

## Short Communication

# Distribution, status, and conservation of *Camellia changii* Ye (Theaceae), a Critically Endangered plant endemic to southern China

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**Abstract** The distribution of the endemic threatened plant *Camellia changii* Ye (Family Theaceae) is restricted to a small area in southern China, and little else is known about its status in the wild. To provide information for the conservation of *C. changii* we investigated its distribution, population size and structure, and habitat, and assessed its conservation status. Surveys confirmed that the species grows in a narrow band along both sides of a 4 km long segment of a stream in Ehuangzhang Nature Reserve, under the discontinuous canopy of a secondary evergreen broad-leaved forest on well-drained, acidic sandy loam soil. We found a total of 1,039 individuals of *C. changii*. The population has a high flowering rate but a low seed-setting rate. The population appears to be in decline because no seedlings and few young plants were evident. Our findings indicate that *C. changii* should be categorized as Critically Endangered on the IUCN Red List. We have recommended an integrated species-conservation plan for the species that includes patrolling the Ehuangzhang Nature Reserve to prevent plant removal, establishing an ex situ living collection that contains the entire wild genetic diversity (accomplished by grafting of short cuttings from all wild individuals), facilitating propagation for commercial use, and implementing reintroduction to augment the wild population.

**Keywords** *Camellia changii*, China, Critically Endangered species, grafting, habitat, small population, rare plant

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*Camellia changii* (Family Theaceae) is a plant endemic to southern China (Zhang, 1999). It is known among Chinese botanists as the so-called giant panda of the plant kingdom because of its rarity and charm (Wang & Xie, 2001). It is evergreen and grows to 4 m in height as a tall shrub or small tree (Supplementary Plate S1), and generally flowers from mid May until February. Its unusually long flowering period, large flowers and evergreen foliage make it an excellent ornamental plant and a valuable economic species (Li et al., 2004). Nevertheless, *C. changii* is not commonly grown. The objectives of the study reported here were to investigate the current status of the sole wild *C. changii* population and its habitat, explore the causes of its rarity, analyse the need for the protection of *C. changii* and recommend conservation measures.

We examined all specimens of *C. changii* deposited in the herbaria of the South China Botanical Garden (Chinese Academy of Sciences, SCBI) and Sun Yat-sen University (SYS). Both herbaria are major depositories for collections of plant material from southern China. In addition we used the *Flora of China* (Zhang, 1999), the *Flora of Guangdong* (Wu, 1998) and other publications that contain information about *C. changii*. These sources indicated that all plants were located within Ehuangzhang Nature Reserve (Fig. 1) in Yangchun County, Yangjiang City, in south-west Guangdong Province. We then surveyed for *C. changii* in the Reserve from January 2009 to January 2013. The locations of all *C. changii* found were recorded with a global positioning system and mapped, and we recorded the elevation, slope, aspect and soil type at all locations. We established three transects (5 × 200 m) across the species' range, which was along a stream, the Erchahe, in December 2011. For all plant species within each transect the identity, height, diameter at breast height (for trees), crown size (for shrubs and herbs), and number of plants were recorded. The leaf-area index (a dimensionless quantity that characterizes plant canopies, defined as the one-sided green leaf area per unit ground surface area) was measured with an LAI-2000 plant canopy analyser (LI-COR, Biosciences, Lincoln, USA). At each transect, we selected three arbitrary points, along the slope, at which five leaf-area index measurements were taken from different directions. In December 2012 soil samples were collected from three arbitrarily selected points

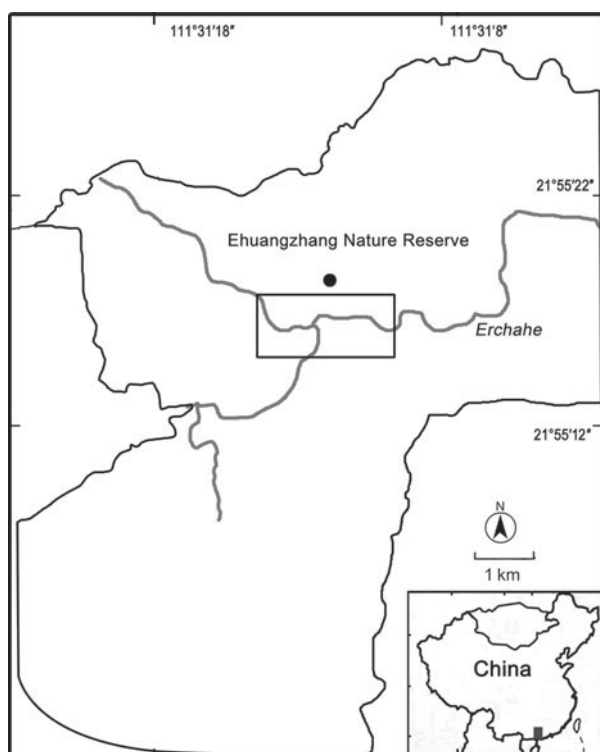


FIG. 1 The range (rectangle) of *Camellia changii* on the banks of a stream, the Erchahe, in Ehuangzhang Nature Reserve. The black dot indicates the location of the administration building in the Reserve. The inset indicates the location of the main figure in Guangdong province in southern China.

in each transect, using a 5 cm diameter soil corer, to a depth of 20 cm. The soil samples were air dried and sieved for analysis of physical and chemical characteristics. We chose five mature individuals of *C. changii* for observation of sexual reproduction from January 2009 to January 2013. The number of flowers, fruit, seeds and seedlings per individual were recorded.

