



## Systematics of *Berberis* sect. *Wallichianae* (Berberidaceae) of Taiwan and Luzon with description of three new species, *B. schaaliae*, *B. ravenii*, and *B. pengii*

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### Abstract

*Berberis* sect. *Wallichianae* are species of evergreen shrubs that in Taiwan are found in subalpine and montane-temperate areas and which have a notoriously controversial taxonomic history. Based on multivariate statistical analyses of morphometric data and an explicitly stated species criterion, the taxonomy of the group in Taiwan and its close relative in Luzon (*B. barandana*) is revised and their endemism is evaluated by molecular data. In addition to the six species recognized in the Flora of Taiwan, 2<sup>nd</sup> ed. (i.e., *B. aristatoserrulata*, *B. brevisepala*, *B. chingshuiensis*, *B. kawakamii*, *B. mingetsensis*, and *B. tarokoensis*), *B. hayatana* (synonymized under *B. mingetsensis*) and *B. nantoensis* (synonymized under *B. brevisepala*) are reinstated, and three new species (*B. pengii*, *B. ravenii*, and *B. schaaliae*) are described and illustrated. Phylogenetic analyses using three chloroplast DNA sequence regions (*rbcL*, *ycf6-psbM*, and *psbA-trnH*) place all Taiwanese species and *B. barandana* in a strongly supported clade derived from within the continental Asian species of sect. *Wallichianae*, indicating their independent evolutionary history and supporting their endemic status.

**Key words:** chloroplast phylogeny, General Lineage Concept of species (GLCS), herbarium taxonomy, multivariate statistical analyses

### Introduction

Plants of the traditionally defined barberry genus, *Berberis* Linnaeus (1753: 330; *Berberis s.s.*), are simple-leaved shrubs or rarely small tree-like bushes known for their characteristic 1–5-armed spines or spiniform structures at the stem nodes (Ahrendt 1961, Landrum 1999, Adhikari *et al.* 2012, Pabón-Mora & González 2012). With an estimated number of species ranging from 400 to 500, *Berberis s.s.* occurs widely across temperate, alpine, or semi-arid habitats of the Northern Hemisphere, with a secondary center of species diversity in the South American Andes (Ahrendt 1961, Landrum 1999, Adhikari *et al.* 2012, Harber 2012). Some recent treatments of *Berberis* (e.g., Laferrière 1997, Marroquín & Laferrière 1997, Whittemore 1997, Stevens 2001 onwards), however, favor the inclusion of the ca. 100–200 species (Ahrendt 1961) of the compound-leaved *Mahonia* Nuttall (1818: 211) within *Berberis* (i.e., *Berberis s.l.*), as supported by molecular phylogenetic studies (Kim & Jansen 1998, Kim *et al.* 2004, Adhikari 2010). Together with ca. 500–600 species, *Berberis s.l.* is the largest woody plant genus of the basal eudicots (Frodin 2004).

### Taxonomic history of *Berberis* sect. *Wallichianae* of Taiwan

Within *Berberis s.s.*, species characterized by evergreen and coriaceous leaves, fascicled or solitary flowers, and blue-black to black fruits have long been assigned to section *Wallichianae* Schneider (1905: 400; Schneider 1939, 1942, Ahrendt 1941, 1961, Chamberlain & Hu 1985, Harber 2012), a prominent group comprising more than 75 taxa distributed in highlands and mountains of India, Nepal, Bhutan, Myanmar, Vietnam, China, Taiwan, Java, Sumatra, and Luzon (Chamberlain & Hu 1985, Harber 2012). Across the distributional range of sect. *Wallichianae*, the species in Taiwan have attracted much attention for their extensive morphological variation (Mizushima 1954, Ahrendt 1961, Chamberlain & Hu 1985). The extent of morphological diversity of the group in Taiwan was first recognized by Ahrendt (1941) and Schneider (1942) and later summarized in Ahrendt's (1961) monograph where the seven recognized Taiwanese species were placed in six subsections. In contrast to Ahrendt's (1961) treatment, however, Chamberlain & Hu (1985) recognized only four species in Taiwan, all placed in the series *Barandanae* (Schneider) Chamberlain & Hu (1985: 538) of the subsection *Wallichianae*. The various classifications of the Taiwanese *Berberis* sect. *Wallichianae* are summarized in Table 1.

**Notes:** The original set of Vidal's specimens in Manila, including the holotype of *Berberis barandana* (Vidal 1911), was destroyed in a fire in 1897 (Stafleu & Cowan 1986, Calabrese & Velayos 2009). In revising the genus, Ahrendt (1961: 65) designated an isotype at K as the lectotype ("Type K"), rendering the isotypes at MA (Calabrese & Velayos 2009) and A as isolectotypes. This Filipino endemic species had been allied with *B. kawakamii* (Merrill 1923); however, *B. barandana* can be easily distinguished from the latter by its ovate outermost sepals. LaFrankie (2010) also documents an unauthenticated report of *B. wallichiana* DC. (as *B. 'wallichii'*) in the Philippines as well as a possible new species from Zambales Mountains, Luzon, neither with any specimen details. However, *B. wallichiana* is endemic to Nepal (Adhikari *et al.* 2010).

**Additional specimens examined:**—PHILIPPINESS. Luzon Island: Benguet Province, Mt. Sto Tomas, 12 October 1904, *Williams 1347* (US), 2440 m, 3 December 1953, *van Steenis s.n.* (PNH), *Walker 7536* (US), 2200 m, 13 May 2006, *Yang 17998* (TNM), Barangay Lab-ang Resthouse Relay Station, 2200 m, 31 January 2012, *Chung 1958* (HAST). Mountain Province, Distr. Lepanto, Mt. Data, November 1905, *Merrill 4506* (US), *4607* (US), 1800 m, 2 April 1946, *Alcasid 7* (PNH), Mt. Data Watershed, 1800 m, 1 February 2012, *Chung 1984* (TAI). Bontoc Province, 26 October 1974, *Apolinaro 251* (UPLB). Mt. Nangaoto, 2300 m, 23 February 1948, *Sulit 2529* (PNH). Mt. Pauai, 5 February 1948, *Sulit 2351* (PNH), 2250 m, 28 April 1960, *Sulit 10733* (UPLB), *10734* (UPLB). Mt. Pulog, January 1909, *Curran et al. 80140-2* (US), 2900 m, 11 March 1948, *M. Celesto s.n.* (PNH), 2650 m, 12 June 1965, *Poicho 19829* (UPLB), *19808* (UPLB).

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