of the several recent findings outside of Siberia (Fig. 1D) are located along railway tracks. For example, in the Russian Far East it was found for the first time in 1973 in Kamchatka Kray (MHA0303450, as *A. rosea*) and correctly identified by Ignatov (1988), then collected once in Khabarovsky Kray in 1990 (MHA0303451). The first record of *A. sibirica* in Primorsky Kray is reported here: “Vladivostok town, Ugol’naya railway station, gravelly substrate, 9 Aug 1988, T. Nechaeva s.n.” (MHA0303481, as *A. tatarica*). Among several sheets collected from this locality by T. Nechaeva, only one specimen belongs to *A. sibirica*, whereas all other specimens were correctly identified as *A. tatarica*. In European Russia, *A. sibirica* was known only from two provinces (Sukhorukov 2014; Fig. 1D in the present paper). Because of its scattered records in both Far East and European Russia, *A. sibirica* should be considered a casual alien without naturalization potential.

Contrary to *A. sibirica* and *A. tatarica*, the secondary range of *A. rosea* (Fig. 2B) in Eastern Europe has dramatically declined (Sukhorukov 2006). Almost all the recent claims about its wide distribution in the central and south parts of European Russia are erroneous, and since the 1930s there were no new records of *A. rosea* except the oc-

**Figure 2.** General view of the plants: **A**. *A. tatarica* **B**. *A. rosea*. Photographs by A. Sukhorukov (**A** Russia, Tambov Oblast, Uvarovo, 20 September 2008) and M. Chambouleyron (**B** Morocco, Jerada, 23 August 2019).
A new classification of C4-Atriplex species in Russia

A new record of an alien C₄-species from Russia

Among the Russian specimens of *Atriplex prostrata* Boucher ex DC. (A. sect. *Teutliopsis* Dumort.: Sukhorukov 2006; Žerdoner Čalasan et al. 2022), which are deposited at MW, an unusual plant was found that readily differs from this species by its (sub)opposite leaves with crenate blades and by the leaf venation with remarkable chlorenchyma stripes that is peculiar for the atriplicoid Kranz anatomy. These features indicate that this plant is actually *A. flabellum*, a desert species from Central Asia, Iran and Afghanistan, which has never been reported for Russia (Lomonosova 1992; Sukhorukov 2006). This record is treated in detail here, separate from the other C₄-species because of its novelty and casual non-native origin.

*Atriplex flabellum* Bunge in Boiss., Fl. Orient. 4: 912 (1879).


**Morphology.** For a detailed description, see Iljin (1936), Hedge (1997) and Sukhorukov (2006). The species is recognisable in all stages by its (sub)opposite crenate leaves with the Kranz-type anatomy, and flabellate and stalked bract-like covers of the female flowers with ventrally fused valves. The (sub)opposite leaves are very rarely found in the C₄-clade of *Atriplex*, and the ventral valve fusion is present only in two Eurasian species of the genus, *A. flabellum* and *A. moneta*.

**Specimen seen** (Fig. 3). Russia, Tyumen Oblast, Yamalo-Nenetsky Autonomous District, Novy Urengoy Town, Aug 199X [year unknown], *P. Zhmylyov & S. Elansky s.n.* (MW0058941!). Image available at https://plant.depo.msu.ru/public/scan.jpg?pcode=MW0058941.

**Habitat.** In Russia, the species occupies ruderal habitats. Within its native distribution range, it occurs in the desert zone on sandy and loamy soils in lowlands and foothills.

**Introduction status.** Casual alien. *Atriplex flabellum* is a typical desert plant, and its populations cannot become established in the extreme north of the boreal zone. For this reason, we presume that this population is most likely extinct now.

**Native distribution.** Afghanistan, Iran, Kazakhstan (south and south-east), Kyrgyzstan, Tajikistan, Turkmenistan, Uzbekistan.

**Alien distribution.** Russia (Tyumen Oblast) (Fig. 4).
Figure 3. The voucher specimen of *Atriplex flabellum* recorded in Russia.
A new classification of C4-\textit{Atriplex} species in Russia

\textbf{Taxonomy.} The phylogenetic position of \textit{A. flabellum} is distant to both \textit{A.} sect. \textit{Obione} and \textit{A.} sect. \textit{Obionopsis}; this species belongs to the basal grade within a large clade encompassing the majority of the Old World species of the genus (Žerdoner Čalasan et al. 2022). It was assigned to \textit{A.} subgen. \textit{Pterotheca} (Aellen) Sukhor. (lectotype species: \textit{A. moneta} Bunge (Sukhorukov 2006)), whose monophyly has not been confirmed, and the sectional placement of \textit{A. flabellum} has not been evaluated. A new classification of \textit{Atriplex} is currently in preparation by Sukhorukov et al.

This Russian record of \textit{Atriplex flabellum} is unexpected. Two more species of the C4-clade of \textit{Atriplex}, \textit{A. dimorphostegia} and \textit{A. pungens} (both belonging to \textit{A.} sect. \textit{Obionopsis}), occur in West Kazakhstan at their western distribution limit (more detail in Sukhorukov 2006) and can potentially be found in adjacent regions of Russia (e.g., Astrakhan Oblast) as alien or sporadically distributed native plants.

\textbf{Key to the native and alien C4-species of \textit{Atriplex} growing in Russia}

1. Leaves (sub)opposite, crenate; valves at fruiting flabellate, stalked, ventrally fused .......................................................................................................................... \textit{A. flabellum}

   – Leaves alternate, of different shape; valves marginally fused...............................2

2. Inflorescence leafy (almost) to the top; leaves rhombic, triangular or spatulate, entire to lobate..................................................................................................................3

   – Inflorescence not leafy, sometimes one to several leaves present; leaves of different shape (linear, lanceolate or rhombic), entire to sinuate ..............................................7

3. Plants small (up to 20–30 cm), not forming a tumble-weed habit; bract-like cover dorsally without outgrowths..................................................................................\textit{A. altaica}

   – Plants forming a tumble-weed or spreading habit; bract-like cover usually with outgrowths........................................................................................................4

\textbf{Figure 4.} The location of a single alien record of \textit{Atriplex flabellum} in Russia.
4 At least some valves of female flowers stalked, with thorn-like outgrowths located along the seed-containing part; plants native to Siberia, rarely found in other regions as aliens ................................................................. 5
– Valves sessile, with one to several outgrowths located near their centre, rarely smooth; plants native to Europe ................................................................. 6

5 Valves monomorphic, all with thorn-like outgrowths .................................. A. sibirica
– Valves dimorphic, smooth and with thorn-like outgrowths on the same plant ....
......................................................................................................................... A. centralasiatica

6 Inflorescence branches almost filiform; each cluster with 1–3 female flowers; steppe plants ................................................................. A. sphaeromorpha
– Inflorescence branches not filiform, stout; each cluster with 3–6 female flowers; ruderal or coastal habitats ......................................................... A. rosea

7 Inflorescence bracteate; bract-like cover not inflated .................................. A. tatarica
– Inflorescence leafy in its lower and middle part; bract-like cover inflated ...... A. fominii

Conclusions

A new, phylogeny-based classification of the C₄-species of Atriplex occurring in Russia, places them into two large groups, which are morphologically similar but geographically rather distinct.

The phylogenetic circumscription of these groups shows that many characters that evolved in these lineages are highly convergent; thus it is impossible to find any clear morphological differences between these lineages. They can be characterised by different tendencies in certain diagnostic characters.

This classification is the first step towards a new phylogeny-based revision of the taxonomy of Atriplex worldwide. In addition to the gaps in the recent phylogenetic studies, for which some important species have not been sampled yet, a significant difficulty is presented by the vast corpus of old taxonomic literature, which has never been evaluated for the infrageneric nomenclature.

Many Atriplex species readily colonise disturbed habitats and spread widely to new territories next to or even far away from their native distribution areas. In addition to the first record of A. flabellum, further records of non-native species are expected in Russia, especially those with the ranges located close to the country, e.g. A. dimorphostegia and A. pungens.

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Monograph of *Doselia* (Solanaceae), a new hemiepiphytic genus endemic to the northern Andes

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Abstract
A new genus, *Doselia* A.Orejuela & Särkinen, *gen. nov.*, is described in the tribe Solandreae (Solanaceae) consisting of four species of hemiepiphytic lianas endemic to the premontane forests of the Colombian and Ecuadorian Andes. The genus is distinguished based on the membranous leaves, usually sparsely pubescent with eglandular simple trichomes, pseudo-verticillate leaf arrangement, and elongated, pendulous, and few-flowered inflorescences with showy flowers and conical fruits. Three new combinations are made to transfer species to the new genus previously described as part of the polyphyletic genus *Markea* Rich. (*Doselia epifita* (S.Knapp) A.Orejuela & Särkinen, *comb. nov.*, *D. huilensis* (A.Orejuela & J.M.Vélez) A.Orejuela & Särkinen, *comb. nov.* and *D. lopezii* (Hunz.) A.Orejuela & Särkinen, *comb. nov.*). One new species is described from the western slopes of the eastern cordillera of the Colombian Andes, known only from three localities in the Boyacá, Santander, and Tolima departments (*Doselia galilensis* A.Orejuela & Villanueva, *sp. nov.*). The new species is unique in the genus in having glabrescent adult leaves, green-purplish calyces and long, greenish-white, infundibuliform corollas with delicate purplish veins and large lobes tinged with purple, and pubescent styles. Here we provide a revision of *Doselia* with a distribution map of all species, an identification key, photographs, preliminary conservation assessments, and line drawings of all four species.

Resumen
Un nuevo género, *Doselia* A.Orejuela & Särkinen, *gen. nov.*, es descrito en la tribu Solandreae (Solanaceae), conformado por cuatro especies de lianas hemiepipífitas endémicas de los bosques premontanos de los Andes de Colombia y Ecuador. El género se distingue por sus hojas membranosas con tricomas simples no
glandulares, el arreglo pseudoverticilado de las hojas y sus inflorescencias paucifloras, largo pedunculadas y péndulas, flores vistosas y frutos cónicos. Se proponen tres nuevas combinaciones para acomodar especies previamente descritas en el polifilético género *Markea* Rich. (*Doselia epifita* (S.Knapp) A.Orejuela & Särkinen, **comb. nov.**, *D. huilensis* (A.Orejuela & J.M.Vélez) A.Orejuela & Särkinen, **comb. nov.** and *D. lopezii* (Hunz.) A.Orejuela & Särkinen, **comb. nov.**) Una nueva especie es descrita aquí proveniente de la vertiente occidental de la cordillera Oriental de los Andes colombianos, y conocida únicamente de tres localidades en los departamentos de Boyacá, Santander y Tolima (*Doselia galilensis* A.Orejuela & Villanueva, **sp. nov.**). La nueva especie se caracteriza por sus hojas glabrescentes cuando adultas, cáliz verde-púrpura, corolas infundibuliformes grandes, blanco-verdosas con una reticulación fina de venas púrpuras, lóbulos corolinos grandes y teñidos de púrpura en su lado ventral y estilos pubescentes. El nuevo género es formalmente descrito incluyendo un mapa de distribución, una clave taxonómica y fotografías e ilustraciones para sus cuatro especies.

**Keywords**
Colombia, *Doselia*, Ecuador, endemism, hemiepiphytes, Juanulloae, lianas, *Markea*, new species, Solandreae

**Palabras clave**
Colombia, *Doselia*, Ecuador, endemismo, hemiepífitas, Juanulloae, lianas, *Markea*, nuevas especies, Solandreae

**Introduction**

The tribe Solandreae Miers (Solanaceae) contains ca. 80 species of mainly epiphytic or hemi-epiphytic lianas and shrubs in a number of genera currently being recircumscribed (Orejuela et al. 2017; Orejuela et al. in prep). The group is restricted to the Neotropics, with species distributed from Mexico and the Caribbean to Bolivia and southern Brazil (Orejuela et al. 2017). A centre of endemism for the tribe lies in Andean Ecuador and Colombia, where ca. 60% of the species are found (Orejuela et al. 2017).

The tribe Solandreae is a unique clade within Solanaceae in that many of its component taxa are epiphytic and hemiepiphytic plants with a great diversity of floral forms, pollinators, and ant associations. Epiphytes are rare in Solanaceae, with only ca. 90 species with this growth form across the family in three distinct tribes (Solandreae 80 spp.; Capsiceae 4–5 spp.; and Solaneae 4–5 spp.), with Solandreae containing most of the epiphytic species (ca. 90%; Hunziker 2001). The tribe is also the only group of Solanaceae with known ant associations (e.g., *Merinthopodium* Donn.Sm., *Markea* Rich., and species of *Hawkesiophyton* Hunz.; Knapp et al. 1997; Hunziker 2001; Orejuela et al. 2017).

Within Solandreae, there is notable morphological variation in corolla shape, size, and colour. Corollas vary from large infundibuliform or campanulate, long tubular, hypocrateriform to minutely campanulate and include pale or dull-coloured to brightly coloured forms. This remarkable variation suggests a diverse coevolutionary history with pollinators: bats, hummingbirds, and bees have all been observed to visit these flowers (Vogel 1958; Cocucci 1999; Muchhala and Jarrin-V 2002; Sazima et al. 2003; Knapp 2010).
Variation in floral form has been used as the basis of previous taxonomic classifications of the tribe. Molecular phylogenetic studies have shown, however, that many of the previously recognised genera in Solandreae are para- or polyphyletic and in dire need of taxonomic revision (Orejuela et al. 2017). In addition to extensive re-circumscription of genera, two new lineages have been identified within Solandreae based on nuclear and plastid Sanger sequences and whole plastome data that represent distinct morphological groups comprised of species previously described as members of *Markea* that are distinct at the generic level: the *Markea lopezii* and *Markea antioquiensis* clades (Orejuela et al. 2017; Orejuela et al. in prep).

Here we focus on the morphologically distinct *Markea lopezii* clade (Figs 1, 2; Table 1), a group of four species from mid-elevation moist Andean forests of Ecuador and Colombia. The group includes three previously described species, *M. epifita* S.Knapp, *M. builensis* A.Orejuela & J.M.Vélez, and *M. lopezii* Hunz. The fourth was discovered in 2018 during fieldwork in Colombia in the Parque Natural Regional Bosque de Galilea in the municipality of Villarrica, Tolima, and is described here. The four species treated here were resolved as a monophyletic group, named the *Markea lopezii* clade, with strong branch support in a molecular phylogenetomic study of Solandreae that included 95% of the species (76 spp.; Orejuela et al. in prep).

### Materials and methods

All specimens of the tribe Solandreae from 25 Colombian and Ecuadorian herbaria were revised for the study to understand morphological variation across the group (acronyms follow Index Herbariorum http://sweetgum.nybg.org/science/ih/): ANDÈS, CAUP, COAH, COL, CUVC, FAUC, FMB, HECASA, HUA, HUAZ, HUQ, JAUM, JBB, JBBP, LLANOS, MEDEL, PSO, QCA, QCNE, TOLI, UDBC, UIS, UPTC, UTMC, and VALLE; as well as major herbaria that hold representatives from countries across the Andes (BM, E, F, K, MO, US). Herbarium material of the new species was collected in 2018 and deposited at Universidad del Tolima herbarium (TOLI) and Herbario del Jardín Botánico de Bogotá (JBB). Flowers and fruits were preserved in 70% alcohol to facilitate the preparation of taxonomic description and illustration.

