

## A New Combination and a New Synonym in *Anna* (Gesneriaceae) Postprint

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### Abstract

Since its establishment in 1930, the genus *Anna* Pellegr. has received few taxonomic revisions. Early species publications and revisions were based on collected specimens, resulting in problems such as brief or inaccurate character descriptions and ambiguous species delimitation. Through historical investigation, morphological comparison, and survey of type localities of *Anna ophiorrhizoides* (Hemsl.) B.L.Burt & R.A.Davidson and *Anna rubidiflora* S. Z. He, F. Wen & Y. G. Wei, the authors discovered that *Didymocarpus cavaleriei* H. Lév., published by H. Lévillé in 1911, is conspecific with *Anna rubidiflora*, with the former having been treated as a synonym of *Anna ophiorrhizoides*. After comparing morphological characters of multiple populations and collating geographical distribution information of *Anna ophiorrhizoides* and *Anna rubidiflora*, it was found that although certain morphological differences exist between the two, using corolla color alone as the boundary for species-level taxa is inappropriate. Considering both morphological and geographical distribution characters, it is proposed that *Anna rubidiflora* be treated as a variety of *Anna ophiorrhizoides*. In accordance with the provisions and recommendations of the International Code of Nomenclature for algae, fungi, and plants (2018), this paper proposes a new combination and rank: *Anna ophiorrhizoides* (Hemsl.) B. L. Burt & R. A. Davidson var. *cavaleriei* (H.Lév.) X. X. Bai & F. Wen, with *Anna rubidiflora* treated as a synonym of the new combination.

### Full Text

### Preamble

A New Combination and New Synonym of *Anna* Pellegr. (Gesneriaceae)

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## Abstract

Since its establishment in 1930, the genus *Anna* has undergone few taxonomic revisions. Early species descriptions and revisions were based on herbarium specimens, which resulted in problems such as brief or inaccurate trait descriptions and ambiguous species delimitation. Through historical investigation, morphological comparison, and type locality surveys of *Anna ophiorrhizoides* (Hemsl.) B.L.Burt & R.A.Davidson and *A. rubidiflora* S.Z. He, F. Wen & Y.G. Wei, we discovered that *Didymocarpus cavaleriei* H. Lév., published by H. Léveillé in 1911, is conspecific with *A. rubidiflora*, though it had previously been treated as a synonym of *A. ophiorrhizoides*. After comparing morphological characteristics across multiple populations of *A. ophiorrhizoides* and *A. rubidiflora*, we found that while certain morphological differences exist, using corolla color alone as the criterion for species-level delimitation is inappropriate. Considering both morphological and geographical distribution characteristics, we propose treating *A. rubidiflora* as a variety of *A. ophiorrhizoides*. In accordance with the regulations and recommendations of the 2018 *International Code of Nomenclature for Algae, Fungi, and Plants* (Shenzhen Code), we propose a new combination and name at new rank: *Anna ophiorrhizoides* (Hemsl.) B. L. Burt & R. A. Davidson var. *cavaleriei* (H.Lév.) X. X. Bai & F. Wen, with *Anna rubidiflora* treated as a synonym of this new combination.

**Keywords:** *Anna*; *Anna rubidiflora*; *Anna ophiorrhizoides*; new combination; new synonym

## Introduction

The genus *Anna* Pellegr. was established in 1930 by French botanist Pellegrin (1930) based on *Anna submontana* Pellegr. It belongs to the tribe Trichosporeae of the subfamily Didymocarpoideae in the family Gesneriaceae. The genus currently comprises four species distributed in Guangxi, Yunnan, Guizhou, Sichuan, and northern Vietnam, typically growing in mid- to high-altitude shaded forests on slopes and in limestone habitats (Li & Wang, 2005; Wei et al., 2010). Since its establishment, taxonomic revisions of *Anna* have been scarce. British botanist B. L. Burt revised the genus in the mid-20th century, proposing a classification system for the subfamily Didymocarpoideae with five tribes and a generic key. Due to his failure to observe the hair-like appendages at both ends of *Anna*

