

## *Cephalanthera exigua* (Orchidaceae), a new species and genus in the flora of Vietnam

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*Summary:* The discovery of *Cephalanthera exigua* (Orchidaceae), a rare mycoheterotrophic species, is reported from southern Vietnam, Lam Dong province, representing a new specific and generic record for the flora of Vietnam. It also significantly expands the knowledge about the distribution area of this species. Problems of phylogeny, taxonomy and species identity within the Asian group of achlorophyllous species of the genus *Cephalanthera* are discussed. Morphological description of the Vietnamese plant including first detailed photos of flower structure of *Cephalanthera exigua* is provided. Thai and Vietnamese plants are compared in terms of flower morphology.

*Keywords:* *Cephalanthera exigua*, Orchidaceae, mycoheterotrophic plants, Vietnam, flora, biodiversity, conservation, flower morphology

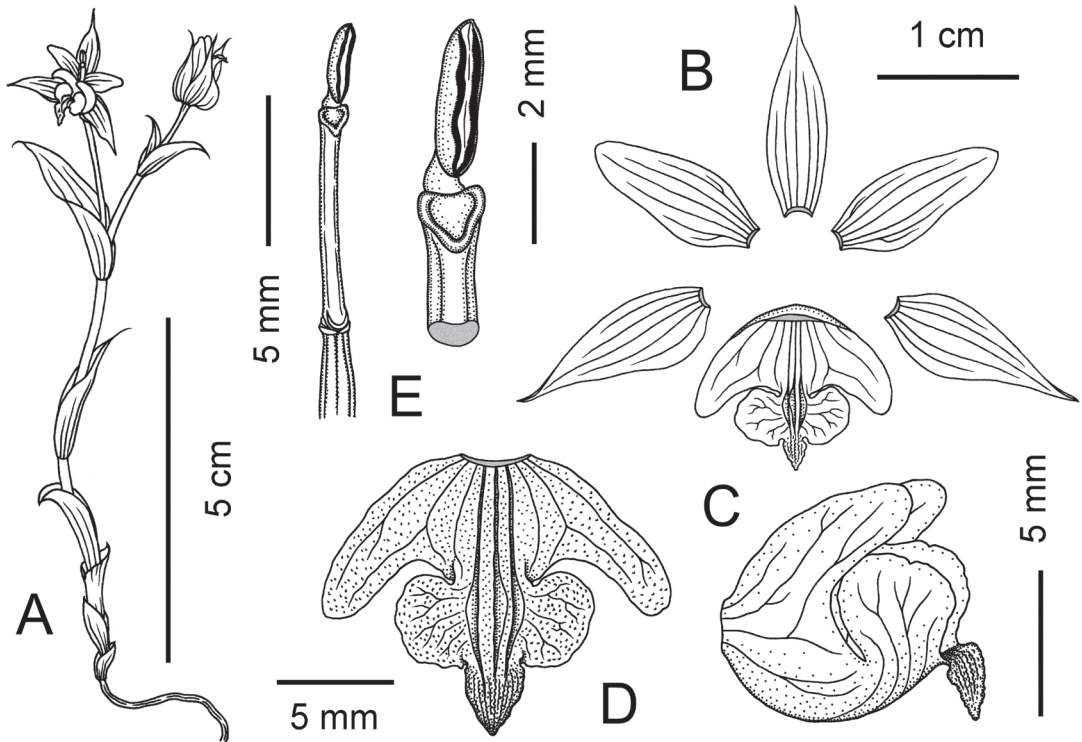
*Cephalanthera* Rich. is a moderately species-rich genus, which comprises about 15 species of terrestrial herbs according to recent treatments (PRIDGEON et al. 2005; CHEN et al. 2009). The genus *Cephalanthera* is well represented in Europe and Asia, with a single species native to North America. To date, species of *Cephalanthera* have never been listed for Vietnam (SEIDENFADEN 1992; SCHUITEMAN & DE VOGEL 2000; PHAM HOANG HO 2000; AVERYANOV & AVERYANOVA 2003; SCHUITEMAN et al. 2008; etc.). Here we report the discovery of *Cephalanthera exigua* Seidenf., an achlorophyllous mycoheterotrophic species, in mountains of southern Vietnam: Lam Dong province, Bao Lam district, Loc Bao municipality, 22.2 km NNW from Bao Loc town at the point N 11°44'19" E 107°43'21", 1000 m a.s.l., in primary broadleaved evergreen forest, near trail, not far from a stream [*Nuraliev 820*, LE]. The population consisted of two above-ground shoots at a distance of 3 cm from each other, probably representing a result of vegetative reproduction. The finding drastically changes the knowledge about the distribution area of *Cephalanthera exigua* since the distance from the Vietnamese population to the nearest of previously known ones (Laos, ca. 950 km) is almost two times larger than the longest distance between previously known populations (ca. 500 km).