Specimens with coordinates were mapped directly, and those lacking coordinates were located using Google Earth, GeoNames gazetteer (http://www.geonames.org), and GEOLocate Web service (https://www.geo-locate.org/default.html). Distribution maps were created using QGIS (QGIS Development Team 2021). Conservation assessments were made based on the IUCN Red List categories and criteria (IUCN 2012) and the most recent guidelines for using the IUCN Red List Categories and Criteria (IUCN 2022). For the conservation assessments, Extent of Occurrence (EOO) and Area of Occupancy (AOO) were calculated using GeoCat (www.geocat.kew.org; Bachman et al. 2011) with a 2 km² cell size. Herbarium material, field observations, and photos were all used to construct the identification key.
**Taxonomic treatment**

*Doselia A.Orejuela & Särkinen,* gen. nov.  
urn:lsid:ipni.org:names:77302328-1

Fig. 1

**Diagnosis.** Like *Solandra* Sw. and *Schultesianthus* Hunz., but differing from both in having membranous leaves (vs. chartaceous or coriaceous), lacking glandular trichomes, having pendulous inflorescences with long slender peduncles (vs. solitary flowers or short erect inflorescences with thick woody peduncles), distally winged pedicels, and actinomorphic corollas (vs. weakly zygomorphic); differing from *Solandra* in its smaller corollas (8.5–15 cm vs. 15–40 cm long), flowers borne in groups (vs. solitary), straight filaments and styles (vs. strongly curved and declinate), and 2-locular ovaries (vs. 4-locular); differing from *Schultesianthus* Hunz. in the chartaceous fruiting calyx with visible venation (vs. a thick, shiny and coriaceous fruiting calyx with no visible venation).

**Type species.** *Doselia lopezii* (Hunz.) A.Orejuela & Särkinen comb. nov. (basionym *Markea lopezii* Hunz.)

**Description.** Hemiepiphytic lianas adhering to the trees by adventitious roots. Stems terete when fresh, irregularly angulate when dry, pubescent with simple, uniseriate multicellular eglandular trichomes, older stems with pale brown and papery bark, often peeling, with broad circular foliar scars left by fallen leaves. Leaves alternate on young stems or tightly clustered appearing sub-opposite in adult branches, simple, broadly elliptic to obovate, membranous, concolorous, sparsely to densely pubescent both abaxially and adaxially with simple, uniseriate eglandular trichomes like those on stem; major veins 3–6 pairs; base attenuate to obtuse, sometimes asymmetric; margins entire to undulate; apex acute, acuminate, or mucronate; petioles well-developed, conspicuously articulate, green. Inflorescences axillary to sub-axillary monochasial cymes, simple to one-branched, occasionally bracteate, usually long-pedunculate and pendulous, 1–7-flowered, pubescent with trichomes as on the stems; peduncles (1.2–) 8.5–50 cm long; bracts absent or if present foliaceous and linear, 5–6 cm long, 1–2 cm wide; pedicels 0.5–3.0 cm long, conical, 5-ribbed, distally thickened and winged in some species, articulated at the base. Flowers 5-merous, actinomorphic, perfect, aestivation valvate in the calyx and cochlear in corolla. Calyx cupuliform, green to whitish-green with purple colouration sometimes on the veins or along the margins only; lobes flat to undulate, 2.4–5.2 cm long, 1–1.5 cm wide, long-triangular to lanceolate, apically long-acuminate to acute, pubescent with simple, uniseriate eglandular, transparent to brown trichomes. Corollas 8.5–15 cm long, the inner corolla diameter from 2.5–5.0 cm, infundibuliform, hypocrateriform to tubular-campanulate, orange, purple, white, yellowish-green with purple veins, sparsely pubescent abaxially with trichomes like those on the calyx; lobes 1.6–4.2 cm long, 1.6–4.3 cm wide, triangular to oblong, spreading to reflexed during anthesis, glabrous to sparsely pubescent, the margins entire to undulate to revolute, the apices acute to obtuse. Stamens 5, equal, included within corolla tube or fully exserted beyond the mouth; filaments 1.7–6.1 cm
long, adnate to the base of the corolla, white to purple-tinged, glabrous to pubescent at
the point of insertion; anthers 1.4–2.7 cm long, 1.3–1.8 mm wide, elongate, basifixed,
not connivent. Ovary conical, 2.9–7.5 mm long, 2.9–7 mm in diameter, light yellow to
brown, 2-carpellate, 2-locular, glabrous, with a well-developed 5-lobed light green to pale
yellow nectariferous disc; style 5.9–8.8 cm long, straight, glabrous to sparsely pubescent
with simple uniseriate trichomes 0.3–0.5 mm long; stigma 2-lobed, ca. 1 mm long and
wide, usually clavate. Fruit a conical berry, 1.5–4.4 cm long, 1.5–4.4 cm in diameter,
pale to dark green, chartaceous to coriaceous when dry, 2-locular, the exocarp 2–2.8 mm
thick; fruiting calyx persistent, the lobes 3–5 cm long, 1.2–2.3 cm wide, appressed and
enveloping the berry loosely, fully covering the fruit. Seeds numerous, 2.2–3.6 mm long,
1–1.7 mm wide, subreniform, the testa reticulate, the testa cells rectangular and straight
in the outline, the embryo slightly curved, the cotyledons accumbent, slightly longer than
the embryo rest, endosperm rather scanty. Chromosome number not known.

Etymology. The generic name *Doselia* is derived from the Spanish word “dosel”,
meaning canopy. It refers to the hemiepiphytic lianescent habit of all species of *Doselia*,
with branches rising high up to the canopy to the top of tree crowns. The plants can be
challenging to see because of their position on top of the tree canopy unless the plants
have their showy pendulous flowers.

Distribution (Fig. 2). Mid-elevation moist Andean forests from 500 to 2,300 m
in Ecuador (Provinces of Morona Santiago, Napo, Pastaza) and Colombia (Depart-
ments of Antioquia, Boyacá, Caldas, Caquetá, Huila, Putumayo, Risaralda, Santander,
Tolima, Valle del Cauca).

Discussion. *Doselia* represents a morphologically distinct group of four hemiepi-
phytic lianas from mid-elevation moist Andean forests with very long branches extend-
ing to the forest canopy through adventitious roots. The combination of hemiepiphyt-
ic lianescent habit, membranous leaves arranged in tight clusters on adult branches,
indumentum consisting of only simple eglandular trichomes, showy actinomorphic
flowers arranged in elongated, pendulous, and few-flowered inflorescences, and conical
fruits is unique within the tribe.

Within Solandreae, the lianescent hemiepiphytic habit is also known in *Solandra*
and *Schultesianthus*, with the rest of the tribe mainly being epiphytic or rarely terrestrial
shrubs (*Markea antioquiensis* clade; Table 1). Leaves of all *Doselia* species are highly
clustered on branch tips in whorls of 4–6 similar to species in the *Markea antioquiensis*
clade and some species of *Markea* (e.g., *M. plowmanii* Hunz.) and differ from all other
genera and species of the tribe where leaves are more spread apart and clearly alternate
(Table 1). Leaves in *Doselia* are membranous with simple eglandular trichomes on
both surfaces, a character shared with some species of the *Markea antioquiensis* clade
(e.g., *M. pilosa* S.Knapp; Table 1). In many other genera of Solandreae, the leaves
are chartaceous (e.g., *Hawkesiphyton* Hunz., *Juanulloa* Ruiz & Pav., *Merinthopodium*
Donn. Sm., *Solandra* and *Trianaea* Planch. & Linden) or subcoriaceous to coriaceous
(e.g., *Schultesianthus*) and often have simple glandular and/or dendritic trichomes in
addition to the simple eglandular ones (Table 1).
Figure 1. Doselia A. Orejuela & Särkinen A pseudoverticillate leaves in D. epifita B infundibuliform cream-purplish corolla of D. epifita C infundibuliform greenish-white corolla with subtle purple veins of D. galilensis D tubular-campanulate yellowish-green corolla of D. huilensis with strong purple-tinged reticulation along major and minor veins E developing fruit in D. huilensis F hypocrateriform orange corollas in D. lopezii G pendent long flowering branches in D. lopezii with clustered leaves and orange corollas in frontal view H developing fruit in D. lopezii with a nectariferous disc at the base (Vouchers: A Orozco et al. 3876 (COL), B no voucher, C Corrales et al. 917 (JBB, TOLI), D Coral 34 (HEEA), E Orejuela & Vélez-Puerta 112 (COL) F Orejuela et al. 727 (JBB) G no voucher H Orejuela & Calderon 170 (COL): photos by Alistair Hay, Andreas Kay, Andrés Orejuela, Boris Villanueva, Brayan Coral, and Eduardo Calderon.)
Inflorescences in *Doselia* are long and pendulous (up to 50 cm long), with up to three flowers of which only one or rarely two develops at a time (Table 1). Such inflorescences are not typical in the tribe but are observed only in a few other species in Solandreae, including *Markea coccinea* Rich., *Merinthopodium nevanthum* (Hemsl.) Donn.Sm., *Merinthopodium pendulum* (Cuatrec.) Hunz., and *Trianaea nobilis* Planch. & Linden. Pedicels in some *Doselia* species are distally winged because the sutures of the calyx are winged and continue onto the pedicel. Distally winged pedicels are also known in some species of the *Markea antioquiensis* clade (e.g., *Markea antioquiensis* S.Knapp and *Markea pilosa* S.Knapp; Table 1).
Corollas in *Doselia* are actinomorphic and showy, similar to species of the *Markea antioquiensis* clade, but these two groups can be distinguished based on other characters such as growth form, peduncle length, number of open flowers per inflorescence, and floral bract and calyx size (Table 1). The two groups also differ in their calyx lobes, where lobes have acute to long-acuminate tips in *Doselia* but are rounded in the *Markea antioquiensis* clade. Corollas in the two other morphologically closely related genera *Solandra* and *Schultesianthus* are slightly zygomorphic (Table 1).

Fruits in *Doselia* are conical, leathery, and fully covered by the calyx, like those of *Solandra*, but differ from the latter in being 2-carpellate and 2-locular, in contrast to the 2-carpellate and 4-locular fruits in *Solandra* (Table 1). Fruits in *Schultesianthus* appear similarly leathery but are globose in shape and covered only partially by an irregularly splitting calyx (Table 1). Chromosome number is not known for *Doselia*, but count numbers in other members of Solandreae, have shown a basic chromosome number $x=12$ for *Dyssochroma* Miers (Piovano 1989; Acosta and Moscone 2000), *Solandra* (Campin 1924; Lepper 1982) and *Trianaea* (Chiarini et al. 2019). Similar chromosome counts might be expected for *Doselia*, but further research is necessary to confirm this assumption.

Table 1. Comparison of the new genus *Doselia* with the morphologically most closely related genera and groups in the tribe Solandreae (Solanaceae).

<table>
<thead>
<tr>
<th></th>
<th><em>Doselia</em></th>
<th><em>Solandra</em></th>
<th><em>Schultesianthus</em></th>
<th><em>Markea antioquiensis</em> clade</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habit</td>
<td>Hemiepiphytic lianas</td>
<td>Hemiepiphytic lianas</td>
<td>Hemiepiphytic lianas</td>
<td>Terrestrial/epiphytic shrubs</td>
</tr>
<tr>
<td>Leaf texture</td>
<td>Membranous</td>
<td>Chartaceous</td>
<td>Coriaceous</td>
<td>Membranous</td>
</tr>
<tr>
<td>Leaf arrangement</td>
<td>Clustered on adult branches</td>
<td>Simple or branched, glandular or not glandular</td>
<td>Simple, not glandular</td>
<td>Clumped on adult branches</td>
</tr>
<tr>
<td>Trichome type</td>
<td>Simple, not glandular</td>
<td>Simple, not glandular</td>
<td>Simple, not glandular</td>
<td>Simple, not glandular</td>
</tr>
<tr>
<td>Inflorescence branching</td>
<td>unbranched to forked</td>
<td>None; flowers solitary</td>
<td>Unbranched, forked or multi-branched</td>
<td>Unbranched</td>
</tr>
<tr>
<td>Open flowers per inflorescence</td>
<td>1–2</td>
<td>Solitary</td>
<td>(1)6–10 (&gt;100)</td>
<td>4–6</td>
</tr>
<tr>
<td>Peduncles</td>
<td>Long (1–50 cm), hanging &amp; slender</td>
<td>Absent</td>
<td>Short (0–3 cm), stout &amp; woody</td>
<td>Intermediate (4–12 cm), hanging &amp; slender</td>
</tr>
<tr>
<td>Pedicels</td>
<td>Unwinged or distally winged</td>
<td>Unwinged</td>
<td>Unwinged</td>
<td>Unwinged or distally winged</td>
</tr>
<tr>
<td>Floral bract number and size</td>
<td>0–2</td>
<td>Absent</td>
<td>Absent</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>5–6 cm long × 1–2 cm wide</td>
<td>0.5–2 cm long × 0.1–0.3 cm wide</td>
<td>0.5–2 cm long × 0.1–0.3 cm wide</td>
<td>0.5–2 cm long × 0.1–0.3 cm wide</td>
</tr>
<tr>
<td>Corolla symmetry</td>
<td>Actinomorphic</td>
<td>Weakly zygomorphic</td>
<td>Weakly zygomorphic</td>
<td>Actinomorphic</td>
</tr>
<tr>
<td>Corolla lobes</td>
<td>Entire</td>
<td>Fimbriate</td>
<td>Fimbriate</td>
<td>Entire</td>
</tr>
<tr>
<td>Corolla shape</td>
<td>Infundibuliform or hypocrateriform to tubular-campanulate</td>
<td>Infundibuliform to cyathiform</td>
<td>Infundibuliform to cyathiform</td>
<td>Infundibuliform</td>
</tr>
<tr>
<td>Corolla length</td>
<td>8.5–15 cm</td>
<td>15–40 cm</td>
<td>2.5–21.5 cm</td>
<td>7–12 cm</td>
</tr>
<tr>
<td>Fruit shape</td>
<td>Conical</td>
<td>Conical</td>
<td>Globose, rarely conical</td>
<td>Conical or globose</td>
</tr>
<tr>
<td>Fruit locule number</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>
Key to the species of *Doselia*

1. Sparse pubescence throughout the plant, on the leaves confined to the veins and margins only, leaves glabrescent with age; style pubescent along its entire length .......................................................... *D. galilensis*
   - Dense pubescence throughout the plant, on the leaves extending to the blade mesophyll, leaves persistently pubescent with age; style glabrous or with only a few trichomes at the very base ...........................................

2. Anthers included within the corolla tube; corolla pale purple or purplish-cream; style with a few trichomes at the base .................. *D. epifita*
   - Anthers partially to entirely exserted beyond the corolla tube; corolla yellowish-green, brownish-green or orange; style completely glabrous ...........

