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Taxonomic revision of the genus *Pseudocodon* (Campanulaceae) based on character analysis and molecular phylogeny

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Abstract

All taxa of the newly established genus *Pseudocodon* (= *Codonopsis* subg. *Pseudocodonopsis*), except for *Pseudocodon rosulatus*, form a complicated group extremely controversial on species delimitation. In the present study, numerous field trips were made, 29 populations were observed, and over 800 specimens of the genus preserved in 18 herbaria were critically examined. Statistical analysis of the characters was carried out based on 148 samples from specimens and 16 field populations. Four fragments of chloroplast DNA (*atpB*, *matK*, *rbcL*, *petD* with *petB-petD* spacer) and *ITS* of nuclear DNA were used in the molecular phylogenetic analysis of 40 samples from specimens and 22 field populations. A taxonomic revision of the genus *Pseudocodon* is presented on the basis of these studies. We recognize eight species: *Pseudocodon convolvulaceus*, *Pse. graminifolius*, *Pse. grey-wilsonii*, *Pse. hirsutus*, *Pse. petiolatus*, *Pse. retroserratus*, *Pse. rosulatus*, and *Pse. vinciflorus*. In the present study, one new species and one new subspecies are described, and one new combination is made. In addition, nine taxa are treated as synonyms, and six lectotypes are designated.

Key words: morphology, multivariate statistical analyses, phylogenetics, population sampling, taxonomy

Introduction

Pseudocodon Hong & Sun (in Wang *et al*. 2014: 546) is a newly established genus in the Campanulaceae. This new genus is distributed in the Himalaya and SW China, from central Nepal eastward to S Yunnan and W Guizhou. *Pseudocodon* was treated as a subgenus (Shen & Hong 1983; Hong *et al*. 2011) of *Codonopsis* Wallich (1824: 103), i.e. *Cod.* subg. *Pseudocodonopsis* Komarov (1908: 102). However, *Pseudocodonopsis* is distinct from *Codonopsis* in a number of morphological characters. For example, it possesses a rotate corolla, globose (rarely elongated) roots, flowers without nectary disc, and a unique type of filaments. Wang *et al.* (2014) raised *Cod.* subg. *Pseudocodonopsis* to the generic rank based on molecular phylogenetics, palynology, cytology, and analysis of morphological characters.

The delimitation of species in *Pseudocodon* has been problematic and highly controversial. Within *Pseudocodon*, only *Pseudocodon rosulatus* (W. W. Smith) Hong in Wang *et al*. (2014: 548) (= *Cod. rosulata* Smith [1921: 157–158]) is clearly distinct from all the other species, and has been continuously recognized as such. In contrast, taxonomic treatments of the other 14 described taxa have long been controversial (Table 1). For the sake of convenience of discussion, we here use the term '*Cod. convolvulacea* complex' to cover all 14 of these taxa. This extremely complicated '*Cod. convolvulacea* complex' comprises *Cod. convolvulacea* Kurz (1873: 195), *Cod. efilamentosa* Smith (1913: 107–108), *Cod. forrestii* Diels (1912: 171), *Cod. forrestii* var. *heterophylla* Wu in Wu & Li (1965: 80), *Cod. forrestii* var. *hirsuta* Tsoong & Shen in Shen *et al.* (1975: 55), *Cod. graminifolia* Léveillé (1916: 24), *Cod. grey-wilsonii* Shaw (1996: 93), *Cod. limprichtii* Lingelsheim & Borza (1914: 391–392), *Cod. limprichtii* var. *hirsuta* Handel-Mazzetti (1924: 169), *Cod. limprichtii* var. *pinifolia* Handel-Mazzetti (1924: 170), *Cod. macrophylla* Lammers & Klein (2010: 557–558), *Cod. mairei* Léveillé (1916: 24), *Cod. retroserrata* Wang & Xu (1993: 186), and *Cod. vinciflora* Komarov (1908: 103–104).

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to rounded, apex obtuse to acute, 2–3.5 cm long, 1.5–2.5 cm wide, margin entire to shallowly crenulate. Flowers solitary, terminal on main stem. Hypanthium obtriangular; calyx lobes 5, strongly reflexed even at anthesis, linear-lanceolate, entire, 7–9 mm long, 3–3.5 mm wide. Corolla blue, 5-lobed to near base, rotate; corolla lobes elliptic, ca 2 cm long, 1 cm wide. Stamens free; filaments 4 mm long, basal part strongly dilated into triangular, ciliate; anthers 4 mm long. Ovary inferior; style glabrous, ca 2 mm long; stigma 3-fid, stigma lobes elliptic-oblong, ca 4 mm long, 2.5 mm wide. Fruit unknown.

Pseudocodon petiolatus differs distinctly from all other species of the genus in having elongate roots, long petioles, strongly reflexed calyx lobes, and large stigma lobes.

Distribution:—Endemic to China: SW Sichuan.

8. *Pseudocodon rosulatus* (W. W. Smith) Hong in Wang *et al.* **(2014: 548).** *Codonopsis rosulata* Smith (1921: 157). Type:—CHINA. Sichuan, Muli, 28°12′N, 3350 m, August 1918, *G. Forrest 16856* (holotype E).

Distribution:—Endemic to China: SW Sichuan.

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