seeds, Burttt placed the genus in the tribe Didymocarpeae (Burttt, 1962). It was not until 1982 that Wang Wencai, upon examining specimens, discovered that the two species in this genus each have a short hair at each end of their seeds, leading to the placement of *Anna* in the tribe Trichosporeae (Wang & Pan, 1982; Wang et al., 1990; Wang et al., 1998). Some early *Anna* species were described based on specimens with brief trait descriptions, reflecting the limitations of their time and resulting in missing important taxonomic information that hindered further research. Against this background, examining type specimens and conducting type locality surveys combined with investigations of extant populations represents a scientifically sound approach for resolving questionable species.

This study focuses on *Anna* resources in Guizhou Province. Through literature review and field surveys, we identified certain problems in the publication and taxonomic treatment of *A. rubidiflora*. Based on the original literature and type specimens of *Didymocarpus cavaleriei*, which had been treated as a synonym of *A. ophiorrhizoides*, as well as extensive field investigations, we conclude that *D. cavaleriei* published by H. Léveillé in 1911 is conspecific with *A. rubidiflora* described by Wei et al. (2013). However, after comparing plant characteristics across multiple populations of *A. ophiorrhizoides* and *A. rubidiflora*, we find that many morphological features show no significant differences, and using corolla color alone as the basis for species delimitation is inappropriate. Considering their geographical distribution patterns, we propose treating *A. rubidiflora* as a variety of *A. ophiorrhizoides*.

## Materials and Methods

We examined the original literature and related materials for both *A. ophiorrhizoides* and *A. rubidiflora*, carefully comparing specimens and morphological descriptions from the original texts (Table 1 ). We also consulted specimen images and distribution information from the Chinese Virtual Herbarium (<https://www.cvh.ac.cn/>). Simultaneously, we conducted extensive field surveys in the type localities and surrounding areas of *A. ophiorrhizoides*, *Didymocarpus cavaleriei*, and *A. rubidiflora*, recording population distribution patterns. Literature sources were primarily obtained from IPNI (<http://www.ipni.org>), Internet Archive (<https://archive.org>), Plant Ecology and Evolution (<http://www.plecevo.eu>), and other websites.

## Results and Analysis

### Historical Taxonomic Background

In 1890, British botanist Hemsley (1890) described a new species, *Lysionotus ophiorrhizoides* Hemsl., based on specimens collected by Faber from Mount Emei in Sichuan. The original description indicated two fertile stamens, but in 1955, B. L. Burttt and R. A. Davidson requested J. R. Sealy to carefully examine the type specimen housed at Kew (K), which confirmed the presence of four fertile

stamens, leading to its transfer to *Anna* as the second species in the genus, *A. ophiorrhizoides* (Burt & Davidson, 1955).

In 1911, French botanist H. Léveillé (1911) described a new species in the genus *Didymocarpus* Wall., naming it *Didymocarpus cavaleriei* H. Lévl. based on specimens collected by French missionary J. Cavalerie in 1905 from western Lo-fou (Luodian). Cavalerie's specimen number 2555 was cited in the publication, though no holotype was designated. Careful examination of Cavalerie 2555 (E00387551) preserved at the Royal Botanic Garden Edinburgh (E) reveals branchlets with ridges, stems with distinct nodes and internodes up to 5.5 cm long, opposite leaves that are slightly unequal within pairs and short-petioled, leaf blades lanceolate-oblong or lanceolate and oblique, subapical axillary inflorescences, and corollas 4.6 cm long—all features consistent with *Anna*. Detailed observation of the holotype of *A. ophiorrhizoides*, Faber E. 872 (K000898142), at Kew shows no differences from Cavalerie 2555 in stem nodosity, leaf arrangement, or inflorescence position. In 1958, after careful examination of specimens at E, B. L. Burt (1958) concluded that *Didymocarpus cavaleriei* should belong to *Anna*, but lacking information on corolla color, he considered it conspecific with *A. ophiorrhizoides* and synonymized *D. cavaleriei* under that species, citing Cavalerie 2555 at E. In 1975, Wang Wencai, believing that establishing *Anna* as a new genus based solely on differences in bract characteristics from *Didissandra* C. B. Clarke was inappropriate, transferred *A. ophiorrhizoides* to *Didissandra* as *D. sinophiorrhizoides* W.T.Wang (Wang, 1975). Later, Wang Wencai (1982) reinstated *Anna* based on the characteristic feature of a short hair at each end of the seeds, placing the genus in the tribe Trichosporeae and restoring the name *A. ophiorrhizoides*, with *Didymocarpus cavaleriei* continuing to be recorded as its synonym.