3. Corolla tubular-campanulate, the tube yellowish-green with a conspicuous reticulum of purple veins on both surfaces; anthers completely exserted .......... *D. huilensis*
   - Corolla infundibuliform, the tube orange with a conspicuous reticulum of purple veins at the base on the adaxial side only; anthers partially included .. *D. lopezii*

Species descriptions


**Type.** Based on *Markea epifita* S.Knapp

**Description.** Hemiepiphytic liana with adventitious roots. Stems sparsely pubescent with simple, uniseriate 2–4-celled hyaline trichomes ca. 0.5 mm long, giving the stems a tuberculate look. Leaves tightly clustered towards the branch tips, 11–25 cm long, 6–12 cm wide, obovate, sparsely pubescent with simple uniseriate 2–4-celled trichomes ca. 0.5 mm long, the trichomes denser and stiffer abaxially along the veins on both surfaces; major veins 4–5 pairs, not raised abaxially, drying dark brown; base attenuate, symmetric; margins entire; apex acute to acuminate; petiole 1–5 cm long, pubescent with stiff trichomes abaxially like those of the leaves. Inflorescence 18.5–45 cm long, axillary, unbranched, ebracteate, ca. 4–5-flowered, densely pubescent with simple, uniseriate trichomes like those of the stems; peduncle 8.5–35.2 cm long; pedicels 1.2–1.7 cm
long, winged. Calyx 3.8–4 cm long, 1.4–1.5 cm wide, green tinged with purple, pubescent with simple uniseriate trichomes 0.5–1 mm long; tube 0.5–0.7 cm long; lobes undulate, 3.0–3.3 cm long, 0.8–1 cm wide, long-triangular, apically acuminate, densely pubescent abaxially with simple uniseriate trichomes 0.5–1 mm long, adaxially similar but also with tiny brownish papillate trichomes. Corolla 9–11 cm long, the inner corolla diameter 3–3.5 cm, infundibuliform, gradually widening from the base, glabrous; tube 7.5–8 cm, cream to green with lines or patches of purple; lobes 3.4–4.2 cm long, 2.5–3.3 cm wide, ovate, purple or violet, reflexed at anthesis, the margins slightly undulate, the apex obtuse to rounded, glabrous or with a few minute trichomes along the veins. Stamens 3.6–7.7 cm long, included within corolla tube; filaments 2–5 cm long, adnate to ca. 1 cm from the base of the corolla tube, white to purple-tinged, glabrous; anthers 1.6–2.7 cm long, 1.7–1.8 mm wide, cream. Ovary 3.3–3.4 mm long, 3.3–3.4 mm wide, colour unknown, glabrous; style 5.5–6 cm long, cream, glabrous except for a few simple uniseriate trichomes ca. 0.5 mm long at the very base; stigma clavate. Fruit not known. Chromosome number not known.

Distribution (Fig. 2). On the eastern slopes of the Andes in central Ecuador (Provinces Morona-Santiago, Napo, and Pastaza) and Colombia (Departments Putumayo and Caquetá).

Ecology. In premontane forest between 500–1,500 m elevation.

Preliminary conservation status (IUCN 2022). Our data support the assessment of the species by Knapp et al. (2017) who considered *D. epifita* as vulnerable (VU) based on the criteria B1ab [iii]. *Doselia epifita* is known from a few collections in the Cordillera de los Guacamayos, the protected areas of Sumaco-Napo-Galeras and Sangay, areas near the city of Puyo in Ecuador, the Natural Reserve “La isla escondida” in Putumayo, and the surroundings of the Alto Fragua indiwasi National Park in Caquetá, Colombia. The biggest threat to the species is deforestation (Knapp et al. 2017).

Discussion. *Doselia epifita* is the only species of *Doselia* that reaches Ecuador and has the lowest elevational range within the genus. *Doselia epifita* is morphologically most similar to *D. galilensis*, and a detailed comparison is presented under the latter. The inflorescence morphology of *D. epifita* was unknown until recently because no complete specimens with entire inflorescences were known when the species was first described (Knapp 1998). Recent collections have revealed that the inflorescences are axillary and long (18.5–45 cm long; Fig. 3B), as correctly predicted by Knapp (1998). The fruits of this species remain unknown.

Etymology. The specific epithet refers to the apparent epiphytic habit of the species, though, like other species in the genus, *D. epifita* is a hemiepiphyte rather than an obligate epiphyte.

Figure 3. *Doselia epifita* A branch with clustered leaves B floriferous branch C flower at anthesis D dissected corolla showing inserted stamens E detail of gynoecium with a five-lobed nectariferous disc and a clavate stigma (A–E Ceron & Hurtado 6534, Palacios 6893: Drawing by Omar Bernal).

NY); Cantón Loreto, Parque Nacional Sumaco, Napo-Galeras, Matorral de Bambú, Bloque 19, línea sísmica 22, Compañía Triton, 0°47'00"S, 77°28'00"W, 500 m, 25 Mar 1996 (fl), Freire & Cerda 271 (MO, QCNE); Cantón El Chaco, Proyecto Hidroeléctrico Coca, Punto ST3, margen derecha del Río Quijos, 10 km al S de Reventador,
0°11’00”S, 77°39’00”W, 1,500 m, 3 Oct 1990 (fl), *Palacios 5893* (MO). **Pastaza:** Cantón Mera, Carretera al Río Ansu, 5 km al NE de Mera, 1°15’36”S, 78°03’36”W, 1,200 m, 16 Mar 1985 (fl), *Palacios et al. 123* (MO); Cantón Mera, Colonia Pindo, Mirador en la Reserva Pindo, 1°27’23”S, 78°04’47”W, 12 Nov 2011, *Orozco et al. 3876* (COL); Road Veracruz (Indillama) – Canelos, 1°35’00”S, 77°51’00”W, 25 Jun 1968 (fl), *Lugo 75* (MO); Cantón Pastaza, Shell, Río Pindo, 1°29’59”S, 78°03’44”W, 1,050 m, 18 Aug 1992 (fl), *Palacios 10380* (MO).

2. *Doselia galilensis* A.Orejuela & Villanueva, sp. nov. urn:lsid:ipni.org:names:77302330-1
Figs 1C, 4, 5

**Diagnosis.** Differing from all other members of *Doselia* in its mature leaves with sparse pubescence of trichomes on the midvein and along margins only (vs. on entire lamina). Like *D. epifita* (S.Knapp) A.Orejuela & Särkinen but differing in the pale green to purplish-green calyces with flat lobes (vs. calyces green with purple patches with undulate lobes) and larger corolla 12–15 cm long (vs. 9–11 cm long).

**Type.** **Colombia.** **Tolima:** Municipio Villarrica, Vereda Galilea, Bosque de Galilea, zona Campo Hermoso, junto a parcela permanente de Monitoreo de 1 ha, 03°46’21”N, 74°39’56”W, 1,543 m, 11 Jun 2018 (fl, fr), L. Corrales, B. Villanueva, K. Sánchez & H. Díaz 917 (holotype: JBB! [JBB34413]; isotype: TOLI [TOLI26800]).

**Description.** Hemiepiphytic liana with adventitious roots. Stems sparsely pubescent with simple, uniseriate 4–7-celled, hyaline trichomes 0.4–1.3 mm long, becoming glabrescent with age. Leaves tightly clustered towards the branch tips, 9.2–17.5 cm long, 6.4–8.4 cm wide, ovate to elliptic, sparsely pubescent with a few simple trichomes like those on the stems distributed along the margins and veins on both surfaces, especially on the young growth, glabrescent with age; major veins 3–4 pairs, slightly raised abaxially; base cuneate or obtuse, symmetric or rarely asymmetric; margins entire; apex acuminate to mucronate; petiole 0.8–1.8 cm long, sparsely pubescent with a few simple trichomes like those on the stems, glabrescent with age. Inflorescence axillary, simple, ebracteate, 11.5–17.2(–44) cm long, 1(–3)-flowered, sparsely pubescent with a few simple trichomes like those on the stems; peduncle 1.2–5.7(–32.5) cm long; pedicels 0.5–1.8 cm long, distally winged and thickened. Calyx 3.7–3.8 cm long, 1.7–1.8 cm wide, pale green with purple margins and reticulation along the veins, sparsely pubescent with simple, uniseriate trichomes like those on the stems; tube 0.5–0.7 cm long; lobes flat, 2.4–3.0 cm long, 1.0–1.2 cm wide, short-lanceolate, apically acute. Corolla 12–15 cm long, the inner corolla diameter 3.5–4.0 cm, infundibuliform; tube 8.3–9.5 cm long, with a narrow base 1.4–1.9 cm long, 0.8–0.9 cm wide and a wide distal portion 7.6–7.7 cm long, 3.6–3.8 cm wide, greenish-white with subtle purple veins, glabrous or sparsely pubescent with a few simple uniseriate trichomes like those of the rest of the plant on the tube externally; lobes 3.2–3.8 cm wide, 2.8–3.1 cm long, ovate, greenish-white with bright purple patches within, reflexed at anthesis, the margins revolute, the apex obtuse, glabrous. Stamens 4.1–4.2 cm long, included
inside the corolla tube; filaments 3.1–3.4 cm long, adnate at ca. 1.4–1.8 cm from the base of the corolla, white, densely pubescent with simple, uniseriate 4–7(–12)-celled, hyaline trichomes at the insertion point; anthers 1.6–2.1 cm long, 1.4–1.5 mm wide. Ovary 3.7(–5.4) mm long, 6.2–6.3 mm wide, light brown, glabrous; style 5.9–6.5 cm

Figure 4. *Doselia galilensis* A floriferous branch B branch with clustered and circular foliar scars C flower at anthesis D dissected corolla showing inserted stamens E detail of a stamen F gynoecium with a five-lobed nectariferous disc G fruit with an accrescent calyx H dissected fruit showing placentation (cross-section) I seed (A–I Corrales et al. 917: Drawing by Marcela Morales).
long, cream, sparsely pubescent with simple short 2–4-celled uniseriate trichomes ca. 0.3 mm long; stigma clavate. Fruit ca. 4.4 cm long, ca. 2.9 cm wide, light green, the exocarp 2.1–2.4 mm thick, coriaceous and light yellow when dry; fruiting calyx persistent, accrescent and covering the fruit, enveloping the berry loosely, the lobes to 4–4.5 cm long, 1.3 cm wide. Seeds numerous, 3.3–3.6 mm long, 1.5–1.7 mm wide, ochre yellow when dry, the testa reticulate, the testal cells rectangular in outline, the embryo slightly curved, the cotyledons accumbent, slightly longer than embryo rest, endosperm rather scanty. Chromosome number not known.

**Distribution (Fig. 2).** *Doselia galilensis* occurs in the western slopes of the eastern cordillera of the Colombian Andes and is only known from three localities in the municipality of Arcabuco (Department of Boyacá), the natural reserve “Reinita Cielo Azul” (Department of Santander) and the Parque Natural Regional Bosque de Galilea (Department of Tolima).

**Ecology.** Grows in Andean tropical cloud forest from 1,500 to 2,300 m elevation.

**Preliminary conservation status** (IUCN 2022). *Doselia galilensis* is considered Data Deficient (DD) due to the small number of known populations. Based on our field observations, the biggest threat to the species is habitat loss due to agricultural expansion near the known localities. The situation has been alarming in the Galilea Forest during the last few years, with several direct threats to forest conservation such as agricultural expansion, unsustainable logging, and oil exploitation activities. Fortunately, the Galilea Forest has been recently declared as a protected area through the Corporación Autónoma Regional del Tolima (“CORTOLIMA” resolution 31 adopted on December 16, 2019). The Arcabuco oak forests in Boyacá do not, however, have any legal protection. It is unclear whether the new species remains in the area based on our unsuccessful attempt to collect *D. galilensis* in Arcabuco in 2019. The third population recently discovered in Santander is under the protection of the Proaves NGO in the natural reserve “Reinita Cielo Azul”.

**Phenology.** *Doselia galilensis* has been collected in flower in May, June and October and with fruits in June.

**Etymology.** The epithet “*galilensis*” is in honour of the recently created “Parque Natural Regional Bosque de Galilea”, where the type specimen was collected. The Galilea Forest is located between 3°53’36”N, 74°31’51”W and 3°40’32”N, 74°44’20”W in the municipalities of Villarrica and Dolores. We hope that the description of this new Colombian endemic species highlights the importance of the Galilea Forest and stimulates more researchers to explore this beautiful reserve. The Galilea Forest covers more than 26,000 hectares and occupies an elevational range from 1,480 to 3,080 m. It represents a mid-elevation Andean montane forest sandwiched between the lowland tropical rain forest and treeline. Besides the typical Andean cloud forest, the Galilea Forest comprises cushion mire wetlands known as “turberas” and white-sand forests with species adapted to grow in these highly specialised soil conditions (e.g., *Utricularia* L., Lentibulariaceae). The Galilea Forest is considered a strategic ecosystem for water regulation in the watershed area of the Negro River and the Aco and Lusitania ravines that feed the Hidroprado Dam (Quimbayo-Cardona et al. 2019).
Figure 5. *Doselia galilensis* A habitat in type locality in Galilea forest, Villarrica, Tolima B mid-elevation moist forest habitat in Galilea forest C floriferous branch with a flower D floriferous branch with a dissected and opened corolla showing corolla colouration inside and the inserted stamens E female *Euglossa* bee visiting the flower F front view of the corolla showing the purple-tinged lobes and the inserted stamens G developing fruit covered by an accrescent calyx (A–G Corrales et al. 917; Photographs by Boris Villanueva).
Discussion. In the area of Arcabuco, Boyacá, *D. galilensis* is sympatric with *Merinthopodium vogelii* (Cuatrec.) Castillo & R.E.Schult., a vegetatively similar species of Solandrae. *Merinthopodium vogelii* differs in having green campanulate corollas with strongly reflexed lobes at anthesis and partially exserted anthers, while *D. galilensis* has included anthers and to greenish-white, infundibuliform corollas with slightly reflexed lobes that are purple-tinged at anthesis.

*Doselia galilensis* can be easily differentiated from other species of *Doselia* in its glabrescent mature leaf blades where pubescence is sparse and restricted to midveins and margins (Fig. 1; Table 2). *Doselia galilensis* is morphologically most similar to *D. epifita*; both species share several characters that are not present in other species of *Doselia*, such as infundibuliform corollas and included stamens with very short filaments (Fig. 1; Table 2). Unlike *D. epifita*, *D. galilensis* is sparsely pubescent, with only a few trichomes along the main veins of the leaves and very few trichomes in other parts of the plant. In contrast, *D. epifita* has a dense and persistent pubescence covering the entire plant with persistent trichomes on both sides of the leaves. The calyx lobes in *D. galilensis* are flat and lanceolate compared to the long-triangular undulate calyx lobes in *D. epifita*. *Doselia galilensis* has slightly larger corollas compared to *D. epifita* with white to purplish corolla tubes with purple lobes on both surfaces (Fig. 1B). Styles are consistently pubescent in *D. galilensis* along their entire length, while *D. epifita* has glabrous styles except for a few simple uniseriate trichomes at the very base.


Table 2. Morphological and geographical comparison of the four species assigned to *Doselia*.