Mycoheterotrophic (more precisely, fully mycoheterotrophic (MERCKX 2013)) species of *Cephalanthera* are characterized by reduced leaves and lack of chlorophyll, being almost completely white in both vegetative and generative aboveground parts. Such species are absent from Europe and temperate Asia, but dominate at the southern edge of distribution of the genus in Yunnan province of China, Indochina and Thailand. The Asian species of this group have recently been reviewed in detail by PEDERSEN et al. (2009), who accounted five of them. One additional species, *C. humilis* X. H. Jin (JIN et al. 2011: 598), was described after the publication of that revision. The only American species of the genus, *C. austiniiae* (A. Gray) A. Heller, also belongs to this group (MERCKX et al. 2013).

From the systematic standpoint the genus *Cephalanthera* is distinct from many other orchids with diversification centers in Europe or the Mediterranean Region (e.g. *Ophrys* L., *Dactylorhiza* Neck. ex Nevski, *Epipactis* Zinn sect. *Epipactis* and others) in absence of a number of traits which complicate species delimitation and phylogenetic reconstructions; particularly, *Cephalanthera* is not characterized by substantial taxonomical controversy driven from ecological, geographical, allopolyploid or pollination-based speciation. However, this genus gives a prominent example of how interpretative problems arise from the transitions to secondary actinomorphy of the flower and shifts to full mycoheterotrophy.

The point of taxonomical controversy of plants characterized by obligate mycoheterotrophy is the possibility of multiple events of transition from partial to full mycoheterotrophy. According to molecular phylogenetic studies *C. exigua* is nested within green-leaved species of *Cephalanthera*, all of which are most likely obligate partially mycoheterotrophic (PEDERSEN et al. 2009; ROY et al. 2009). Since none of the other fully mycoheterotrophic taxa of *Cephalanthera* had never been included in molecular analysis, their possible phylogenetic relations can be judged only by morphology. Though these taxa can be assumed to represent a monophyletic group on the basis of the strictly achlorophyllous habit (which is to be treated as their synapomorphy in this case), multiple origins of the white fully mycoheterotrophic species from the green-leaved species can also be suggested. The latter hypothesis implies homoplastic evolution of the discussed characteristic (achlorophyllous vs. chlorophyllous habit). Several cases of the occurrence of achlorophyllous form (so-called albinos) in normally green-leaved species have already been described. For example, such forms were found in the widely distributed species *Cephalanthera damasonium* (Mill.) Druce (JULOU et al. 2005) and several times in *Epipactis helleborine* (L.) Crantz and in some of its allies (JAKUBSKA & SCHMIDT 2006); remarkably, *Epipactis* is a genus closely related to *Cephalanthera*. While in *Epipactis* the achlorophyllous individuals were shown to appear due to variation of green-leaved species, the taxonomically independent status of most of the fully mycoheterotrophic taxa in *Cephalanthera* is widely accepted (e.g., CHEN et al. 2009; PEDERSEN et al. 2009). In our opinion, these examples prove the possibility of multiple origin of strictly achlorophyllous species within the genus *Cephalanthera*; in this case, this group of species do not deserve a separate taxonomic status.