In September 2009, Wei et al. discovered a *Anna* species in Zijiang Gorge, Kaiyang County, Guizhou Province, which was subsequently described as a new taxon, *Anna rubidiflora* (Wei et al., 2013). This species is morphologically similar to *A. ophiorrhizoides* but was distinguished by several features: *A. rubidiflora* has larger plants that are unbranched or rarely branched (vs. smaller, highly branched plants in *A. ophiorrhizoides*), terminal cymes with 2-3 flowers per inflorescence (vs. subapical axillary cymes with 3-4 flowers), reddish-purple corollas (vs. white or pale pink), and four decussate bracts (vs. two free bracts).

Through study of the original literature and type specimen of *Didymocarpus cavaleriei*, we found that H. Léveillé's 1911 protologue described the corolla color as "corolla ventricosa" (purple corolla), matching the reddish-purple corolla of *A. rubidiflora*. In September 2022, during surveys in Lo-fou and surrounding areas, we discovered a population matching *D. cavaleriei* in Lewang Town, Wangmo County, adjacent to western Luodian. Detailed comparison revealed no essential difference from *A. rubidiflora* at the type locality (Figure 2 [Figure 2: see original paper]). Historical documents of Guizhou Province and *Toponymic Studies of Sichuan, Yunnan, and Guizhou* indicate that eastern Wangmo County was originally under the jurisdiction of Luohu Zhoupan, which gradually evolved

into present-day Luodian County through subsequent administrative changes (Cen, 2018). Furthermore, based on the protologue and careful examination of morphological features of the type specimen, we compared plant, leaf, calyx, and corolla characteristics between *D. cavaleriei* and *A. rubidiflora* (Table 1), finding no clear morphological traits that effectively separate the two taxa.

Through historical investigation, morphological comparison, and type locality surveys, we confirm that these represent the same species published independently.

**Table 1** Comparison of morphological traits between *Didymocarpus cavaleriei* and *Anna rubidiflora*

Character	<i>Didymocarpus cavaleriei</i>	<i>Anna rubidiflora</i>
Branching	Branched, angulate, nodose, longest internode 5.5 cm	Simple or upper branched, inconspicuously angulate
Leaf blade	Opposite, lanceolate-oblong or lanceolate, apex acuminate, margin indistinctly denticulate, villosula ferruginea	Opposite, lanceolate or narrowly lanceolate, apex caudate-acuminate or acuminate, entire or margin indistinctly denticulate
Leaf size (cm)	4-8.5 × 1.2-2.2	5-12.5 × 1.5-2.8
Petiole	Short, 0.5-1.5 cm	Short, 0.4-2.0 cm
Calyx segments	Apex rotund, venose, pale red	Apex rotund, without nerve or extremely unapparent 5-nerves
Inflorescence	Axillary, close to top	Axillary, close to top
Corolla color	Ventricosa (purple)	Reddish-purple
Corolla size (cm)	c. 4 × 1	4.0-4.7 × 1-1.4
Corolla	Glabrous, venose, lobes obtuse	Glabrous, venose, every lobe with 3 dark purple stripes, lobes suborbicular