<table>
<thead>
<tr>
<th></th>
<th><em>D. epifita</em></th>
<th><em>D. galilensis</em></th>
<th><em>D. huilensis</em></th>
<th><em>D. lopezii</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Distribution</td>
<td>Napo, Pastaza (Ecuador), Putumayo, Caquetá (Colombia)</td>
<td>Boyacá, Santander, Tolima (Colombia)</td>
<td>Huila, Putumayo (Colombia)</td>
<td>Antioquia, Caldas, Risaralda, Valle del Cauca (Colombia)</td>
</tr>
<tr>
<td>Elevation (m)</td>
<td>500–1,500</td>
<td>1,500–2,300</td>
<td>2,200–2,300</td>
<td>1,700–2,100</td>
</tr>
<tr>
<td>Leaf length × width (cm)</td>
<td>11–25 × 6–12</td>
<td>9.2–17.5 × 6.4–8.4</td>
<td>9.0–16.7 × 4.6–11.7</td>
<td>14–22 × 4–9.8</td>
</tr>
<tr>
<td>Leaf shape</td>
<td>Obovate</td>
<td>Ovate to elliptic</td>
<td>Elliptic to broadly elliptic</td>
<td>Elliptic to broadly elliptic</td>
</tr>
<tr>
<td>Mature leaf pubescence</td>
<td>Sparsely pubescent on both surfaces with simple uniseriate trichomes</td>
<td>Sparsely pubescent on the main veins and margins with simple uniseriate trichomes, becoming glabrescent with age</td>
<td>Densely pubescent on both surfaces with simple uniseriate trichomes</td>
<td>Sparsely pubescent on both surfaces with simple uniseriate trichomes</td>
</tr>
<tr>
<td>Peduncle length (cm)</td>
<td>8.5–32.2</td>
<td>1.2–5.7(–32.5)</td>
<td>8.5–39</td>
<td>6–24(–39)</td>
</tr>
<tr>
<td>Corolla shape</td>
<td>Infundibuliform</td>
<td>Infundibuliform</td>
<td>Tubular-campanulate</td>
<td>Hypocrateriform</td>
</tr>
<tr>
<td>Corolla length (cm)</td>
<td>9–11</td>
<td>12–15</td>
<td>8.5–10</td>
<td>8–11</td>
</tr>
<tr>
<td>Corolla lobe length × width (cm)</td>
<td>3.4–4.2 × 2.5–3.3</td>
<td>3.2–3.8 × 2.8–3.1</td>
<td>2.3–3.3 × 1.6–1.7</td>
<td>3.2–3.9 × 3.7–4.1</td>
</tr>
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<td>Anther position</td>
<td>Included</td>
<td>Included</td>
<td>Exserted</td>
<td>Partially exserted</td>
</tr>
<tr>
<td>Anther length (cm)</td>
<td>1.6–2.7</td>
<td>1.6–2.1</td>
<td>1.4–1.9</td>
<td>1.9–2.2</td>
</tr>
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</table>
Riachón, cerca de parcela permanente de monitoreo de 1 Ha No 5, 03°40’53.10”N, 74°41’6.56”W, 2122 m, 08 Aug 2019 (fl) Rivera et al. 26 (JBB); Municipio Villarrica, La Colonia, vereda La Colonia, Bosque de Galilea 03°52’20.61”N, 74°33’12.12”W, 2000 m, 10 Jan 2020 (fl), M. F. Valencia & M. Rincón 308 (TOLI).

Figs 1D, E, 6


Type. Colombia. Huila: Municipio de La Plata, vereda La María, Finca Merenberg, sitio Agua Bonita, 02°12’13”N, 76°06’33”W, 2,287 m, 5 Aug 2010 (fl,fr), A. Orejuela & J.M. Vélez-Puerta 112 (holotype: COL! [COL000420611]; isotypes: COL! [COL000420613]).

Type. Based on *Markea huilensis* A.Orejuela & J.M.Vélez

Description. Hemiepiphytic liana with adventitious roots. Stems densely pubescent with simple, uniseriate (2–) 4–7 (–11)-celled, hyaline to ochre-brown trichomes 0.2–1.8 mm long, with a deciduous apex and a persistent multicellular base giving the surface a tuberculate appearance, stems glabrescent with age. Leaves tightly clustered towards the branch tips, 9.0–16.7 cm long, 4.6–11.7 cm wide, elliptic to broadly elliptic, densely pubescent with simple 4–9-celled uniseriate hyaline to dark olive-brown trichomes 0.3–2 mm long on both surfaces; major veins 4–6 pairs, slightly raised abaxially; base cuneate or obtuse, asymmetric; margins entire to undulate; apex usually acuminate, mucronate; petiole 0.4–3.8 cm long, densely pubescent. Inflorescence sub-axillary, simple to branched, bracteate, 18–50 cm long, ca. 2–7-flowered, surface tuberculate and densely pubescent with trichomes as on the stems; peduncle 8.5–39 cm long; bracts foliaceous and linear, 5–6 cm long, 1–2 cm wide; pedicels 1.5–2 cm long, distally winged and thickened. Calyx ca. 3.3 cm long, 1.5 cm wide, dark green with purple margins and reticulate along the veins, pubescent with simple 4–7-celled uniseriate white hyaline to brown trichomes; tube 0.5–0.7 mm long; lobes undulate, 2.7–5.2 cm long, 1.3–1.5 cm wide, lanceolate, apically acuminate with an acumen 0.6–0.9 mm long, green with the main vein and the margins purple-brown, pubescent with simple uniseriate trichomes on the abaxial side. Corolla 8.5–10 cm long, the inner corolla diameter 4.5–5 cm, tubular-campanulate; tube 6.2–6.7 cm long, scarcely pubescent with trichomes similar to those of the calyx, yellowish green with strong purple-tinged reticulation along major and minor veins both abaxially and adaxially; tube differentiated into a narrow base ca. 0.2 cm long and 0.8–1 cm wide and a wide distal portion 4.2–4.6 cm long, ca. 5 cm wide; lobes 2.3–3.3 cm long, 1.6–1.7 cm wide, oblong, reflexed during anthesis, colour similar to that of the corolla tube, the margins revolute, the apex obtuse, glabrous. Stamens 6.1–6.9 cm long, fully exserted beyond corolla tube; filaments 4.7–5 cm long, adnate at ca. 2 cm from the base of the corolla, purplish, densely pubescent with simple uniseriate trichomes at the
Figure 6. *Doselia huilensis* **A** floriferous branch **B** indument on the leaf blade **C** indument on young stems **D** leaf arrangement **E** flower bud **F** flower in anthesis **G** stamens **H** gynoecium **I** fruit with sepals removed **J** fruit in cross section **K** seed **L** embryo (A–L. A. Orejuela & J.M. Vélez 112: Drawing by Marcela Morales, first published in Orejuela et al. (2014), reproduced with permission).
insertion point like those on calyx; anthers 1.4–1.9 cm long, 1.3–1.5 mm wide. Ovary ca. 7 mm long, ca. 3.5 mm wide, light yellow, glabrous; style 7.3–8 cm long, cream; stigma clavate. Fruit ca. 4.2 cm long, ca. 2.5 cm wide, dark green, exocarp 2–2.8 mm thick when fresh, coriaceous, black when dry; fruiting calyx persistent, accrescent and covering the fruit, appressed at maturity, the lobes 4–5 cm long, 2.2 cm wide. Seeds numerous, 2.6–3.0 mm long, 1.2–1.4 mm wide, ochre when fresh, dark brown when dry, the testa reticulate, the testal cells rectangular in outline. Chromosome number unknown.

**Distribution** (Fig. 2). *Doselia huilensis* is known only from the Departments of Huila and Putumayo in southwestern Colombia.

**Ecology.** *Doselia huilensis* is found in preserved or partially altered oak forests from 2,200 to 2,300 m elevation.

**Preliminary conservation status** IUCN (2022). *Doselia huilensis* is reaffirmed (following Orejuela et al. 2014) here as an endangered species (EN) according to criteria B1ab [i, iii] based on the small EOO (~750 km²), a small number of known populations, and the highly fragmented condition of the relictual forests where it occurs. The species is known from five collections from three localities. Two of these localities are in the Department of Huila 80 km apart, and one recent collection is known from the Valle del Sibundoy, Department of Putumayo, that extends the species distribution approximately 100 km to the south.

**Discussion.** *Doselia huilensis* differs from all other *Doselia* species in its tubular-campanulate corollas with fully exserted anthers (Table 2; Fig. 1D). The species is densely pubescent throughout, which is useful in distinguishing it from other *Doselia* species that are either glabrescent or less densely pubescent (Table 2).

**Specimens examined.** COLombia. Huila: Municipio de La Plata,-vereda Agua Bonita, Finca Meremberg, 2,200–2,300 m, 21 Jul 1975 (fl), Díaz-Piedrahita et al. 793 (COL); Carretera Popayán-La Plata, km 100, Reserva forestal de Fauna y Flora Meremberg, 2,300 m, 12 Dec 1982 (fl), Murcia 09 (COL); Municipio San Agustín, vereda La Castellana, reserva privada Los Yalcones, interfluvio quebrada El Palmar-río Balseros, sitio El Palmar, 1°47’44”N, 76°21’5”W, 2,400–2,600 m, 15–20 Aug 2005, Mendoza & Robles 16548 (FMB). Putumayo: Valle del Sibundoy, Reserva Natural Yumartán, cuenca alta del río Putumayo, por la garganta del Balsayaco, 3 Mar 2021 (fl), Coral 34 (HEAA).

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urn:lsid:ipni.org:names:77302332-1
Figs 1F–H, 7


**Type.** Based on *Markea lopezii* Hunz.
**Description.** Hemipiphytic liana with adventitious roots. Stems sparsely pubescent with simple, uniseriate 4–8-celled, hyaline ochre trichomes 0.5–1.2 mm long, with deciduous apex and a persistent multicellular base giving the surface a tuberculate appearance, stems glabrescent with age. Leaves tightly clustered towards the branch tips, (7–)10–22 cm long, 4–9.8 cm wide, elliptic to broadly elliptic, sparsely pubescent with simple uniseriate 4–7-celled hyaline trichomes 0.8–1.2 mm long on both sides; major veins 4–6 pairs, slightly raised abaxially; base cuneate, slightly asymmetric; margins entire; apex acute to acuminate; petiole (7–)10–19(–25) mm long, densely pubescent with simple trichomes as on the leaves. Inflorescence axillary, simple, ebracteate, 7–35(–50) cm long, ~2–5-flowered, densely pubescent with simple, uniseriate trichomes like those on stems; peduncle 6–24(–39) cm long; pedicels 0.8–1.7(–3.0) cm long, distally winged and thickened. Calyx 3.8–5.6 cm long, 1.4–1.9 cm wide, green, sometimes tinged with purple, densely pubescent with simple, uniseriate trichomes like those on leaves; tube 8–9 mm long; lobes flat, 3.5–4.4 cm long, 1.2–1.4 cm wide, long-triangular, apically long-acuminate, green or green with purple margins, sparsely pubescent with simple uniseriate trichomes on the abaxial side. Corolla 8–11 cm long, the inner corolla diameter 2.5–2.8 cm, hypocrateriform; tube 7–10 cm long, orange and tinged with purple in the throat internally, glabrous; lobes 3.2–3.9 cm long, 3.7–4.1 cm wide, triangular, orange, spreading to slightly reflexed at anthesis, the margins flat and entire, the apex acute, glabrous or with a few minute trichomes along the veins. Stamens 7–8.6 cm long, partially exserted beyond the mouth of corolla tube; filaments 5.3–6.1 cm long, adnate at 1.0–1.3 cm from the base of the corolla tube, purple-tinged, densely pubescent with simple 6–10-celled uniseriate trichomes at the insertion point; anthers 1.9–2.2 cm long, 1.4–1.8 mm wide. Ovary ca. 7.5 mm long, ca. 2.9 mm wide, yellow, glabrous; style 7.9–8.8 cm long, glabrous; stigma clavate. Fruit 2.7–3.2 cm long, 1.5–3.3 cm wide, light green; fruiting calyx persistent, accrescent and fully covering the fruit, the lobes 3–3.3 cm long, 1.2–1.4 cm wide. Seeds numerous, 2.2–2.7 mm long, 1–1.3 mm wide, ochre when fresh, brown when dry, the testa reticulate, the testal cells rectangular in outline. Chromosome number not known.

**Distribution** (Fig. 2). *Doselia lopezii* is endemic to the pre-montane forests of the Colombian Andes in the departments of Antioquia, Caldas, Valle del Cauca and Risaralda.

**Ecology.** Mid-elevation moist forests from 1,700 to 2,100 m elevation.

**Preliminary conservation status** (IUCN 2022). *Doselia lopezii* is classified as vulnerable (VU) according to the B1a criterion with an EOO of ca. 6,000 km². The area where it is distributed is severely fragmented and the species is known from fewer than ten localities.

**Discussion.** *Doselia lopezii* is the type species of the genus and the easiest species to recognise on account of its showy flowers with large orange corollas (Table 2; Fig. 1F, G). *Doselia lopezii* has anomalous and apparently unique pollen in the genus with prominent spiny supratctal processes (Persson et al. 1994). Preliminary observations in *D. huilensis* (Orejuela et al. 2014) and specimens of *D. epifita* examined by Hunziker (1997, as *M. lopezii*) indicate that the pollen of these two species lack these spiny supratctal processes.
Figure 7. *Doselia lopezii* A branch with clustered leaves and an inflorescence axis B trichomes on leaves C trichomes on the calyx D trichomes at the filament insertion point E flower at anthesis F dissected corolla showing partially exserted stamens G stamen in lateral view H detail of a stamen showing the insertion of the filament I detail of the stigma J fruit with an accrescent calyx with two calyx lobes removed (A–I López Filgueiras 8208: Drawing by Nidia Flury, first published in Hunziker (1985), reproduced with permission, the original drawing was edited by Omar Bernal and the fruit drawn by Humberto Mendoza).
Specimens examined. **Colombia.** *Antioquia:* Medellín—Puerto Triunfo, Cocorna, ca. 5 km E of Cocorna Peaje, Quebrada El Biadal, 6°N, 75°10’W, 1,830 m, 23 Nov 1983 (fl), *Juncosa 1400* (JAUM); Pulperies 6000, Jul 1880 (fl), *Kalbreyer 1638* (K, MO). **Caldas:** Municipio Samaná, corregimiento Florencia, Vereda San Vicente, sector río Claro - Sierra Morena, Parque Nacional Natural Selva de Florencia, 5°31’21”N, 75°3’40”W, 1,840 m, 2 Oct 2012 (fl), *Betancur et al. 16698* (COL). **Risaralda:** Municipio de Pablo Rico, en cercanías de los límites con el PNN Tatamá, Reserva Santuario-Tatamá, 5°11’03.1”N, 76°01’16,5”W, 1821 m, 18 Mar 2022 (fl), *Orejuela et al. 3849* (JBB). **Valle del Cauca:** Finca Torremolinos, km 22, carretera entre Cali y Buenaventura, cordillera occidental, vertiente occidental, 1,800 m, 13 Oct 1982 (fl), *Albert de Escobar et al. 2678* (HUA); km 18, vía Cali–Buenaventura, chemin lateral, 1,920 m, 8 Mar 1997 (fl), *Billiet & Jadin 6904* (MO); Estación Microondas Tokio, 8 km W of Queremal (along old road to Buenaventura), 2°27’00”N, 76°45’00”W, 26 Sep 1980 (fl), *Croat 50164* (MO); Hoya del río Dígua, Quebrada del San Juan, subiendo a Paragüita desde Queremal, 3°32’09”N, 76°42’42”W, 1,570–1,740 m, 17 Mar 1947 (fl), *Cuatrecasas 23830* (F); Hacienda Tokio, wet montane forest behind microwave tower ca. 10 km S of Queremal, 3°30’00”N, 76°42’00”W, 2,000 m, 26 Feb 1983 (fl), *Gentry et al. 40820* (MO); La Cumbre, vereda La Sofía, corregimiento de Bitaco, Cerro de Yumbillo, cordillera occidental, vertiente occidental, 1,850 m, 6 Dec 1988 (fl), *Klimkiewicz & Cabrera 275* (CUVC); Cuenca del río Cali, cercanías de Peñas Blancas, 3°26’10”N, 76°38’28”W, 10 Jan 1963 (fl), *López-Filgueiras 8208* (US); La Cumbre, corregimiento de Bitaco, vereda Chicoral, 3°33’56”N, 76°35’3”W, 2,020 m, 23 Jul 2003 (fl), *Mendoza et al. 15275* (FMB); km 18, vía Cali–Buenaventura, vereda Dapa, Finca Zíngara, 1,800 m, 6 Nov 2009 (fl), *Orejuela 59* (COL); vía Cali–Dagua, km 23, Reserva Privada El Refugio, 4 Nov 2011 (fl), *Orejuela & Calderón-Sáenz 170* (COL); Vía Cali-Dagua, km 23, Reserva Privada El Refugio, 3°32’02”N, 76°36’56”W, 1,870 m, 13 Feb 2014 (fl), *Orejuela et al. 727* (COL, JBB).

