

# Distribution and conservation status of *Magnolia ovoidea* (Magnoliaceae): a Critically Endangered species in Yunnan, China

CHUNYAN HAN, LIDAN TAO and WEIBANG SUN

**Abstract** *Magnolia ovoidea* is a narrowly endemic, Critically Endangered tree with a fragmented distribution in south-west Yunnan, China. We examined the size structure of this species, documented threats and assessed its extinction risk. We found the species in six locations, all in unprotected areas, in Maguan County. The largest subpopulations are in Donggua Lin and Youfang Po, with 17 and 50 living individuals, respectively. The distribution of the diameter at breast height of the *M. ovoidea* population has an inverse J-shape, indicating a stable size structure. However, the distribution of the height of seedlings is L-shaped, suggesting inhibited regeneration. The natural vegetation is severely fragmented in all six locations, surrounded by roads, farmlands, and *Alnus nepalensis* or *Cunninghamia lanceolata* plantations. We recommend that *M. ovoidea* should be categorized on the IUCN Red List as Critically Endangered based on criteria B2ab(iii) + C2a(i).

**Keywords** China, Critically Endangered, endemic, *Magnolia ovoidea*, Magnoliaceae, Plant Species with an Extremely Small Population, Red List, size structure

The plant family Magnoliaceae has a disjunctive geographical distribution: two-thirds of species occur in Asia, the others in Central America and northern South America (Liu, 2004; Cicuzza et al., 2007; Xia et al., 2008). The family comprises c. 314 species, of which 147 (46.8%) are threatened in the wild (Rivers et al., 2016). China and Latin America are the hotspots for Magnoliaceae (Rivers et al., 2016). There are c. 108 species in China, of which 78 are in south-west China (Shui, 2003; Xia et al., 2008). This area is a biodiversity hot-spot, with > 13,000 vascular plant species, of which c. 29% are endemic (Chen et al., 2017). Of these, 38 species belong to Magnoliaceae (Chen et al., 2017),

and one of the most seriously threatened is *Magnolia ovoidea* (Hung T. Chang and B.L. Chen) V.S. Kumar, categorized as Critically Endangered (Rivers et al., 2016), and as a Plant Species with an Extremely Small Population (Ma et al., 2013).

The first specimen of *M. ovoidea* was collected in Maguan County, Yunnan, by Baoliang Chen in April 1986 (Chen, 1988). We obtained information on this species from *Flora Yunnanica* (Law, 2006), *Flora of China* (Xia, et al., 2008) and *Magnolias of China* (Liu, 2004), and examined all specimens in the Chinese Virtual Herbarium (CVH, 2015), to determine the species' range. Based on the specimens and habitat of *M. ovoidea*, we conducted field surveys in eight counties of Wenshan Prefecture in Yunnan during 2012–2015, during which we also interviewed a total of 24 local foresters from all counties surveyed, showing them photographs and specimens of *M. ovoidea*, to obtain additional information on the species. Our surveys and the interviews indicated that *M. ovoidea* occurs only in Maguan County, at altitudes of 1,460–1,700 m.

In October 2016, to investigate the size structure of the population and to assess any potential threats, we surveyed all known populations. We recorded the position of all living individuals with a GPS, noting habitat characteristics and any evidence of disturbance. The Townships of Miechang and Bazhai, Maguan County (Fig. 1), where the known individuals were found, have a mean annual temperature of 22.8 °C, with a mean minimum temperature of –4 °C in January and a mean maximum of 32.3 °C in July (Zhou et al., 2012), and mean annual total precipitation of 1,254 mm.

