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Codonopsis gongshanica (Campanulaceae), a new species from NW Yunnan based on morphology and molecular phylogenetic analysis

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Abstract

In the present study, a new species *Codonopsis gongshanica* is described. This species is endemic to Gaoligong Mountains of NW Yunnan. *Codonopsis gongshanica* is similar to *Codonopsis bhutanica* and *Codonopsis subsimplex* in morphology, but it can be separated from these species by its simple stem, sub-rosulate leaves, short petiole, solitary flower, and diagnostically dark purple ring just below the corolla throat. Our molecular phylogenetic analysis based on chloroplast DNA fragments (*atpB*, *matK*, *rbcL*, *petD* with *petB-petD*, and *psbA-trnH*) shows that the new species is well recognized in our molecular tree, with its taxonomic position revealed.

Key words: Gaoligong Mountains; new taxon; phylogeny; systematic position; taxonomy

Introduction

Our recent studies (Hong & Pan 1998, 2012, Wang *et al.* 2013, Wang *et al.* 2014a) confirm the merger of *Campanumoea* Blume (1826: 726) and *Leptocodon* (Hook. f. & Thomson) Lemaire (1856: 49) to *Codonopsis* Wallich (1824: 103), the restoration of *Cyclocodon* Griff. ex Hook. f. & Thomson (1858: 18) as an independent genus, and the segregation of three new genera (*Himalacodon* D. Y. Hong & Q. Wang in Wang *et al.* (2014a: 548), *Pankycodon* D. Y. Hong & X. T. Ma in Wang *et al.* (2014a: 549), and *Pseudocodon* D. Y. Hong & H. Sun in Wang *et al.* (2014a: 546)) from *Codonopsis*. Based on molecular phylogenetics, molecular dating, and biogeographic analysis, we discussed the biogeographic events and character evolution of *Codonopsis* and its allies (Wang *et al.* 2014b). Currently, Hong (the co-author of the present article) has finished his worldwide taxonomic revision of *Codonopsis*, and he recognized 46 species in his unpublished monograph.

To prepare for the worldwide taxonomic revision of *Codonopsis*, and for the 'Flora of Pan-Himalaya', we have made numerous field trips to the whole distribution range of *Codonopsis* since 2010, especially to the Himalaya and Hengduan Mountains region with concentration on observing *Codonopsis*. When we made an expedition to the Gaoligong Mountains of NW Yunnan province in August 2013, we found a large population of an unknown species in *Codonopsis*, with more than 100 individuals. It was in a thicket at an altitude of ca. 3800 m. This entity is characterized by pale, shallowly lobed, and shortly tubular corolla, and by sub-rosulate leaves. It was inferred to be a new species when we found it. To confirm its status of new species and to clarify its systematic position in *Codonopsis*, we randomly sampled 3 individuals of the new species, and collected silica-gel dried leaves for molecular phylogenetic analysis.

Material and methods

The molecular phylogenetic analysis was conducted on 30 samples representing three randomly sampled individuals of the inferred new species and 27 allied species. The sampled taxa covered more than half the species number of *Codonopsis*, and the four genera separated from *Codonopsis*, including *Cyclocodon*, *Himalacodon* (= *Codonopsis*

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Roots carrot-shaped, 9–25 cm long, 0.4–1.3 cm in diameter. Stems erect, simple, very rarely with branches in lower and middle parts, 20–45 cm long, glabrous or sparsely villous at base. Leaves alternate, sub-rosulate; petiole 0.2–0.5 cm long, glabrous; leaf blade broadly ovate, ovate or lanceolate, 1.7–3 cm long, 0.6–1.7 cm wide, glabrous, base cuneate, apex slightly obtuse, margin entire to slightly sinuate. Flowers solitary, terminal on the main stem. Calyx tube entirely adnate to hypanthium; calyx lobes lanceolate, 0.5–0.7 cm long, 1.4–2.6 mm wide, apex obtuse, margin entire or slightly sinuate. Corolla shortly tubular, 0.9–1.3 cm long, 0.6–0.9 cm wide, grey or slightly pale purple, glabrous, shallowly lobed to ca. 1/6, with a dark purple ring just below throat; corolla lobes ovate-deltoid. Stamens glabrous; filaments slightly dilated at base, 4–6 mm long; anthers 1–2 mm long. Fruit unknown.

Phenology:—Flowering in July and August; fruiting in September.

Habitat:—Alpine scrubs at altitudes of 3400–4600 m.

Distribution:—Endemic to China: Yunnan, N Gaoligong Mountains.

Key to *Codonopsis gongshanica* and its allies

1. Corolla campanulate, 1.7–5.5 cm long; reticulate veins present on corolla surfaces 2
– Corolla tubular, 0.9–2 cm long; veins absent on corolla surfaces 5

2. Vines; corolla campanulate, 3.3–5.5 cm long, ca. 3 cm wide; calyx lobe linear-lanceolate. ..... *Codonopsis farreri*
– Herbs erect or scandent; corolla broadly campanulate, 1.7–4 cm long and 1–4 cm wide; calyx lobes ovate or ovate-triangular..... 3

3. Leaf blade deltoid-ovate or broadly ovate..... *Codonopsis deltoidea*
– Leaf blade non-deltoid..... 4

4. Stem branched; leaves non-rosulate, 1.5–3.5(–5) cm long, 1.3–3 cm wide; leaf base slightly cordate or rounded. ..... *Codonopsis viridiflora*
– Stem simple; leaves sub-rosulate, 3–11 cm long, 1.5–3.8 cm wide; leaf base cuneate..... *Codonopsis meleagris*

5. Stems erect, mostly simple; leaves sub-rosulate; leaf base cuneate, margins entire to slightly sinuate; corolla grey or slightly pale purple, lobed to ca. 1/6, with a pale amaranthine ring below throat. ..... *Codonopsis gongshanica*
– Stems procumbent, ascending or trailing, always branched at lower and middle parts; leaves non-rosulate; leaf base cordate, or rounded, margins crenate, dentate, or recurved; corolla pale yellow, yellow-green or pale blue, lobed to 1/4 or 1/3, without rings. 6

6. Leaf base cordate, margins recurved; corolla lobed to ca. 1/3 ..... *Codonopsis bhutanica*
– Leaf base rounded or cuneate, margins crenate or dentate; corolla lobed to ca. 1/4 ..... *Codonopsis subsimplex*

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