

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

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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 ≥ 1.3 tall, and counted and measured the height of all seedlings (height < 1.3 m). A total of 62 individuals ≥ 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

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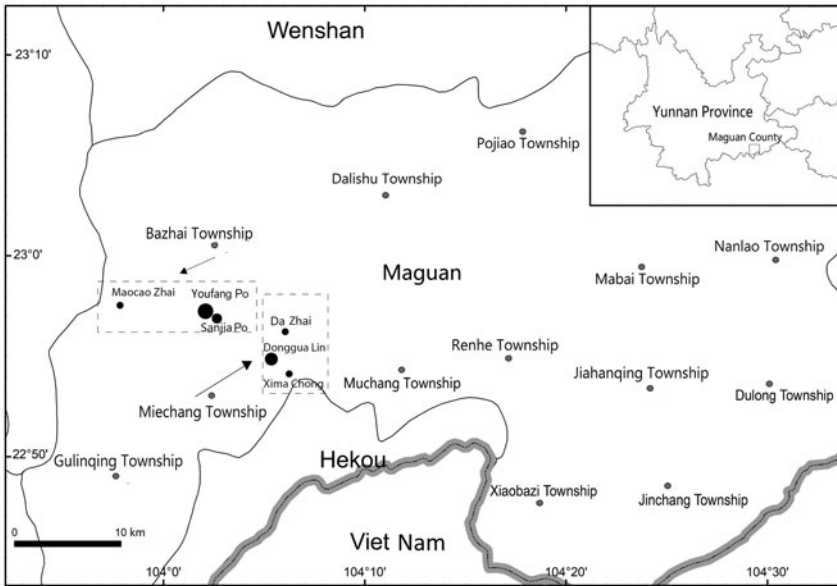


FIG. 1 The six known localities (Table 1) of *Magnolia ovoides*, in Bazhai and Miechang Townships in Maguan County, Yunnan, China.

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

Location	Geographical coordinates	Altitude (m)	No. of individuals	Characteristics of forest stands
Miechang Township				
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
Bazhai Township				
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
Total			80	



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

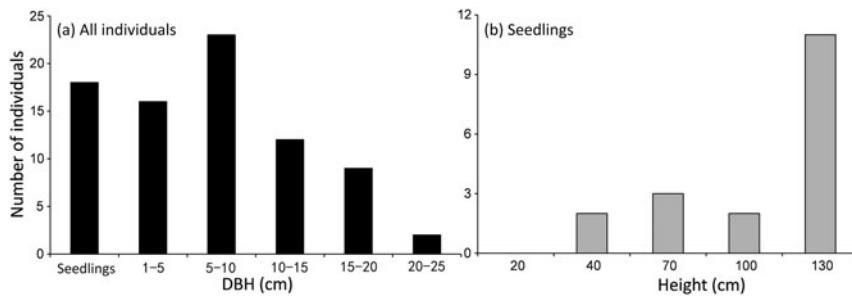


FIG. 2 The frequency distribution of (a) the diameter at breast height (DBH) of all living individuals, and (b) the height of all seedlings (height < 1.3 m or DBH < 1.0 cm) of *M. ovoides* in Maguan County (Fig. 1).

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

Magnolia ovoides is threatened by habitat degradation and fragmentation. In the six locations, vegetation clearing for planting of crops is ongoing, and we witnessed *M. ovoides* 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. ovoides* seedlings.

Rivers et al. (2016) categorized *M. ovoides* 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 m² (< 10 km²), 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. ovoides* may be applicable for other plants species with extremely small populations in China (Ma et al., 2013), many of which are threatened.

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Conflicts of interest None.

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

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