Transitions from normal zygomorphic flowers to partially or fully actinomorphic flowers probably proceed quicker. This has been widely discussed concerning both genetic regulations of this process and forces carrying on the evolution of Orchidaceae (RUDALL & BATEMAN 2002; MONDRAGÓN-PALOMINO & THEISSEN 2009). In relation to *Cephalanthera*, several (at least three) species with more or less actinomorphic flowers have been described. One is *C. nanlingensis* A. Q. Hu & F. W. Xing (HU et al. 2009: 56), which might also be regarded as an actinomorphic form of *C. erecta* (Thunb.) Blume (CHEN et al. 2009: 176). Another form with actinomorphic flowers lacking a modified lip but with rudiments of five stamens was assigned to the monotypic genus *Tangtsinia* S. C. Chen (CHEN 1965). The latter entity was widely discussed in orchidologic literature (e.g., CHEN & TSI 1987) regarding its primitive morphology and possible ancestral position in the phylogeny of epidendroid orchids; however, it has been hypothesized (RUDALL & BATEMAN 2002: 421; CHEN et al. 2009: 177) and recently it has got a molecular-based confirmation (JIN et al. 2011) that it represents an actinomorphic form of *Cephalanthera*, probably *C. falcata* (Thunb.) Blume. Finally, the only species of *Tangtsinia* was moved to *Cephalanthera* and treated as a distinct species *C. nanchuanica* (S. C. Chen) X. H. Jin &