**Figure 1.** Holotype of *D. cavaleriei* and holotype of *A. ophiorrhizoides* [Figure 1: see original paper]

**Figure 2.** Comparison of *Didymocarpus cavaleriei* and *Anna rubidiflora* [Figure 2: see original paper]

## Population-Level Investigations

In recent years, extensive surveys of Gesneriaceae resources in Guizhou have located *A. rubidiflora* populations in karst regions of Longli, Jinsha, Dafang, Huaxi, Wangmo, Majiang, and Kaiyang counties, while *A. ophiorrhizoides* populations are mainly distributed in danxia landforms of southwestern Sichuan and northwestern Guizhou (Chishui and Xishui counties). Comparison of morphological features among numerous populations revealed that some diagnostic characters are not stable. *Anna rubidiflora* plants are often branched in the upper portion, leaves are entire or indistinctly denticulate, inflorescences are subapical axillary with 3–4 flowers per cyme, and bract number is two, opposite—showing no clear differences from *A. ophiorrhizoides* in peduncle, involucre, or calyx features (Figure 3 [Figure 3: see original paper]). Examination of specimens from southern and central Guizhou in the Chinese Virtual Herbarium (CVH) shows most identified as *A. ophiorrhizoides*, with morphological distinction based on specimens alone being difficult, yet field surveys consistently revealed *A. rubidiflora* populations in these collection areas.

Geographic distribution data reveal that *A. ophiorrhizoides* primarily occupies the transition zone from the northern Yunnan-Guizhou Plateau to the Sichuan Basin, while *A. rubidiflora* is mainly distributed across the Guizhou Plateau. No overlapping distributions have been found, though some continuity exists in the northwestern Guizhou mountain gorge subregion of the Guizhou Plateau. B. L. Burt's 1958 synonymization of *D. cavaleriei* under *A. ophiorrhizoides* was understandable given the context of his time, but current evidence supports treating *A. rubidiflora* as an infraspecific taxon. First, their geographic distribution patterns suggest population differentiation within their respective ranges. Second, comparison of multiple populations reveals extremely stable morphological differences, with *A. rubidiflora* consistently exhibiting reddish-purple corollas.

In summary, according to the regulations and recommendations of the 2018 *International Code of Nomenclature for Algae, Fungi, and Plants* (Turland et al., 2018), we propose treating *A. rubidiflora* as a variety of *A. ophiorrhizoides*, establishing the new combination and name at new rank: *Anna ophiorrhizoides* (Hemsl.) B. L. Burt & R. A. Davidson var. *cavaleriei* (H. Lév.) X. X. Bai & F. Wen, with *Anna rubidiflora* as its synonym.

## Taxonomic Treatment

*Anna ophiorrhizoides* (Hemsl.) B.L.Burt & R.A.Davidson var. *cavaleriei* (H.Lév.) X.X.Bai & F.Wen, **comb. & stat. nov.**

—*Didymocarpus cavaleriei* H.Lév. in Fedde, Repertorium Specierum Novarum Regni Vegetabilis 9: 453. 1911, non *Diddissandra cavaleriei* H. Lév. & Vant.

**Type:** China. Guizhou Province: Lo-fou, 9 November 1905, J. Cavalerie 2555 (holotype: E00387551)

= *Anna rubidiflora* S.Z.He, F.Wen & Y.G.Wei in *Plant Ecology and Evolution* 146(2): 203-211. 2013. **syn. nov.**

**Type:** China, center of Guizhou province, Zijiang gorge, Kaiyang county, grows on cliffs under forests along the road, alt. 1,000–1,020 m, 18 August 2009, Shun-Zhi He 090818 (holotype: HGCM; isotype: IBK; image: electronic appendix).

**Diagnosis:** Differs from the typical variety in having reddish-purple corolla color.

**Distribution and habitat:** Kaiyang, Wangmo, Jinsha, Dafang, Longli, Duyun, Huaxi, Fuquan, Majiang, and Anlong counties in Guizhou Province. Grows on rocks and in forests on shaded slopes at elevations of 460–1,500 m.