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References


**Rungia fangdingiana** (Acanthaceae), a new species from Guangxi, China

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**Abstract**

*Rungia fangdingiana*, a new species of Acanthaceae from Guangxi, China is described and illustrated. This new species belongs to *Rungia* sect. *Rungia*, and resembles *R. sinothailandica* and *R. burmanica* in the erect perennial herbaceous habit, elliptic leaves and inflorescence form, but differs mainly by the indumentum and the morphology of the bracts and corolla. The pollen and seed micromorphology of this new species are studied, with photographs and a line drawing provided.

**Keywords**
limestone, SEM, taxonomy, tricolporate pollen
Introduction

Rungia Nees is a genus of Acanthaceae, comprising about 50 species and distributed through tropical and subtropical regions of the Old World (Mabberley 2017). It is closely related to Justicia L., but differs from the latter mainly by the rising placenta in ripe fruit (Hansen 1989; Hu 2002; Hu et al. 2011; Kiel et al. 2017; Deng 2020; Deng and Gao 2020). Some Rungia species were transferred to Justicia in regional Floras (Darbyshire et al. 2010; Wood 2014; Vollesen 2015), but the recent systematic studies (Kiel et al. 2017; Manzitto-Tripp et al. 2021) do not agree with this treatment based on molecular and some morphological evidence. In this work, we treat Rungia as a separate genus; however, the relationship between Rungia and its related genera is awaiting further study.

Sixteen species of Rungia were recognized in the “Flora of China” (Hu et al. 2011). Amongst these, R. monetaria (Benoist) B. Hansen was misidentified (the collection is actually R. flaviflora) and should be excluded from the list of species found in China, R. axilliflora and R. densiflora were treated as synonyms of R. stolonifera (Lin et al. 2020), Whereas R. burmanica (C. B. Clarke) B. Hansen is newly recorded in China (Lin and Deng 2017a, 2018), and recently two new species, Rungia sinothailandica Z. L. Lin & Y. F. Deng and R. flaviflora Z. L. Lin & Y. F. Deng, were described (Lin and Deng 2017b, 2018). Consequently, sixteen species of Rungia are still recognized in China at present.

During examination of the specimens in Herbaria (HITBC, PE), a distinctive specimen (H. Wang 6616) collected from Napo County, Guangxi in 2002, attracted our attention because of its secund spike, which is the typical character of the genus Rungia, but it lacked flower and fruit. Recently, it was collected again in the field complete with flowers and fruits from Napo in 2015 (Y. H. Tan et al. 4366) and 2019 (Y. F. Deng et al. 29030). After careful study of the specimens and living plants, we confirmed that it represents a new species of Rungia and is described below.

Materials and methods

The morphological description of the new species was based on both fresh and dried materials. The voucher specimens (Y. H. Tan et al. 4366, Y. F. Deng et al. 29030 and H. Wang 6616) are deposited in the Herbaria of South China Botanical Garden, Chinese Academy of Sciences (IBSC), Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences (HITBC) and Institute of Botany, Chinese Academy of Sciences (PE).

The pollen and seeds were washed in 70% alcohol and then gilded using the auto-fine sputter coater (JEOL JFC-1600 Auto Fine Coater, Japan). The micrographs were taken using the scanning electron microscope (JEOL Model JSM-6360 LV, Japan). The polar (P) axis and equatorial (E) diameter of 20 pollen grains were measured and the average, maximum, minimum and ratio (P/E) values were recorded to represent the range of variation. The pollen terminology follows Daniel (1998) and Scotland and Vollesen (2000). The seed terminology follows Graham (1988).
A new Runiga from China

Runiga fangdingiana
Z. L. Lin, Y. F. Deng & Y. H. Tan, sp. nov.
urn:lsid:ipni.org:names:77302500-1
Figs 1–3


Diagnosis. Similar to Runiga sinothailandica and R. burmanica, but is readily distinguishable by the flat, entire bract margin (vs. crispate, tawny membranous bract margin in R. sinothailandica, and crenulate bract margin in R. burmanica), glabrous calyx and capsule (vs. puberulous calyx and puberulent capsule in R. sinothailandica and R. burmanica), pale yellow corolla with red stripes, upper lip unlobed (vs. white corolla with red stripes, upper lip 2-lobed in R. sinothailandica, and white corolla with purple dotted stripes, upper lip unlobed in R. burmanica). A detailed comparison of the three species is given in Table 1.

Description. Perennial erect herb, about 1 m tall. Stem terete, glabrous. Leaves usually anisophyllous; petiole 1–2 cm long, glabrous; blade elliptic, 5–15 × 2–5 cm, base cuneate, margin entire, apex attenuate or acute, both surfaces glabrous, but densely covered with linear cystoliths, secondary veins 5–10 on each side of mid-vein. Inflorescence of terminal and axillary spikes, 3–7 cm long; peduncle 1–2 cm long, glabrous. Bracts 4-ranked, only two ranks fertile; sterile bracts ovate, oblique at base, 1.4–1.6 × 0.9–1.1 cm, green, glabrous, both surfaces covered with linear cystoliths, lacking hyaline margins; fertile bracts rhombic to elliptic, symmetrical, 1.3–1.5 × 0.9–1.1 cm, green, glabrous, both surfaces covered with linear cystoliths, membranous hyaline margin flat, 0–0.5 mm wide. Bracteoles elliptic, 1.0–1.1 × 0.3–0.4 cm, green, glabrous, abaxial surface covered with linear cystoliths, membranous hyaline margin flat, sometimes slightly puberulent at margin, ca. 1 mm wide. Calyx 5-lobed almost to the base, lobes linear, equal, 8–8.5 × 0.9–1.1 mm, glabrous. Corolla bilabiate, glabrous, ca. 1.5 cm long, pale yellow with red stripes on lower lip and throat; tube cylindrical at base and enlarged abruptly in throat, ca. 1 cm long; upper lip unlobed, attenuate at apex; lower lip 3-lobed, lobes rounded at apex. Stamens 2, 4.5–5 mm

Table 1. Morphological comparison of Runiga fangdingiana, R. sinothailandica and R. burmanica.

<table>
<thead>
<tr>
<th>Characters</th>
<th>R. fangdingiana</th>
<th>R. sinothailandica</th>
<th>R. burmanica</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stem</td>
<td>glabrous</td>
<td>bifariously pubescent</td>
<td>glabrous</td>
</tr>
<tr>
<td>Leaves</td>
<td>glabrous</td>
<td>pubescent</td>
<td>glabrous</td>
</tr>
<tr>
<td>Sterile bract</td>
<td>without membranous margin, margin entire</td>
<td>membranous margin crispate, hyaline with slightly tawny colour, 1.5 mm wide</td>
<td>without membranous margin, margin crenulate towards the apex</td>
</tr>
<tr>
<td>Fertile bract</td>
<td>rhombic to elliptic, membranous margin flat and hyaline, 0–0.5 mm wide, margin entire</td>
<td>obovate to elliptic, membranous margin crispate, hyaline at base and tawny at apex, 2 mm wide</td>
<td>obovate, without membranous margin, margin crenulate towards the apex</td>
</tr>
<tr>
<td>Calyx</td>
<td>lobes linear, glabrous</td>
<td>lobes linear, puberulous</td>
<td>lobes linear, puberulous</td>
</tr>
<tr>
<td>Corolla</td>
<td>pale yellow with red stripes, upper lip unlobed</td>
<td>white with red stripes, upper lip 2-lobed</td>
<td>white with purple dotted stripes, upper lip unlobed</td>
</tr>
<tr>
<td>Capsule</td>
<td>glabrous</td>
<td>puberulent</td>
<td>puberulent</td>
</tr>
</tbody>
</table>
Figure 1. Photographs of Rungia fangdingiana sp. nov. A habit B spike (abaxial view showing the sterile bracts) C spike (adaxial view showing the fertile bracts and fruits) D spike (adaxial view showing the fertile bracts and corolla) E corolla F, G adaxial view of leaf blade (showing the linear cystoliths) A–E by Yun-Hong Tan, F, G by Zhe-Li Lin.
A new Runiga from China

long, inserted at base of corolla throat, base adnate with corolla tube; filaments glabrous; anthers bithecous, superposed, ca. 3 mm long, thecae ovoid, glabrous, lacking a conspicuous basal spur. Pollen prolate, 35.99 (33.2–38.5) × 18.94 (15.7–21.6) μm, with P/E = 1.90, tricolporate, with one row of insulae on each side of aperture, exine ornamentation reticulate. Ovary glabrous, ca. 1.5 mm long; style slightly puberulent at base and middle part, ca. 1 cm long; stigma minutely 2-lobed. Capsule clavate, stipitate, glabrous, 1.1–1.2 × 0.3–0.35 cm. Seeds suborbicular to elliptic, compressed, dark brown, 2.5–3.5 × 2–2.5 mm, surface covered with brain-like verrucae.

Phenology. It was observed with flower and fruit at the same time from October to December and June to July.

Etymology. This new species is named in honor of Mr. Fang Ding (1924–2017) for his contributions to studies of the family Acanthaceae from Guangxi, China. He was the co-author of the account of family Acanthaceae for “Flora of Guangxi” and has published 37 new taxa of Acanthaceae from Guangxi (Fang and Deng 2017).

Vernacular name. 方鼎孩儿草 (Chinese pinyin: fāng dǐng hái ér cǎo).

Distribution and habitat. This species is currently known from three localities in Napo County of Guangxi Province. It grows close to stream sides in evergreen forest on limestone at elevations of 600 to 1200 m.

Conservation status. During the field investigations, only three scattered populations of Runiga fangdingiana were discovered, which all grow in forest on limestone in Napo county. Because of its narrow distribution (extent of occurrence < 20,000 km²), limited locations (< 10), with an estimated population size of < 1000 mature individuals, and there is continuing decline estimated in quality of habitat and number of locations

Figure 2. Fruit, seed and pollen morphology of Runiga fangdingiana sp. nov. A dehiscent capsule (showing the rising placenta and seeds) B seed C seed testa (SEM) D detail of the verrucae of seed testa (SEM) E interapertural view of pollen grain F apertural view of pollen grain. Photos by Zhe-Li Lin.
due to human activities as the localities are not protected, it should be assessed as Vulnerable (VU) (B1ab(iii)(iv)) according to the IUCN Red List Categories and Criteria (IUCN 2012, 2022). However, the area around the localities of this new species is poorly investigated, and further rigorous investigations are necessary to confirm this assessment.

Figure 3. Line drawings of *Rungia fangdingiana* sp. nov. A flowering branch B spike (abaxial view showing the sterile bracts) C spike (adaxial view showing the fertile bracts and corolla) D sterile bract E fertile bract F bracteole (abaxial view) G bracteole (adaxial view) H calyx I corolla J opened corolla K pistil L stigma M stamen (adaxial view) N stamen (abaxial view) O dehiscent capsule (showing the rising placenta and seeds) P seed. Drawn by Yun-Xiao Liu.
**A new **Rungia** from China**

**Additional specimens examined (paratypes):** China. Guangxi, Napo County: Nonghe Cun, on the way from Nonghe Cun to Tongziwan Power Station, on the rocks near stream-sides, 674 m elev., 11 December 2019, Y. F. Deng *et al.* 29030 (IBSC!); Napo County, in limestone forest, 1200 m elev., 24 October 2002, H. Wang 6616 (HITBC!, PE!).

**Discussion**

*Rungia fangdingiana* fits well with the circumscription of *Rungia* sect. *Rungia* according to the infrageneric classification by Gao and Deng (2007), as its flowers are arranged in a secund spike with heteromorphic bracts in two ranks of fertile bracts and two ranks of sterile bracts. Among the species in *Rungia* sect. *Rungia*, this new species is morphologically most similar to *Rungia sinothailandica* and *R. burmanica*, a key to these three similar species are provided as below.

**Key to Rungia fangdingiana and morphologically similar species in China**

1. Bracts with a crispate, tawny margin, upper lip of corolla 2-lobed ............................................................. **R. sinothailandica**
   – Bracts lacking a crispate, tawny margin, upper lip of corolla unlobed........2

2. Calyx and capsule glabrous; corolla pale yellow with red stripes ................ ................................................................. **R. fangdingiana**
   – Calyx and capsule puberulous; corolla white with purple dots ................. ................................................................. **R. burmanica**

Previously, the pollen morphology of ten species were reported in *Rungia* (Raj 1961, 1965; Scotland and Vollesen 2000; Rueangsawang *et al.* 2013; Lin *et al.* 2016; Lin and Deng 2017b, 2018; Kiel *et al.* 2017), amongst which nine species have dicolporate pollen grains and one species (*Rungia flaviflora*) has tricolporate pollen grains. In this study, *R. fangdingiana* is the second species found to have tricolporate pollen grains in *Rungia*.

The seed micromorphology of the four species in *Rungia* has been reported previously (Rueangsawang *et al.* 2012; Lin *et al.* 2016; Kiel *et al.* 2017; Lin and Deng 2017b), with two species having volcano-like verrucae on the seed testa, one species having brain-like verrucae, and *R. repens* was not observed under SEM (Kiel *et al.* 2017) so the detail of verrucae is not clear. The seed testa of *R. fangdingiana* has brain-like verrucae.

The micromorphology of pollen and seed is important in taxonomy in the family Acanthaceae (Radlkofer 1883; Lindau 1895; Raj 1961; Graham 1988; Daniel 1998; Scotland and Vollesen 2000; Cui and Hu 2005; Hu *et al.* 2005a, 2005b; Rueangsawang *et al.* 2012, 2013; Kiel *et al.* 2017; Manzitto-Tripp *et al.* 2021). However, due to the limited number of species studied in *Rungia*, further studies on pollen and seed morphology are necessary to understand its significance in species delimitation and the systematics in this genus.
Acknowledgements

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References


A new Runiga from China


Selaginella wuyishanensis (sect. Tetragonostachyae, Selaginellaceae), a new species from East China and its phylogenetic position based on molecular data

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Abstract
A new spikemoss species, Selaginella wuyishanensis, is described and illustrated based on materials collected from Fujian Province, East China. The new species can be distinguished from S. lutchuensis Koidzumi and S. albociliata P. S. Wang by its leaves with extremely long cilia (up to 8 mm) and distinctly white margins, ovate ventral sporophylls, and sporophyll-pteryx completely inverted on dorsal sporophylls. In the present work, a molecular phylogeny, taxonomic description, distribution information, line drawing, and photographs of this new species are presented. A morphological comparison is also given to distinguish it from morphologically similar species in Selaginella sect. Tetragonostachyae (Hook. & Grev.) Hieron. & Sadeb.