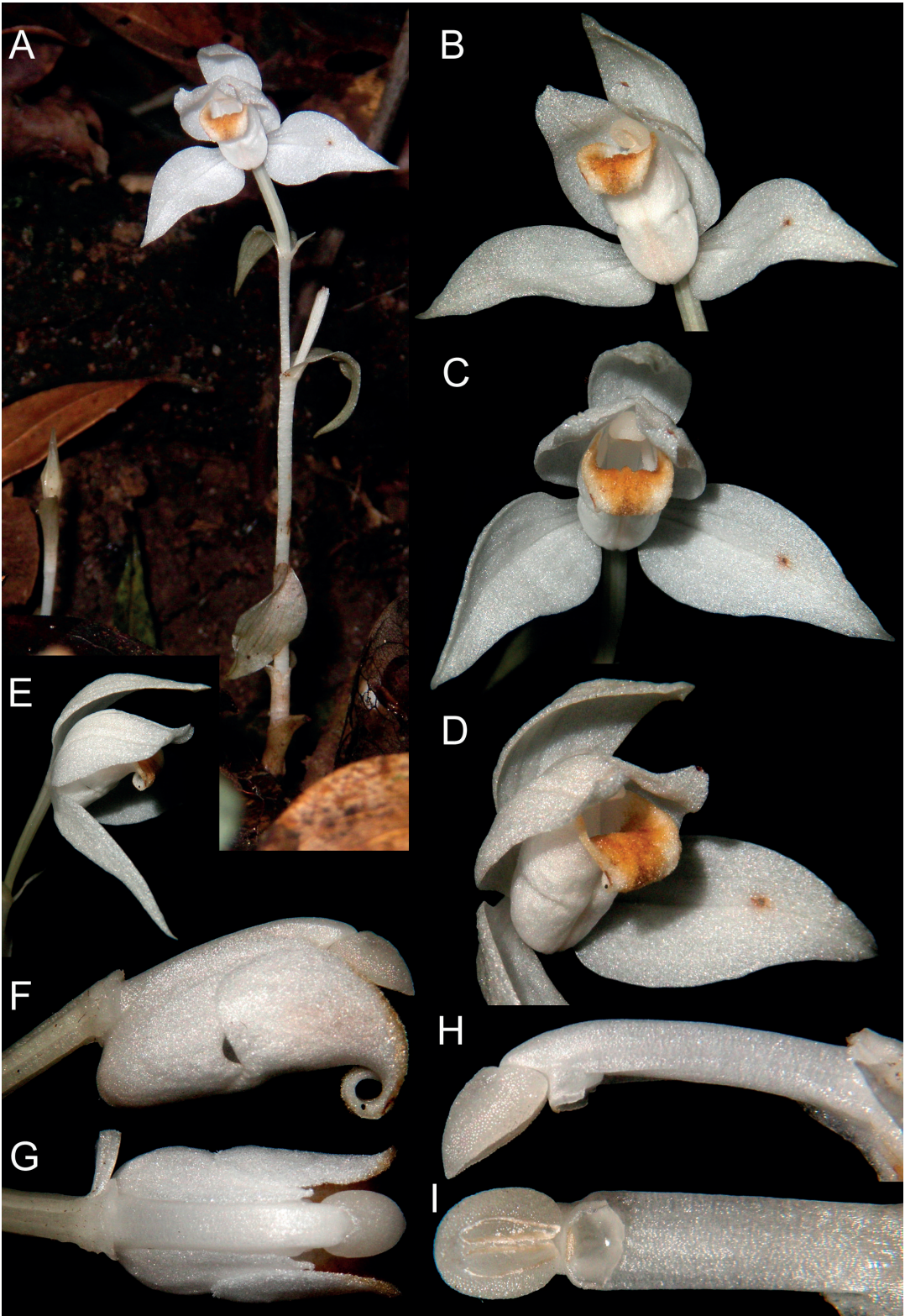


*Cephalanthera exigua* Nuraliev 820

**Figure 1.** *Cephalanthera exigua*. A – Flowering plant (above-ground part). B – Flattened sepals and petals. C – Lip, side view. D – Lip, frontal view. E – Column, half side view. Drawings by L. Averyanov.

X. G. Xiang on the basis of molecular evidences (XIANG et al. 2012). The third example of species with actinomorphic flowers is displayed by *C. humilis*, a newly described species from Yunnan (JIN et al. 2011). It's noteworthy that this species shows mycoheterotrophy simultaneously with actinomorphy of the flower.

*Cephalanthera exigua* has been described from Laos (SEIDENFADEN 1975) and recently has also been reported from Thailand, where two populations were discovered (PEDERSEN et al. 2009). These plants were thoroughly studied in terms of ecology, morphology and pollination biology; a key for determination of all mycoheterotrophic species of *Cephalanthera* from Asia known at that time have been provided (PEDERSEN et al. 2009) and mycorrhizal associations have also been studied in detail (ROY et al. 2009). In connection with quick degradation of primary forest communities in Indochina, we provide here a detailed morphological description of our finding, as there is a certain probability that it would have never been repeated in the future. Both the description and the drawing of Vietnamese plants are based on spirit collection. Morphology of our plants is almost congruent with the detailed characteristics provided by PEDERSEN et al. (2009), except for the structure of lip epichile. Drawings of the plants from Thailand show that the median lobe of the epichile is bigger than the lateral lobes, whereas the plant from Vietnam has a median lobe at least two times smaller than the lateral ones. We are not sure whether this difference in the dimensions of the epichile lobes reflects morphological variation between populations of *C. exigua* or represents an artifact based on the different condition of the material. An epichile median lobe of the Vietnamese plant is distinctly fleshy, whereas the



**Figure 2.** *Cephalanthera exigua*. A – Plants in natural habitat. B, C – Flower, frontal view. D – Details of perianth. E – Flower, side view. F, G – Lip and column. H, I – Details of column. *Nuraliev 820*. Photos by M. Nuraliev.