**Additional specimens examined:** China, Guizhou Province: Anlong County, alt. 460 m, 19 October 1930, Y. Tsiang 7397 (IBSC); Duyun City, alt. 730 m, 20 March 1930, Y. Tsiang 5952 (IBSC); Majiang County, alt. 1,500 m, 20 May 1999, An Mingtai 990024 (GFS); Suiyang County, alt. unknown, 10 February 2015, An Mingtai et al. 2015-0128 (GZAC); alt. unknown, 10 September 2015, Suiyang Team 520323150910402LY (GZTM); Kaiyang County, alt. 1,000 m, 18 August 2021, BXX20210818 (GZAC); Wangmo County, 20 September 2022, alt. unknown, BXX20220920 (GZAC); Longli County, alt. 1,270 m, 13 September 2023, BXX20230913 (GZAC); Dafang County, alt. 1,350 m, 24 August 2020, BXX20200824 (GZAC); Jinsha County, alt. 1,040 m, 9 September 2021, BXX20210909 (GZAC).

## Discussion

Most early Chinese Gesneriaceae species were named and published by Western botanists based on herbarium specimens. However, publishing based on pressed specimens has many limitations, such as failing to reflect the extent and patterns of individual variation within populations, loss of important features because specimens represent only partial rather than entire plants, and deformation or loss of characters during specimen pressing and preservation (Chen & Wang, 1986). For widely distributed groups with large variation, specimens provide limited information, making population-level investigations crucial. Extensive population surveys and comparisons enable more accurate assessment of individual variation within species, facilitating species identification, differentiation of closely related taxa, and comprehensive analysis to identify morphological characters with taxonomic value. Academician Hong Deyuan (2016) proposed that rational species delimitation should embrace the population concept, which should also be reflected in herbarium studies. Characters extracted from few specimens cannot fully represent a species; to understand individual variation, analysis of numerous specimens from different populations is required.

The value of population concepts and research methods in taxonomy is also evident in infraspecific classification, particularly in the treatment of varieties and subspecies. Since their recognition as infraspecific categories in 1867, no unified

standard for distinguishing between subspecies and varieties has been established. The concept of “subspecies” emphasizes geographic isolation leading to reproductive isolation within species, with these special geographic distribution areas often resulting in greater distinction from typical varieties; this concept is more widely used in zoological and microbial classification. The concept of “variety” emphasizes stably inherited morphological differences arising from different microhabitats within the same distribution area. In botany, “variety” is used in many situations: considering only morphological variation regardless of geographic distribution, morphological variation with special geographic distribution, or even just differences in color and locality (Hu, 1958). Perhaps due to its long and widespread usage, “variety” is the most commonly used infraspecific category in plant classification (Gao, 2017).

Based on surveys of Gesneriaceae resources in Guizhou, *A. rubidiflora* is currently found mainly in the karst plateau region from southern to northwestern Guizhou, while *A. ophiorrhizoides* is primarily distributed in the danxia landform areas of the transition zone from the Sichuan Basin to the plateau in southwestern Sichuan and northwestern Guizhou. Geographic continuity exists in the northwestern Guizhou mountain gorge subregion of the Guizhou Plateau, though no overlapping distributions have been observed to date; more comprehensive surveys are needed. Both taxa mostly grow in mid- to high-altitude mountain gorges and lowland river valleys within subtropical humid monsoon climate zones with high humidity. The currently recognized difference lies in their landform types: karst landforms have distinctly alkaline soils with extremely high calcium content, whereas danxia landforms have more acidic soils with extremely high potassium content (Yu et al., 2019). These two landform types are interspersed across southwestern China, and the heterogeneous habitats they create, particularly soil heterogeneity, may have promoted differentiation and adaptation in this species.

**Figure 3.** *Anna ophiorrhizoides* [Figure 3: see original paper]. A. Habitat; B. Flowering plant; C, D. Flower; E. Stem and phyllotaxy; F. Leaves; G. Stamens; H. Dissected flower: stamens and pistils; I. Sepals.

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