Keywords
Danxia landform, Selaginella albociliata, Selaginella subg. Heterostachys, species diversity

* These authors contributed equally as co-first authors.
Introduction

Selaginella P. Beauv. (Selaginellaceae) is the largest genus of seed-free vascular plants with more than 700 species worldwide (Jermy 1990; Zhou and Zhang 2015; PPG 2016; Weststrand and Korall 2016a). It is mainly distributed in tropical and subtropical regions, with a few species reaching the arctic-alpine zones in both hemispheres (Jermy 1990; Zhang et al. 2013). Members of Selaginella are heterosporous, and usually have rhizophores, leaves arranged in four rows, and terminal strobili. Though the subgeneric classification of Selaginella has been controversial (Zhou and Zhang 2015; Weststrand and Korall 2016b), integrative taxonomy based on morphological, cytological, and molecular data can effectively provide new insights into the species delimitation and discovery of new taxa (Zhou and Zhang 2015; Zhou et al. 2015a, b, 2016; Wu et al. 2017; Ye et al. 2020; Zhang et al. 2021; Wang et al. 2022).

Since 2019, we have conducted investigations into wild vascular plants in Wuyishan National Nature Reserve (WNNR) in Fujian Province, East China. Most of the Selaginella species we have encountered are common in WNNR and can be easily identified to described species. However, one species collected from Danxia regions of WNNR didn’t match species listed in available checklists and monographs or those recently described species from East Asia (Zhang et al. 2013; Zhou et al. 2015a, b; Wu et al. 2017; Shalimov et al. 2019; Ye et al. 2020; Zhang et al. 2021; Wang et al. 2022). Based on morphological study of herbarium specimens and consultation of literature, we found that this species is most similar to S. albociliata, but this species has smooth megaspore surfaces and ovate-lanceolate ventral sporophylls. In order to infer the phylogenetic relationships of this species, we conducted a phylogenetic analysis using both plastid and nuclear loci. With evidence from morphological characters and molecular phylogeny, we propose it as a new spikemoss species, and describe and illustrate it herein.

Materials and methods

The gross morphology of the new species was observed and examined both from the fresh plants and dried herbarium specimens using SMZ1270 stereomicroscope (Nikon, Japan). For spore morphology, a scanning electron microscope (SEM) was used to observe the megaspores and microspores. Spore samples obtained from herbarium specimen were mounted on specimen tabs and then coated with platinum in a sputter coater. Observations were conducted using an ESEM-Quanta 200 (FEI, Hillsboro, Oregon, USA) with 15 Kv at Nanjing Forestry University, Nanjing, China. The quantitative characters of the new species were measured using the ImageJ software (Pérez and Pascau 2013). Voucher specimens (see Appendix 1) were deposited at NF and PYU (herbaria acronyms according to Thiers 2018).

For the phylogenetic study, a total of 84 accessions representing 50 species of the genus were included, of which four accessions representing four species were selected
as outgroups based on earlier phylogenetic analysis (Zhou et al. 2016; Weststrand and Korall 2016b). Three samples from three different populations of the new species were newly sequenced. Total genomic DNA was extracted from silica-dried leaves using a TIANGEN plant genomic DNA extraction kit (TIANGEN Biotech, Beijing, China) Mini Kits (Qiagen, Germany) following the manufacturer’s protocols. One plastid gene *rbcL* and one nuclear region *ITS* were selected for the phylogenetic analysis based on Zhou et al. (2016). The PCR and sequencing protocols follow Zhou et al. (2016). The newly generated sequences were assembled and edited using Sequencher ver. 4.14 (GeneCodes Corporation, Ann Arbor, Michigan). All sequences of *rbcL* and ITS regions were initially aligned with MAFFT ver. 7 (Katoh and Standley 2013) and manually adjusted in BioEdit (Hall 1999). The two alignments were concatenated and the final combined dataset was analyzed with maximum likelihood (ML) and Bayesian inference (BI) methods. The ML tree searches were performed using RAxML-HPC2 on XSEDE with 1000 bootstrap replicates. The model GTR+I+G was chosen for the combined dataset using the AIC criterion with JModelTest 2 (Darriba et al. 2012). The BI was conducted using MrBayes ver. 3.2.7a (Ronquist and Huelsenbeck 2003) with temperature parameter set to 0.2, and keeping other parameters consistent with the default parameters of the software. Two independent runs of four Markov chain Monte Carlo chains, each with four chains (one cold, three heated), were conducted, each beginning with a random tree and sampling one tree every 1000 generations of 10 000 000 generations. Convergence among runs and stationarity were assessed using Tracer ver. 1.4 (Rambaut and Drummond 2007), and the first 25% was discarded as burnin. The remaining trees were used to calculate a 50% majority-rule consensus topology and posterior probabilities (PP).

**Results and discussion**

Based on our phylogenetic analysis, three collections from three different populations of the new species is in a polytomy with *S. lutchuensis* and *S. albociliata* (Fig. 1). Three samples of this new species are not resolved as a monophyletic group. However, both *S. lutchuensis* and *S. albociliata* are monophyletic and they form a strongly supported clade together (MLBS = 95% and BIPP = 0.99) (Fig. 1). Morphologically, all the three species have leaves ciliate along the margin. Based on the recent infrageneric classification of *Selaginella* proposed by Zhou and Zhang (2015), *S. wuyishanensis* should be assigned to *S*. subg. *Heterostachys* Baker sect. *Tetragonostachyae* (Hook. & Grev.) Hieron. & Sadeb.

Morphologically, *Selaginella wuyishanensis* is most similar to *S. albociliata* and *S. lutchuensis* in having plants creeping (Fig. 2A), leaf margins white (Fig. 2H–L), axillary and ventral leaves ciliate along the margins (Fig. 2H–L), megaspore surfaces reticulate ornamentation with fine muri (Fig. 2M, N), and microspore surfaces verrucate (Fig. 2O, P), but *S. wuyishanensis* has long cilia on ventral leaves up to 0.6 mm long (Fig. 2H; vs. short cilia up to 0.2 mm long in *S. lutchuensis*), dorsal leaves long
Figure 1. The maximum likelihood phylogeny of *Selaginella wuyishanensis* and its congeners based on plastid gene *rbcL* and nuclear locus *ITS*. Support values [maximum likelihood bootstrap support (MLBS) ≥ 50%, Bayesian inference posterior probability (BIPP) ≥ 0.5] are shown above the main branches. The dash (--) indicates MLBS < 50% or BIPP < 0.5.

ciliate (Fig. 2); vs. loosely serrulate in *S. lutchuensis*), verrucate ornamentation covered with small rodlet in microspore (Fig. 2P; vs. covered with coral-like structures in *S. lutchuensis*; Chang et al. 2009). *Selaginella wuyishanensis* is morphologically also similar to *S. albociliata* in having plants epilithic and leaves ciliate along the margins. However, *S. wuyishanensis* has smooth megaspore surfaces (Fig. 2M, N; vs. megaspore surface with fine and low papillae structure in *S. albociliata*; Zhou et al. 2015b), ventral sporophylls ovate with length-to-width ratio of ca. 2.4 (Fig. 2K; vs. ovate-lanceolate with length-to-width ratio of ca. 3.2 in *S. albociliata*). In geography, *S. wuyishanensis* is only known to occur in the Danxia landform of East China, whereas *S. albociliata* is restricted to the limestone mountains of the karst regions in the Southwest (Guizhou) and South (Guangxi) China.
Taxonomic treatment

Selaginella wuyishanensis K.W.Xu, X.M.Zhou & Y.F.Duan, sp. nov.
urn:lsid:ipni.org:names:77302501-1
Figs 2, 3


Diagnosis. The new species is most similar to Selaginella albociliata and S. lutchuensis in the habit, sterile leaves, and spores. However, S. wuyishanensis can be distinguished from the latter two species by its long leaf cilia (up to 0.6 mm), ovate ventral sporophylls, and the smooth perispore surface of the megaspores (Figs. 2, 3).

Description. Plants epilithic, evergreen, creeping, without erect or ascending stems. Rhizophores present at intervals throughout the length of creeping stem and branches, born on ventral side in the axil of main branches, slender, glabrous, 2–5 cm long, 0.1–0.2 mm in diameter; roots usually forked at the apex. Stem 5–12 cm long, rarely longer than 12 cm, 3–4 mm in width, irregularly and slightly dichotomously branched. Leaves arranged in four ranks (two dorsal and two ventral). Axillary leaves present at branching points, oblong-ovate, base slightly cuneate, apex acuminate, 0.8–1.2 × 2.2–2.5 mm, long ciliate along the margin from base to 2/3 of the axillary leaves, cilia up to 0.8 mm long. Ventral leaves asymmetrical, those on main stem similar to those on branches, imbricate on stem and branch throughout, ovate, 1.5–2.8 × 0.8–1.2 mm, apex slightly acute to acuminate, acroscopic base rounded, basiscopic base slightly cuneate, margin conspicuously white-margins; acroscopic margins ciliate at the base, cilia up to 0.6 mm long, basiscopic margins nearly entire at the base, ciliate or denticulate upward. Dorsal leaves symmetrical, ovate to oval, 0.8–1.6 × 0.6–0.9 mm, base rounded, apex aristiform, often reflexed, margins conspicuously white-callous, acroscopic margins sparsely ciliate, cilia up to 0.5 mm long, basiscopic margins ciliate, cilia short, no more than 0.1 mm long. Strobili usually in pairs or rarely three on the branches, terminal, resupinate, 1–2 cm long, megasporangia usually present at basal sporophylls and microsporangia present at upper ones; dorsal sporophyll ovate-lanceolate, base nearly rounded, apex acuminate, 1.2–1.8 × 0.4–0.8 mm, margin conspicuously white-callous, ciliate along the margin of basal part, cilia short; ventral sporophylls membranous, ovate-lanceolate, base rounded, apex caudate, ca. 0.6 × 1.3 mm, ciliate along the margin, cilia ca. 0.3 mm long. Megaspores yellow, trilete, oblate spheroid to subglobose, equatorial diameter 240–260 μm; perispore reticulate ornamentation with fine muri. Microspores reddish orange, trilete, hemispheric, equatorial diameter 35–42 μm; verrucate ornamentation of microspore covered with dense rodlets.

Distribution and habitat. Selaginella wuyishanensis is known only from Fujian Province, East China. Three populations were observed to grow on rocks of the Danxia landform in evergreen broad-leaved forests at elevations of ca. 200–800 m.
**Additional specimens examined.** China. Fujian: Wuyishan City, Mt. Wuyishan, alt. 327 m, 27°41’12.82”N, 117°56’12.24”E, 25 Nov. 2021, Ke-Wang Xu et al. WY521 (NF); the same locality, alt. 280 m, 27°39’17”N, 117°57’50”E, 27 Nov. 2021, Ke-Wang
Selaginella wuyishanensis sp. nov.

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Xu et al. WY596 (NF); the same locality, Ke-Wang Xu et al. WY597 (NF); the same locality, Ke-Wang Xu et al. WY598 (NF); Yongan City, Tianbaoyan National Nature Reserve, 25°57'11"N, 117°33'14"E, 1 Nov. 2020, Wei & Chen JSL7744A (CSH).

Etymology. The species epithet is based on the name of the famous mount Wuyishan, referring to the type locality of the new species.

Key to Selaginella wuyishanensis and its closely related species and morphologically similar species in Fujian Province

1 Leave margins denticulate and not white-margined .........................................2
   – Leave margins more or less ciliate and/or white-margined............................3
2 Strobili non-resupinate ......................................................................................S. nipponica
   – Strobili resupinate .........................................................................................S. heterostachys

Figure 3. Illustration of Selaginella wuyishanensis A habit B adaxial view of branch C abaxial view of branch with rhizophore D axillary leaf E ventral leaf F dorsal leaf G strobili H ventral sporophyll I dorsal sporophyll (A–F drawn by Sun YB based on the isotype at NF G–I drawn by Wei HJ based on the paratype at CSH).
3 Leaves not white-margined, both sides of ventral leaves long ciliolate at margins

4 Leaves white-margined, acroscopic base of ventral leaves long ciliolate at margins, elsewhere denticulate or subentire

--- S. xipholepis

4 Ventral leave margins with short cilia up to 0.2 mm; dorsal leave margins loosely serrulate

--- S. lutchensis

4 Ventral and dorsal leave margins with cilia up to 0.6 mm

5 Ventral sporophylls ovate-lanceolate with length-to-width ratio of ca. 3.2; megaspore surfaces with fine and low papillae structure

--- S. albociliata

5 Ventral sporophylls ovate with length-to-width ratio of ca. 2.4; megaspore surfaces smooth

--- S. wuyishanensis

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References


### Appendix I

List of taxa sampled with information related to taxonomy, GenBank accession numbers (*rbcL*, 5.8S+ITS2), references, and voucher information. Herbarium acronyms follow Index Herbariorum (Thiers 2018).

Selaginella wuyishanensis sp. nov.  


Selaginella whitmeei Baker K.R. Wood 17032 (PTBG), Samoa (Savaii), MT657910 (Nitta et al. 2020), —. Selaginella wuyishanensis (1) K.-W. Xu WY596 (PYU), China (Fujian): ON994453 (this study), —; (2) K.-W. Xu WY598 (PYU), China (Fujian): ON994454 (this study), —; (3) H.-J. Wei JSL7744A (CSH), China (Fujian): ON994455 (this study), ON994202 (this study). Selaginella xipholepis Baker (1) S.-Y. Dong 2377 (PYU), China (Guangdong): KT161645 (Zhou et al. 2016), —; (2) L.-B. Zhang & al. 6668 (CDBI, MO, VNMN, PYU), Vietnam (Bac Kan): KT161646 (Zhou et al. 2016), KT161867 (Zhou et al. 2016). Selaginella yunckeri Alston T. G. Yuncker 15933 (U); Tonga, KY023182 (Weststrand and Korall 2016b), —.
Novelties on the genus Vaccinium (Ericaceae) from Hainan, China: a new species and a new record for the country

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Abstract
Here we describe a new species, Vaccinium pseudopubicalyx, and report a new record for the flora of China, V. viscifolium, both from Hainan Province. Vaccinium viscifolium also represents the first record of V. sect. Euepigynium for China. Detailed descriptions and illustrations with analytical photographs of the two taxa are provided.