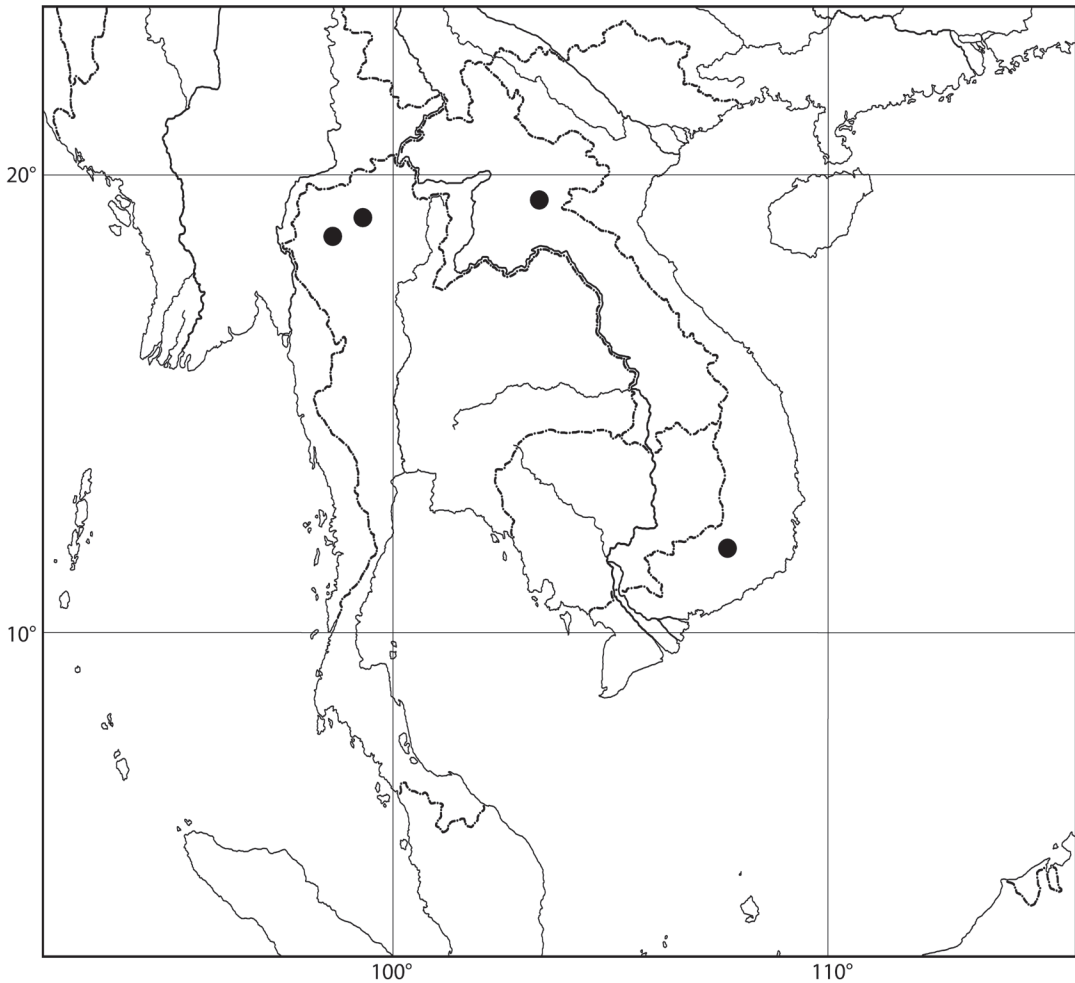


Figure 3. Distribution map of *Cephalanthera exigua*.

drawings of Thai plants show a relatively thin blade. This allows the assumption that it might have been accidentally flattened and enlarged during maceration of dried material. The number of thickened nerves of the lip, which is different in depicted specimens, is not significant because in Thai plants it was found to be polymorphic (from three to five).

*Cephalanthera exigua* Seidenf. (Figs 1, 2). Type: Laos, Xiangkhoang, Phu Muten, 20 April 1932, Kerr 1024 [holotype K].

Description based on plants from Vietnam: Stem erect, slender, 5–10 cm tall, the lower part covered by 3–5 papyraceous sheaths 0.5–1 cm long, upper part with 1–3 distant tiny floral bracts. Floral bracts narrowly ovate, acute to shortly acuminate, 0.5–1 cm long, same length as the ovary. Flowers 1–2(3), not widely opening, campanulate, 1.5 cm across. Sepals subsimilar, narrowly ovate, acuminate to shortly apiculate, 11–12 mm long, 4–5 mm wide, lateral sepals slightly broader, oblique at the base. Petals narrowly ovate, little shorter, obtuse. Lip 10–11 mm long, inside very papillose, distinctly separated into hypochile and epichile. Hypochile cup-shaped, with oblong, falcate, erect side lobes 6–7 mm long. Epichile cordate, 7–8 mm long and wide, 3-lobed; lateral lobes half circular, shallowly crenulate; median lobe triangularly ovate,

reflexed downwards, roughly papillate, grooved, at least two times smaller than the lateral ones. Lip with 3 low keels running from the base almost to the apex, lamellately thickened at the basal half of epichile. Column narrow, slender, straight, 5–7 mm tall, with erect oblong anther 3 mm long. Stigma apical, obscurely triangular, concave.

Distribution: Laos, Thailand, Vietnam (Fig. 3).

Ecology: In Vietnam it grows in primary broad-leaved evergreen shady forests on mountain slopes composed by silicate rocks. 1000 m. Fl. April–May. The area inhabited by *C. exigua* is fairly rich in mycoheterotrophic plants. Particularly, *Vietorchis furcata* Aver. & Nuraliev, Orchidaceae (AVERYANOV et al. 2013), *Epipogium roseum* D. Don, Orchidaceae, and *Thismia mucronata* Nuraliev, Thismiaceae (NURALIEV et al. 2014) were reported to occur at a distance of 3 km and less from the population of *C. exigua*.

Conservation status: *Cephalanthera exigua* in Indochina is defined as Critically Endangered [CR B2ab(iii)] based on its small geographic range (IUCN 2014).

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