For all *M. ovoidea* located, we recorded the diameter at breast height (DBH) and height of all living individuals  $\geq 1.3$  tall, and counted and measured the height of all seedlings (height < 1.3 m). A total of 62 individuals  $\geq 1.3$  m tall and 18 seedlings were recorded (Table 1; Plate 1). As a whole, the DBH of the population has an inverse J-shaped distribution, with most individuals in the 5–10 cm class (Fig. 2). Such a distribution indicates a stable population structure in which naturally senescent individuals are replaced with seedlings and saplings (Tang et al., 2011; Ren et al., 2014; Qian et al., 2016). However, of the six sites, seedlings were only found in Donggua Lin, Maocao Zhai and Youfang Po, and the distribution of seedling height is L-shaped, with fewest seedlings in the smallest classes. The persistence of small populations usually depends on a few mature plants

CHUNYAN HAN\*§, LIDAN TAO†§ and WEIBANG SUN (Corresponding author) Kunming Botanical Garden and Yunnan Key Laboratory for Integrative Conservation of Plant Species with Extremely Small Populations, Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, Yunnan 650201, China. E-mail hanchunyan@mail.kib.ac.cn

\*Also at: Guizhou University of Traditional Chinese Medicine, Guiyang, Guizhou, China

†Also at: University of Chinese Academy of Sciences, Beijing, China

§Contributed equally.

Received 18 January 2018. Revision requested 7 March 2018.

Accepted 2 May 2018. First published online 16 October 2019.

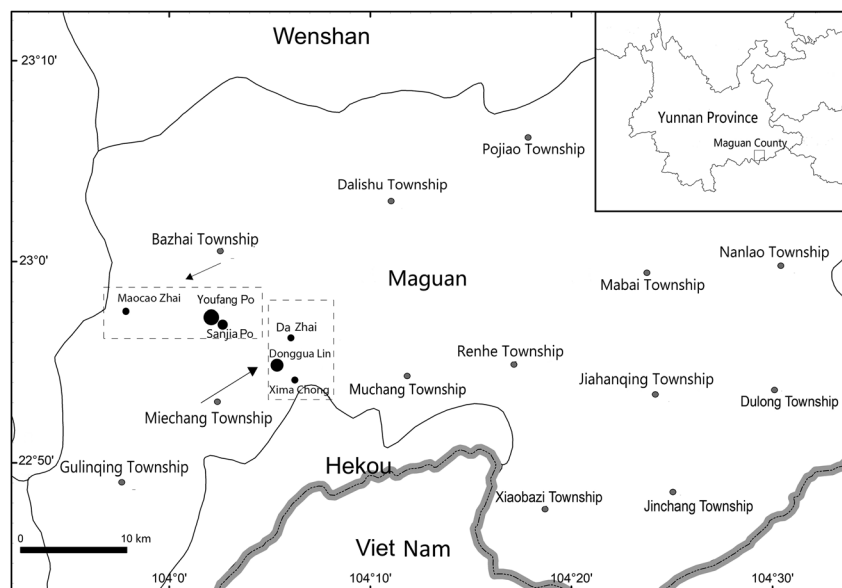


FIG. 1 The six known localities (Table 1) of *Magnolia ovoidea*, in Bazhai and Miechang Townships in Maguan County, Yunnan, China.

TABLE 1 Characteristics of the six known localities of *Magnolia ovoidea* in Maguan County (Fig. 1).

Location	Geographical coordinates	Altitude (m)	No. of individuals	Characteristics of forest stands
<b>Miechang Township</b>				
Donggua Lin	104°05'21.63" E 22°54'51.25" N	1,463	17	Shady slopes, surrounded by farmland & roads, selective logging & fuel wood collection; formerly a large population but has shrunk because of land reclamation (from interviews with villagers)
Xima Chong	104°06'15.04" E 22°54'7.03" N	1,420	1	Single tree, ridge of slope by roads
Sanjia Po	104°02'39.58" E 22°56'52.24" N	1,510	2	Shady slopes by stream; forests being replaced by <i>Alnus nepalensis</i> plantations
<b>Bazhai Township</b>				
Da Zhai	104°06'3.46" E 22°56'12.81" N	1,500	2	In secondary forest at edge of village, disturbed by human activities
Maocao Zhai	103°57'50.72" E 22°57'31.54" N	1,460	8	Open & dry slopes, disturbed by logging & rural activities
Youfang Po	104°02'05.69" E 22°57'13.77" N	1,641	50	Shady moist slopes, surrounded by roads; habitat declined following establishment of <i>Cunninghamia lanceolata</i> plantations; road building has had a negative influence
<i>Total</i>			80	



PLATE 1 (a) *M. ovoidea* seedling, and (b) and (c) adult *M. ovoidea* in Youfang Po (Fig. 1).