Keywords
Morphology, new species, taxonomy, Vaccinium pubicalyx

Introduction

The genus Vaccinium L., with about 450–500 species distributed worldwide, is the largest genus of the tribe Vaccinieae in Ericaceae (Fang 1991; Fang and Stevens 2005; Vander Kloet and Dickinson 2009; POWO 2022). In China, 97 species of Vaccinium have been recorded, with several new species or records reported from the country after the revision completed by Fang and Stevens (2005) in “Flora of China”, such as

During a recent field trip to Hainan, two species never recorded from the province were respectively found in Wuzhi Mountain and Mazui Mountain. The one from Wuzhi Mountain is similar to V. pubicalyx Franch. and V. bracteatum Thunb. var. chinense (Lodd.) Chun ex Sleumer due to their similar habit and leaf blade shape. The other one from Mazui Mountain firstly reminded us of V. hainanense, a species that has never been collected again since 1933 when the type specimens were collected, and owns the similar leathery leaf blades with an obtuse or abruptly obtuse-acute apex as this unknown species. However, its pinnipalmate leaf venation and glabrous floral disk are rather different from V. hainanense.

After a detailed examination of our materials and possible similar species from China and neighbouring countries (King and Gamble 1910; Dop 1930; Sleumer 1967; Pham 1999; Nguyen 2005; Newman et al. 2007; Watthana 2015), we concluded that the species from Wuzhi Mountain is new to science, and the other from Mazui Mountain is V. viscifolium King & Gamble, which represents a new record for the flora of China. Thus, we report these novelties as follows.

**Taxonomy**

**Vaccinium pseudopubicalyx** X. H. Ye, Q. L. Wang & Y. H. Tong, sp. nov. urn:lsid:ipni.org:names:77302514-1
Figs 1–3

**Type.** China, Hainan, Wuzhishan City, Wuzhi Mountain, montane summit scrub, 18.89°N, 109.69°E, 1867 m a.s.l., 20 March 2020, Yi-Hua Tong, Xue-He Ye, Xin-Ting Ma & Qing-Long Wang YXH-18 (holotype: IBSC; isotypes: IBSC, ATCH).

**Diagnosis.** Vaccinium pseudopubicalyx is morphologically similar to V. pubicalyx and its varieties, but can be distinguished by having fewer pairs of secondary veins (3–5 (Fig. 2E) vs. 5–9 (Fig. 5A, B)), smaller (2–3.5 × ca. 1 mm vs. 5–8 × ca. 1.5–2 mm) and lanceolate (vs. ovate) floral bracts, young twigs and inflorescences rachis white-pubescent (vs. brownish-tomentose), and anthers with smaller dorsal spurs (0.5–1 mm vs. ca 4 mm, Fig. 5F).

**Description.** Evergreen terrestrial shrubs or small trees, 2–4 m tall; much branched, young twigs pubescent, glabrescent. Petioles 3–5 mm long, pubescent; blades elliptic or ovate, 2.2–5 × 0.8–1.9 cm, chartaceous, glabrous on both sides, midvein prominent on both sides, pubescent, glabrescent abaxially, secondary veins 3–5 pairs, visible in vivo, inconspicuous adaxially and slightly raised abaxially when dry, base broadly
A new species and record of *Vaccinium* from Hainan

cuneate, margin serrulate, apex acuminate, shortly caudate. Perennating buds monomorphic. Inflorescence pseudo-terminal or axillary on distal part of twigs, racemose, with 10–13 flowers, rachis 1.4–2.5 cm long, densely pubescent; floral bract caducous, 1, inserted at the base of pedicel, lanceolate to linear, 2–3.5 × ca. 1 mm, glabrous adaxially, pubescent abaxially, margin entire, ciliate; bracteoles 2, unequally inserted at the lower part of pedicel, long ovate-triangular to linear, 1–1.6 × ca. 1 mm, glabrous adaxially, pubescent abaxially, margin entire, ciliate; pedicel articulated between pedicel and calyx, 3–4.5 mm long, densely pubescent. Hypanthium cupuliform, 1–2 × 1.5–2 mm, pubescent; calyx lobes triangular to broadly triangular, 1–2.5 × 1–1.5 mm, glabrous adaxially, pubescent abaxially, margin entire, ciliate. Corolla white, tinged with red, tubular, sometimes slightly urceolate, 4.5–8 × 3.5–4.5 mm, pubescent outside, pilose

Figure 1. *Vaccinium pseudopubicalyx* **A** habit **B** trunk **C** leafy branch **D** flowering branch. Photos **A–C** by Y. H. Tong; **D** by X. H. Ye.
inside; corolla lobes slightly reflexed, small, triangular, 1–1.8 × 1–1.5 mm; stamens 10, dimorphic, 4.5–5 mm long, filaments 2–3 mm long, densely pilose, anthers dorsifixed with 2 minute spurs, ca. 2.5 mm long, thecae ca. 1 mm long, papillate, spurs on antepetalous anthers ca. 0.1 mm long, those on antepetalous anthers ca. 0.05 mm long, inconspicuous, tubules 1.5–2 mm long, 1.5–2 times as long as anther thecae, apex poricidal, pores 0.45–0.6 mm long, teeth absent; ovary inferior, pseudo-10-locular, disk disciform, 10-ridged, pilose, style cylindrical, 6–6.5 mm long, glabrous, stigma punctate. Fruits not seen.
A new species and record of *Vaccinium* from Hainan

**Figure 3.** *Vaccinium pseudopubicalyx* A flowering branches B bracteoles, adaxial (left) and abaxial (right) view C floral bract, adaxial view D flower E hypanthium, disk and style with front one calyx lobe removed F calyx lobe, adaxial view G opened corolla, adaxial view H stamens, adaxial view I dorsal anther spurs of antepetalous anthers (left) and antesepalous anthers (right) J ovary, transverse view. Drawn by Mr. D. H. Cui.

**Etymology.** The specific epithet *pseudopubicalyx*, a noun in apposition, alludes to close alliance to *Vaccinium pubicalyx*.

**Vernacular name.** 拟毛萼越橘 (Chinese pinyin: nǐ máo è yuè jú).
Phenology. Flowering in January–June; fruiting time unknown.

Distribution and habitat. *Vaccinium pseudopubicalyx* has been found at four localities in Hainan, viz. the type locality, Bawangling National Nature Reserve (19.12°N, 109.08°E), Jianfengling Tropical Forest Nature Reserve (18.72°N, 108.91°E) and Yinggeling National Nature Reserve (19.18°N, 109.45°E) (Fig. 4). It grows in montane forests or scrub on the mountain summits at elevations from 1122 to 1867 m.

Taxonomic notes. Besides the differences mentioned in the diagnosis, *Vaccinium pseudopubicalyx* and *V. pubicalyx* are strictly allopatric: the former one is endemic to Hainan, while the other one is distributed in southwest China and Myanmar.

The new species has also been occasionally identified as *V. bracteatum* var. *chinense* (Champ. ex Benth.) Chun ex Sleumer (Zhang et al. 2007; Xing et al. 2012). It can be easily separated from *V. bracteatum* var. *chinense* by its inconspicuous (vs. prominent) secondary veins on adaxial surface of leaf blade. Besides, the elliptic or ovate (vs. rhombic-elliptic or lanceolate-elliptic) leaf blades with fewer pairs of secondary veins (3–5 vs. 5–7), shorter inflorescence rachis (1.4–2.5 cm vs. 4–10 cm), smaller (2–3.5 × ca. 1 mm vs. 5–20 × 1–3 mm), entire (vs. serrated) and lanceolate to linear (vs. ovate to oblong-ovate) floral bracts, and different ratio of the length of anther tubules to anther thecae (1.5–2 vs. 2–2.5) can also separate the new species from *V. bracteatum* var. *chinense*.

*Vaccinium pseudopubicalyx* should be assigned to sect. *Eococcus* Sleumer, because its morphological characteristics match well with those of that section, such as a terrestrial habit, serrate leaf blades, axillary racemes with elongate rachis, deciduous bracts, articulation

Figure 4. The distribution of *Vaccinium pseudopubicalyx* and *V. viscifolium* in Hainan Island (China).
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between hypanthium and pedicel, spurred anthers and a pseudo-10-locular ovary. According to Sleumer (1941), the main difference between sect. Eococcus and sect. Bracteata Nakai is that the former has caducous bracts during anthesis, whereas the latter has persistent ones. However, when examining specimens of V. iteophyllum Hance, a widespread species (distributed in almost every province in southern China) placed in sect. Eococcus by Sleumer (1941), we observed that some populations (e.g., Y. H. Tong & L. Bai 12062414, IBSC) also have persistent bracts even when fruiting. Thus, the delimitation of the two sections appears to not be natural, and the relationship of the two sections needs further study.

Additional specimens examined. Vaccinium pseudopubicalyx (paratypes): CHINA. Hainan: Baisha County, Yuanmen Town, Yinggeling National Nature Reserve, main peak, 31 May 2005 (fl.), F. W. Xing, Rong-Jing Zhang & Yu-Shi Ye 16371 (IBSC); ibid., same date as above, Sai-Chit Ng 5766 (HK, not seen); Changjiang County, Bawangling National Nature Reserve, mountain top, 1380 m a.s.l., 6 January 1964, Pei Zeng 13511 (HITBC); ibid., the second peak (Axe Peak), 27 April 1988 (fl.), Ze-Xian Li & Fu-Wu Xing 4004 (IBSC0528562); ibid., the second peak (Axe Peak), June 1983 (fl.), Guo-Ai Fu 3408 (IBSC0420642); Ledong County, Jianfengling Tropical Forest Nature Re-

Figure 5. Vaccinium pubicalyx and comparison of stamen of V. pubicalyx and V. pseudopubicalyx A young leafy branch of V. pubicalyx B branch with young inflorescences of V. pubicalyx C flowering branches of V. pubicalyx D floral bract of V. pubicalyx, abaxial (left) and adaxial (right) view E stamens of V. pubicalyx (left) and V. pseudopubicalyx (right) F dorsal anther spurs of V. pubicalyx (left) and V. pseudopubicalyx (right). Scale bars: 3 mm (D, E); 2 mm (F). Materials of V. pubicalyx in D–F from G. Forrest 7637 (IBSC0457011), and those of V. pseudopubicalyx in E–F from type. Photos A, C by H. B. Ding; B by Y. H. Tong; D–F by X. H. Ye.
serve, 1400 m a.s.l., 25 January 1984 (fl.), Shi-Man Huang 306 (IBSC0420202); ibid., the second peak, 1220 m a.s.l., 29 November 1957, Qi-Cai He 90777 (IBSC0420580).

*Vaccinium pubicalyx*: CHINA. Yunnan: Tali [Dali Prefecture], Huang-kia-pin [Huangjiaping], 4 July 1888, P. J. M. Delavay 3311 (syntypes: P04484707, image; P04484708, image; P04484709, image; L008184, image); [Tengchong City], hills at the north end of the Tengyueh Valley, May 1912, G. Forrest 7637 (IBSC0457011; K00780601, image; E00327780, image; E00327781, image).

*Vaccinium bracteatum* var. *chinense*: CHINA. Hong Kong: Champion s. n. (K00780589, image).


Figs 6, 7

**Type.** MALAYSIA, Perak, Scortechini 405 (lectotype CAL, not seen, designated by Sleumer in 1961: 84; isolecotypes BM000996430, image!, K, not seen, P00647874, image!)

**Description.** Evergreen terrestrial shrubs or trees, up to 6 m tall; young twigs pubescent, glabrescent. Petioles flat, 0.5–1.2 cm long, pubescent; blades elliptic, oblanceolate, obovate or oblong-ovobovate, 4.8–11.1 × 1.3–3.4 cm, coriaceous, stipitate-glandular on both sides, pinnipalmate, midvein prominent abaxially, flat or slightly sunken adaxially, secondary veins 3–6 pairs, in vivo visible adaxially, flat or slightly raised, inconspicuous abaxially, in sicco inconspicuous on both sides, apex obtuse or rounded, margin entire, slightly revolute, with 1–3 pairs of glands at the basal part, base attenuate, extended. Perennating buds monomorphic. Inflorescence axillary, racemose, with 11–18 flowers; rachis 3.8–5 cm long, sparsely stipitate-glandular; bract caducous, 1, inserted at the base of pedicel, ovate or lanceolate, 9–16 × 3–6.5 mm, glabrous, margin entire, involute; bracteoles oppositely inserted at the base of pedicel, 2, linear, 1.5–2.5 × ca. 0.5 mm, glabrous on both sides, margin entire, ciliate; pedicel articulated between pedicel and calyx, 3–5.5 mm long, glabrous. Hypanthium cupuliform, 2–2.5 × 2.5–3 mm, glabrous; lobes triangular to broadly triangular, 1–2.5 × 1.5–2 mm, glabrous on both sides, margin ciliate. Corolla pinkish to white, cylindric-urceolate, 8–10 × 4–5 mm, glabrous on both sides; lobes reflexed or slightly spreading, small, ovate or triangular, 1.5–2 × 1.5–2 mm, glabrous abaxially, papillate adaxially; stamens 10, dimorphic, 6–7 mm long, filaments swollen at base, 3–3.5 mm long, densely pilose, anthers without dorsal spurs, 3–3.5 mm long, thecae 1–1.5 mm long, papillate, tubules 1.5–2.5 mm long, 1.5–2 times as long as anther thecae, apex poricidal, pores ca. 0.5 mm long, antepetalous anthers with 1 tooth at apex of anther tubules, antepetalous anthers with 2 teeth at apex of anther tubules, teeth ca. 0.5 mm long; ovary inferior, pseudo-10-locular, disk disciform, 10 ridged, glabrous, style cylindrical, 0.8–0.9 cm long, glabrous, stigma truncate. Young fruits glaucous, subglobose, persistent calyx lobes incurved, nearly covering disk.

**Vernacular name.** 楝寄生叶越橘 (Chinese pinyin: hú jì shēng yè yuè jú).
A new species and record of *Vaccinium* from Hainan

**Distribution and habitat.** *Vaccinium viscifolium* is distributed in China (Hainan, Fig. 4), Southern Indochina to Peninsular Malaysia. So far, Hainan is the northernmost distribution locality of this species. It grows on open limestone of mountainsides or mountain ridges in montane forests at an elevation of ca. 750 m in Hainan.

**Taxonomic notes.** *Vaccinium viscifolium* has two varieties, viz. the nominate variety and *V. viscifolium* var. *bicalcaratum* Sleumer. The latter differs from the former by having leaves with a shortly (ca. 1 cm) and obtusely attenuate (vs. obtuse or rounded) apex and anthers with (vs. without) 2 distinct dorsal spurs (Sleumer 1967). The plants from Hainan should belong to the nominate variety, as they have leaves with an obtuse or rounded apex and anthers without dorsal spurs.

*Vaccinium viscifolium* was initially assigned to sect. *Euepigynium* Schltr. by Sleumer (1941). However, when compiling *Flora Malesiana*, he reassigned it to sect. *Bracteata*, which was recognized with an extremely broad sense to include 163 species consisting of members from several sections, such as sect. *Bracteata* s.s., sect. *Nesococcus* H. F. Copel., and sect. *Euepigynium* (Sleumer, 1967). Stevens (1969) pointed out that the leaves of the species of sect. *Euepigynium* with an entire margin and plinerved venation were very different from those of sect. *Bracteata*, which have a serrate margin and pinnate venation. Vander Kloet and Dickinson (2009) also treated sect. *Euepigynium* and sect. *Bracteata* as two distinct sections. Moreover, the marginal or basal glands often occur to sect. *Euepigynium*, and are absent in the species of sect. *Bracteata* s.s. without exception. Thus, we do not adopt Sleumer’s broad sense of sect. *Bracteata*.