The *C. changii* population occupies an area 8–10 m wide and 4 km long, on both banks of the Erchahe. Altitude is 50–150 m, and slopes are 5–12°, with easterly and westerly aspects along the water catchment (Fig. 1). We found a total of 1,039 individuals of *C. changii*, fewer than the number (1,200) estimated by Zhang & Liang (2003). About 84% of the individuals were taller than 3 m. There were no seedlings and few small plants (height < 0.5 m).

A total of 160 vascular plant species were recorded in the three transects (Supplementary Table S1). The plant community is a secondary tropical evergreen broadleaved forest (Luo et al., 2008), dominated by species of *Camellia* and of the families Rubiaceae and Lauraceae. The canopy is not continuous, with 48% canopy cover and a mean leaf-area index of  $1.92 \pm \text{SE } 0.10$ . Individuals of *C. changii* are scattered in the *Gordonia axillaries*–*Ormosia emarginata*–*Syzygium buxifolium*–*Dicranopteris pedata* community in exposed locations. The associated soil is well-drained, acidic,

sandy loam with low contents of water, phosphorus and organic matter but high contents of potassium (Supplementary Tables S2–3). This combination of soil properties is atypical for this region.

Individual *C. changii* produced a mean of  $381 \pm \text{SE } 135$  flowers per year ( $n = 5$  plants) but only  $5 \pm \text{SE } 1$  fruits and  $3 \pm \text{SE } 2$  seeds per fruit. The dominance of medium-sized to large plants and the absence of seedlings indicate that the population is declining. The observed low rate of fruit production may be the result of a combination of factors. Fruit set in *C. changii* relies on insect pollinators but the species is self-incompatible and exhibits heterostyly, which, coupled with low pollinator visitation frequencies, are responsible for a high abortion rate (Luo et al., 2011). The low rate of seed production we observed and the poor seed quality and low seed germination rate observed in other studies (Xue et al., 2011) presumably limit the regeneration of the species.

Considering the small size of the population, skewed population structure, low level of regeneration, very narrow geographical range and small area of occupancy, *C. changii* should be categorized as Critically Endangered, based on criteria  $\text{Biab}(v)+2\text{ab}(v)$  (IUCN, 2001). Because of its desirable horticultural traits, wild individuals of *C. changii* have been poached aggressively by local people over the past 2 decades (authors, pers. obs.). Although poaching pressure persists the remaining plants and their habitat have been more effectively protected since the establishment of the Ehuangzhang Nature Reserve in 2000 (Luo et al., 2011), with weekly monitoring by Reserve staff.

Horticultural propagation techniques, including grafting *C. changii* scions to rootstock of *Camellia gauchowensis*, *Camellia oleifera* and *Camellia japonica*, and propagation by cuttings, have been developed by private nurseries (Zhang & Liang, 2003; Li et al., 2004). The Nature Reserve took advantage of these techniques to purchase and redistribute 10,000 grafted plants to local people in 2010–2011, to support livelihoods and reduce poaching pressure.

We recommend that an integrated conservation plan is required for *C. changii*. As part of this plan, the Nature Reserve should continue the promotion of the established propagation techniques, using scions and cuttings from existing ex situ private and government collections, for commercial horticultural use. This measure, together with the public education and awareness programmes that are already underway, will alleviate the threats to *C. changii* from development of local tourism and recreation areas within the Nature Reserve, the construction of small dams, and small-holder farming. Other threats to *C. changii* are its restricted range, limited recruitment, and potential inbreeding depression as a result of the small population size and low genetic diversity (Luo et al., 2007). As a precaution we have successfully established an ex situ collection in the experimental area of the Nature

Reserve, duplicating all 1,039 wild plants by grafting two or three 2–3 cm cuttings per plant onto *C. oleifera* rootstock. We also recommend that artificial pollination be used to increase fruit set both in situ and ex situ, and that reintroduction should be implemented to augment the population at carefully selected locations, guided by IUCN/SSC (2013). In addition, we recommend that the species be added to the list of species with extremely small populations, which is an endangered category for plant species recognized by the State Forestry Administration of China. The placement of *C. changii* in this category would facilitate funding for implementation of the conservation measures we recommend.

Narrow endemic species are an important but vulnerable component of global biological diversity (Fenu et al., 2012; Ren et al., 2012). In depth analyses of the challenges to and strategies for conserving narrow endemic species such as *C. changii* and others (Fenu et al., 2011, 2012; Martinell et al., 2011; Cogoni et al., 2013) are needed to prevent extinction of these unique species.

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### Biographical sketches

HAI REN is interested in vegetation restoration and reintroduction of rare and threatened plant species. SHUGUANG JIAN's research interests include community ecology and the biogeography of rare and threatened plants. YONGJU CHEN is in charge of in situ conservation and the nursery at Ehuangzhang Nature Reserve. HONG LIU has been carrying out research on biodiversity conservation in the USA and China for the past 15 years. QIANMEI ZHANG is a data analyst with interests in long-term ecological studies. NAN LIU focuses on plant ecophysiology and soil monitoring. YI XU is interested in mapping and spatial analysis. JIAN LUO conducts field monitoring and plant grafting.