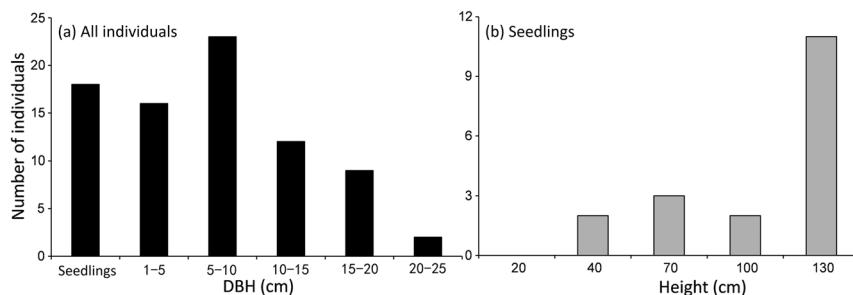


FIG. 2 The frequency distribution of (a) the diameter at breast height (DBH) of all living individuals, and (b) the height of all seedlings (height < 1.3 m or DBH < 1.0 cm) of *M. ovoidea* in Maguan County (Fig. 1).

and is therefore highly vulnerable to factors limiting seedling recruitment (Tang et al., 2011; Qian et al., 2016).

*Magnolia ovoidea* is threatened by habitat degradation and fragmentation. In the six locations, vegetation clearing for planting of crops is ongoing, and we witnessed *M. ovoidea* being felled or partially felled (all six locations are in unprotected areas). All locations are surrounded by roads, farmlands, and *Alnus nepalensis* or *Cunninghamia lanceolata* plantations (Table 1). The restricted area of vegetation, and human activities, are probably limiting the recruitment of *M. ovoidea* seedlings.

Rivers et al. (2016) categorized *M. ovoidea* as Critically Endangered based on criterion (IUCN, 2012) D (i.e. total number of mature individuals < 50). Our findings support the categorization as Critically Endangered but based on alternative criteria. The total extent of occurrence across the Bazhai and Miechang Townships is 2,600 m<sup>2</sup> (< 10 km<sup>2</sup>), the total number of mature individuals is < 250, and the number of individuals in each subpopulation is < 50, and therefore the appropriate criteria are B2ab(iii) + C2a(i).

For endemic and narrowly distributed species habitat destruction and human disturbance increase the risk of extinction. A small population size and fragmented habitats are likely to reduce the viability of such species (Li et al., 2014; Wang et al., 2015). It is not unusual for extremely restricted endemics to survive with < 5 subpopulations (Martinell et al., 2011), and such species may be best managed by local conservation efforts (Crain et al., 2015), in this case for all of the remaining six populations. We plan to collect seeds for cultivation and ex situ conservation in the Germplasm Bank of Wild Species in Southwest China (Li et al., 2010), and to study the genetic diversity of this species. Our approach to the conservation of *M. ovoidea* may be applicable for other plants species with extremely small populations in China (Ma et al., 2013), many of which are threatened.

**Acknowledgements** This study was supported by grants from the National Science and Technology Basic Resources Investigation Special Project (2017FY100100), the NSFC-Yunnan Joint Fund (U1602264) and Mohamed bin Zayed Species Conservation Fund (12053820).