**Figure 6.** *Vaccinium viscifolium* A habitat B habit C flowering branch D fruiting branch. Photos by Y. H. Tong.
(Sleumer, 1967), and prefer to agree with the assignment of *V. viscifolium* to sect. *Euepigynium* Sleumer (1941). Whereas sect. *Euepigynium* is only found in Malesiana and Indochina formerly, *Vaccinium viscifolium* is the first species of sect. *Euepigynium* reported from China.


A key to the species of *Vaccinium* from Hainan Province is provided below.

**Figure 7.** *Vaccinium viscifolium* **A** flowering branch **B** leaves **C** floral bract, adaxial (left) and abaxial (right) view **D** bracteoles, adaxial (left) and abaxial (right) view **E** calyx lobe, adaxial (left) and abaxial (right) view **F** flower **G** opened corolla, adaxial (up) and abaxial (below) view **H** hypanthium, disk and style with front two calyx lobes removed **I** stamens, lateral (left), abaxial (middle) and adaxial (right) view **J** ovary, apical (left) and transverse (right) view. Scale bars: 5 cm (**A, B**); 1 cm (**C, F, G, H**); 5 mm (**I**); 2 mm (**D, E, J**). Photos by X. H. Ye.
Key to the species of Vaccinium in Hainan

1 Leaves serrate, chartaceous or subcoriaceous .................................................. 2
   – Leaves entire, coriaceous ............................................................................. 3
2 Secondary veins inconspicuous adaxially, 3–5 pairs; inflorescence rachis 1.4–2.5 cm long; floral bracts small, 2–3.5 mm long, caducous, lanceolate to linear, margin entire; anther tubules 1.5–2 times as long as anther thecae .... ................................................................. V. pseudopubicalyx
   – Secondary veins prominent adaxially, 5–7 pairs; inflorescence rachis 4–10 cm long; floral bracts large, leaf-like, 5–20 mm long, usually persistent, ovate to oblong-ovate, margin serrate; anther tubules 2–2.5 times as long as anther thecae ........................................................................... V. bracteatum
3 Leaf apex caudate; racemes 5–9 flowered; calyx lobes lanceolate .... V. chunii
   – Leaf apex obtuse or abruptly obtuse-acute; racemes with 10 flowers or more; calyx lobes triangular or broadly triangular .................................................. 4
4 Leaf venation pinninerved; veins conspicuous on both sides; disk tomentose .............................................................................................. V. hainanense
   – Leaf venation pinnipalmate; veins inconspicuous on both sides; disk glabrous ................................................................................. V. viscifolium

Acknowledgements

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References


Erythroxylum austroguangdongense (Erythroxylaceae), a new species from Guangdong, China

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Abstract
Erythroxylum austroguangdongense (Erythroxylaceae), a new species from Guangdong Province, China, is described and illustrated. This new species is morphologically most similar to E. calyptratum, but is distinguished by the leathery leaf blade with fewer pairs of secondary veins and flowers borne on leafless nodes of the basal part of the current branch with much longer pedicels and sub-rectangular petal appendages. This is the second native species of Erythroxylum recorded from China.

Keywords
Coca family, morphology, taxonomy

Introduction
The genus Erythroxylum P. Browne (Erythroxylaceae), with about 264 species, is widely distributed in tropics and subtropics with the center of its diversity in Neotropics (POWO 2022). Many species of this genus contain the substance cocaine, and can be used medicinally as a narcotic. In China, only two species of Erythroxylum are recorded,
i.e., the introduced *E. novogranatense* (D. Morris) Hieron. and the widely distributed *E. sinense* Y. C. Wu (Liu and Bartholomew 2008).

During field surveys of medicinal plant resources in Guangdong Province, we encountered an unknown *Erythroxylum* species with white flowers, while the species previously recorded from China either has whitish-yellow (*E. novogranatense*) or pinkish (*E. sinense*) flowers. After a morphological comparison with specimens in the herbarium (IBSC) and consulting the relevant literature (e.g. Guillaumin 1907; Chung 1996; Hô 2003; Liu and Bartholomew 2008; Harwood and Chayamarit 2011; Komada et al. 2018), we concluded that this unknown species is morphologically distinct from all the other species previously known in China and its surrounding countries. Thus, we describe and illustrate it as a new species.

### Materials and methods

Flowering and fruiting material was collected from Zhuhai and Taishan, Guangdong Province, China during several field trips from 2019 to 2022. Descriptions were based on both living and dried collections, which were deposited at the herbarium of South China Botanical Garden, Chinese Academy of Sciences (IBSC). Measurements were performed with a ruler, and small plant parts were observed and measured under a stereo microscope (Mshot-MZ101).

### Taxonomic treatment

*Erythroxylum austroguangdongense* C. M. He, X. X. Zhou & Y. H. Tong, sp. nov.

urn:lsid:ipni.org:names:77302515-1

Fig. 1

**Type.** China. Guangdong Province: Taishan, Chaliao Ao, 22°12'54.87"N, 112°57'34.84"E, 563 m a.s.l., 3 April 2021 (fl.), Xin-Xin Zhou & Yue-Yao Liu LSX303 (holotype: IBSC, isotypes: IBSC).

**Diagnosis.** Most similar to *E. calyptratum* Komada & Tagane in having reddish brown to grayish brown branches with dense lenticels, and white petals with appendages, but distinguished by the leathery (vs. thinly chartaceous) leaf blade with fewer pairs of secondary veins (6–8 pairs vs. 11–15 pairs), and flowers borne on leafless nodes of the basal part of current branch (vs. in leaf axils) with longer pedicels (1–1.5 cm vs. 5.2–7 mm) and sub-rectangular petal appendage (vs. bilobed appendage with each lobe consisting of a short anterior auricle and a large posterior auricle). A more detailed comparison of the two species is shown in Table 1.

**Description.** Shrubs deciduous, 1.5–2 m tall, dioecious. Young branches greenish, old branches reddish-brown to grayish-brown, lenticellate. Stipule triangular to narrowly triangular, 1.8–3 × 0.7–0.8 mm, margin entire when young, gradually fimbriate,
A new species of *Erythroxylum* is described and illustrated.

**A new species of *Erythroxylum* is described and illustrated.**

**or dissected, caducous when old. Leaves alternate, simple; petiole 3.5–6 mm long; blade elliptic or lanceolate, 4–7.7 × 1.6–2.5 cm, leathery, apex acuminate, acumen to 5 mm long, base cuneate or attenuate, margin entire, dark green and shining adaxially, pale green abaxially, midrib sunken adaxially, prominent and pale yellow to brownish-yellow abaxially, secondary veins 6–8 pairs, almost flat, faintly visible on both surfaces, tertiary veins reticulate, obscure adaxially, slightly visible abaxially. Flowers solitary on leafless nodes of the basal part of current branch, pedicel 1–1.5 cm long; bracteole triangular, ca. 0.8 mm long, margin fimbriate or serrately dissected; calyx 1.6–1.8 mm long, lobes 5, ovate-triangular, ca. 1 mm long, apex brownish, acute; petals 5, white, oblong, 3.7–4 mm long, apex obtuse or rounded, adaxially with one appendage attached ca. 1.5 mm above from base, appendage sub-rectangular, ca. 1.6 × 1 mm, papillate throughout, slightly concave on both upper and lower margin. Stamens or staminodes 10. Male flowers: stamens with different length of filaments arranged alternately, short filaments ca. 3.7 mm long, long ones ca. 4 mm long, all basally connate into a tube, tube ca. 2 mm long, densely covered with papillary trichomes; anthers ca. 1.1 mm long; sterile pistil ca. 4 mm long. Female flowers: staminodes ca. 1.2 mm long, staminodal tube ca. 1 mm long, anther absent; ovary ellipsoidal, 2–2.5 mm long, 1–1.3 mm in diam., 3-locular, with 1 fertile locule, styles 3, entirely free at base, ca. 1 mm long including stigma, stigma clavate, ca. 0.5 mm long, reflexed, with papillae. Young fruits green, turning to yellowish, ripening red, ovoid to reniform, apex oblique, 7–9 × 2.5–3 mm.

**Etymology.** The species epithet is named after the distribution area of this new species, South Guangdong.

**Vernacular name.** 南粤古柯 (Chinese pinyin: nán yù gǔ kē).

**Distribution and habitat.** This species is currently known only from Guangdong Province, China. Three populations are found in Yangchun (E’huangzhang), Zhuhai (Fenghuang Mountain) and Taishan (Gudou Mountain) respectively. It grows in evergreen broadleaved forests at elevations of 170–800 m.

**Conservation Status.** According to the field observation, the number of mature individuals of *Erythroxylum austroguangdongense* is less than 100. Thus, it is assigned a status of ‘Endangered’ (EN) following the IUCN Red List categories and criteria (IUCN Standards and Petitions Committee 2022). Since most of its distribution area is under the protection of E’huangzhang Natural Reserve and Gudou Mountain Natural Reserve, and it is not economically valuable, the threat risk seems to be low.

**Table 1.** Morphological comparison of *Erythroxylum austroguangdongense* and *E. calyptratum*.

<table>
<thead>
<tr>
<th>Character</th>
<th><em>E. austroguangdongense</em></th>
<th><em>E. calyptratum</em></th>
</tr>
</thead>
<tbody>
<tr>
<td>Leaf blade texture</td>
<td>Leathery</td>
<td>Thinly chartaceous</td>
</tr>
<tr>
<td>Leaf blade shape</td>
<td>Elliptic or lanceolate</td>
<td>Elliptic, oblong, oblong-lanceolate or ovate</td>
</tr>
<tr>
<td>Leaf blade color</td>
<td>Dark green and shining adaxially</td>
<td>Pale green adaxially</td>
</tr>
<tr>
<td>Secondary veins</td>
<td>6–8 pairs</td>
<td>11–15 pairs</td>
</tr>
<tr>
<td>Flower</td>
<td>Solitary on leafless nodes of the basal part of current branch</td>
<td>Solitary to 3-fascicled in leaf axils</td>
</tr>
<tr>
<td>Pedicel length</td>
<td>1–1.5 cm</td>
<td>5.2–7 mm</td>
</tr>
<tr>
<td>Petal appendage</td>
<td>Sub-rectangular</td>
<td>Bilobed and each lobe consisting of a short anterior auricle and a large posterior auricle</td>
</tr>
</tbody>
</table>

or dissected, caducous when old. Leaves alternate, simple; petiole 3.5–6 mm long; blade elliptic or lanceolate, 4–7.7 × 1.6–2.5 cm, leathery, apex acuminate, acumen to 5 mm long, base cuneate or attenuate, margin entire, dark green and shining adaxially, pale green abaxially, midrib sunken adaxially, prominent and pale yellow to brownish-yellow abaxially, secondary veins 6–8 pairs, almost flat, faintly visible on both surfaces, tertiary veins reticulate, obscure adaxially, slightly visible abaxially. Flowers solitary on leafless nodes of the basal part of current branch, pedicel 1–1.5 cm long; bracteole triangular, ca. 0.8 mm long, margin fimbriate or serrately dissected; calyx 1.6–1.8 mm long, lobes 5, ovate-triangular, ca. 1 mm long, apex brownish, acute; petals 5, white, oblong, 3.7–4 mm long, apex obtuse or rounded, adaxially with one appendage attached ca. 1.5 mm above from base, appendage sub-rectangular, ca. 1.6 × 1 mm, papillate throughout, slightly concave on both upper and lower margin. Stamens or staminodes 10. Male flowers: stamens with different length of filaments arranged alternately, short filaments ca. 3.7 mm long, long ones ca. 4 mm long, all basally connate into a tube, tube ca. 2 mm long, densely covered with papillary trichomes; anthers ca. 1.1 mm long; sterile pistil ca. 4 mm long. Female flowers: staminodes ca. 1.2 mm long, staminodal tube ca. 1 mm long, anther absent; ovary ellipsoidal, 2–2.5 mm long, 1–1.3 mm in diam., 3-locular, with 1 fertile locule, styles 3, entirely free at base, ca. 1 mm long including stigma, stigma clavate, ca. 0.5 mm long, reflexed, with papillae. Young fruits green, turning to yellowish, ripening red, ovoid to reniform, apex oblique, 7–9 × 2.5–3 mm.

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Figure 1. *Erythroxylum austroguangdongense* A flowering branches B leafy branches C female flowers D male flower E stipule, showing fimbriate margin F flower bud, showing calyx G petals, adaxial (left), lateral (middle) and abaxial (right) view H androecium I staminodes and pistil J cross section of ovary, showing one fertile locule (low right) K–L fruits. Scale bars: 3 mm (H); 2 mm (E–G, I); 1 mm (J). Photographs A–B by Xin-Xin Zhou D, K by Wei-Jun Chen H by Xue-He Ye and others by Chun-Mei He.
A new species of *Erythroxylum* is described and illustrated

**Phenology.** Flowering in March-April and fruiting in April-August.

**Additional specimens examined (paratypes).** China. Guangdong, Taishan: Banyuzui, 448 m a.s.l., 28 March 2019 (fl.), Lei Jiang, Jin-Fan Lin, Jin-Ye Feng, Fu-Jun Chen & Jie-Lin Chen GDS-00291 (IBSC); Chaliao Ao, 205 m a.s.l., 25 April 2019 (fr.), Teng-Hui Guo, Jin-Fan Lin & Jia-Ming Chen GDS-00484 (IBSC); ibid., 19 May 2019 (fr.), Taishan Expedition 440781190519024LY (IBSC). Yangchun: Bajia, Xianjia-dong Reservoir, 800 m a.s.l., 1 August 2001 (fr.), *Hua-Gu Ye* 6094 (IBSC); Bajia Reservoir, 750 m a.s.l., 5 August 2001 (fr.), *Hua-Gu Ye* 6199 (IBSC). Zhuhai: Fenghuang Mountain, 177 m a.s.l., 2 April 2021 (young fr.), Yi-Hua Tong, Wei-Jun Chen & Feng Ling TYH-2526 (IBSC); ibid. 20 March 2022 (fl.), Wei-Jun Chen TYH-2561 (IBSC).

**Discussion**

This new species is the second native species reported from China, and it differs from previously recorded species, i.e., *Erythroxylum sinense*, in having leathery (vs. chartaceous) leaf blades with faintly visible (vs. prominent) veins and white (vs. pinkish) petals with sub-rectangular (vs. ligule-like) appendages.

*Erythroxylum* species, especially *E. coca* Lam. and *E. novogranatense*, are well known for their tropane alkaloids, such as cocaine (Aynilian et al. 1974). According to Lv et al. (2022), 383 compounds, including diterpenes, triterpenes, flavonoids, alkaloids, and other derivates, have been found in 67 *Erythroxylum* species. Investigating this new taxon for its phytochemical constituents could lead to the discovery of novel sources of these compounds, as well as possibly new compounds unknown to science.

**Acknowledgements**

We are grateful to Mr. Feng Ling and Mr. Yue-Yao Liu for their help during field trips. Our thanks also go to the curators of IBSC for allowing us to examine their specimens. This study was funded by the Guangdong Provincial Special Fund for Natural Resource Affairs on Ecology and Forestry Construction with the project “Survey of Woody Plant Germplasm Resources in Guangdong”, the National Survey of Traditional Chinese Medicine Resources from National Administration of Traditional Chinese Medicine (grant no. GZY-KJS-2018-004) and Forestry Science and Technology Innovation Specific Project of Guangdong Province (grant no. 2018KJCX002).

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