**Author contributions** Surveys: CH, LT; data analysis: CH, LT, WS; writing: CH; revision: WS.

**Conflicts of interest** None.

**Ethical standards** This research abided by the Oryx guidelines on ethical standards.

## References

- CHEN, B.L. (1988) New taxa of Magnoliaceae from Yunnan. *Acta Scientiarum Naturalium Universitatis Sunyatseni*, 1, 107–112.
- CHEN, C., LU, R.S., ZHU, S.S., TAMAKI, I. & QIU, Y.X. (2017) Population structure and historical demography of *Dipteronia dyeriana* (Sapindaceae), an extremely narrow palaeoendemic plant from China: implications for conservation in a biodiversity hot spot. *Heredity*, 2, 95–106.
- CICUZZA, D., NEWTON, A. & OLDFIELD, S. (2007) *The Red List of Magnoliaceae*. Fauna & Flora International, Cambridge, UK.
- CRAIN, B.J., SÁNCHEZ-CUERVO, A.M., WHITE, J.W. & STEINBERG, S.J. (2015) Conservation ecology of rare plants within complex local habitat networks. *Oryx*, 4, 696–703.
- CVH (2015) *Chinese Virtual Herbarium v.5.0*. <http://www.cvh.ac.cn> [accessed 19 January 2018].
- LI, D.Z., YANG, X.Y., WANG, Y.H. & CAI, J. (2010) The Germplasm Bank of Wild Species, Southwest China. *BCAS*, 4, 264–267.
- IUCN (2012) *IUCN Red List Categories and Criteria v.3.1*. 2nd edition. IUCN, Gland, Switzerland, and Cambridge, UK.
- LAW, Y.W. (2006) Magnoliaceae. In *Flora Yunnanica* (ed. Z.Y. Wu), pp. 1–63. Science Press, Beijing, China.
- LI, B., ZHANG, Z. & ZHANG, D. (2014) Conservation status of the unique populations of *Wenchengia alternifolia*, an enigmatic plant endemic to Hainan island, China. *Oryx*, 3, 354–357.
- LIU, Y.H. (2004) *Magnolias of China*. Science Press, Beijing, China.
- MA, Y., CHEN, G., GRUMBINE, R.E., DAO, Z.L., SUN, W.B. & GUO, H.J. (2013) Conserving plant species with extremely small populations (PSESP) in China. *Biodiversity and Conservation*, 22, 803–809.
- MARTINELL, M.C., LÓPEZ-PUJOL, J., BLANCHÉ, C., MOLERO, J. & SÁEZ, L. (2011) Conservation assessment of *Aquilegia paui* (Ranunculaceae): a case study of an extremely narrow endemic. *Oryx*, 2, 187–190.
- QIAN, S.H., YANG, Y.C., TANG, C.Q., MOMOHARA, A., YI, S. & OHSAWA, M. (2016) Effective conservation measures are needed for wild *Cathaya argyrophylla* populations in China: insights from the population structure and regeneration characteristics. *Forest Ecology and Management*, 361, 358–367.
- REN, H., JIAN, S., CHEN, Y., LIU, H., ZHANG, Q., LIU, N. et al. (2014) Distribution, status, and conservation of *Camellia changii* Ye

- (Theaceae), a Critically Endangered plant endemic to southern China. *Oryx*, 48, 358–360.
- RIVERS, M., BEECH, E., MURPHY, L. & OLDFIELD, S. (2016) *The Red List of Magnoliaceae*. Botanic Gardens Conservation International, Richmond, UK.
- SHUI, Y.L. (2003) *Seed Plants of Honghe Region in SE Yunnan, China*. Yunnan Science and Technology Press, Kunming, China.
- TANG, C.Q., HE, L.Y., GAO, Z.R., ZHAO, X.F., SUN, W.B. & OHSAWA, M. (2011) Habitat fragmentation, degradation, and population status of endangered *Michelia coriacea* in Southeastern Yunnan, China. *Mountain Research and Development*, 4, 343–350.
- WANG, B., MA, Y.P., CHEN, G., LI, C.R., DAO, Z.L. & SUN, W.B. (2015) Rescuing *Magnolia sinica* (Magnoliaceae), a Critically Endangered species endemic to Yunnan, China. *Oryx*, 3, 446–449.
- XIA, N.H., LIU, Y.H. & NOOTEBOOM, H.P. (2008) Magnoliaceae. In *Flora of China*, vol. 7 (eds Z.Y. Wu & P. Raven), pp. 48–91. Science Press, Beijing, China, & Missouri Botanical Garden Press, St Louis, USA.
- ZHOU, Y., JIANG, H., YANG, W.Z., ZHANG, S.S. & XIANG, Z.Y. (2012) Study on stock of *Pinus wangii*, an extremely small population species. *Journal of West China Forestry Science*, 3, 80–83.