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COMMENTARY

The conservation of *Rhododendrons* is of greater urgency than has been previously acknowledged in China

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Abstract The *Rhododendron* of China exhibit great diversity, however no conservation evaluation of the genus had been performed, as a result of no governmental financial support. Based on our recent field investigations covering a total of seven provinces and 95 days from 2011 to 2013 in China, we herein provide an updated conservation status on eight species plus two further species that are listed as endangered and vulnerable in the Red List of *Rhododendrons* in which the evaluation was mainly based on old records. Our surveys indicated that urgent conservation actions to the two critically endangered species *R. magniflorum* (less than 10 extant plants) and *R. roxieoides* (only 22 mature individuals) should be performed. Moreover, we proposed that species represented by few plants, and that grow at low altitude, in disturbed habitats, should be given priority for ex- and in-situ conservation. Despite current distributions of all listed endangered *Rhododendrons* were not fully covered, our report aimed to arouse conservation attention and actions on *Rhododendrons* preferably by governmental financial support in China.

Keywords China · Governmental financial support · *Rhododendron* conservation · *R. magniflorum* · *R. roxieoides*

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Introduction

The genus *Rhododendron* is the largest genus in the family of Ericaceae, containing about 1,025 species that are prized in the temperate parts of the world for their horticultural value (Chamberlain et al. 1996). There are 571 species in 6 subgenera in China, of these 405 are endemic. They occur in most provinces (except Xinjiang and Ningxia) (Ma et al. 2013; Wu et al. 2005). Of these provinces, Yunnan, Sichuan and Tibet have the greatest diversity, with approximately 374, 255 and 227 *Rhododendron* species, respectively (Zhang et al. 2004). Furthermore it is one of the signature genera by which the health of the Flora of the Sino-Himalayas in particular will be measured. The ever-increasing pressures on the land to service the needs of an expanding population are placing some of the Chinese species of *Rhododendron* at risk of extinction. China must accept responsibility for adopting conservation measures for its own species, before it is too late.

In 2011, the Red List of *Rhododendrons* was published with the aim of evaluating the global conservation status of *Rhododendron* species (Gibbs et al. 2011). The Red List ranks a total of 31 species as endangered or critically endangered in China, accounting for 41 % of globally endangered species. However, this evaluation was also mainly based on records associated with old specimens; information specifically involving their current distribution was very limited. Comprehensive conservation assessments of *Rhododendrons* in China have not been drawn up due to a lack of basic data collected directly from field investigations and more importantly no support from governmental fund. Therefore, no attempts have been made to carry out conservation projects, even though the potentially endangered *Rhododendrons* have been identified by the Red List. In this paper, we have focused on the updated conservation status for endangered *Rhododendrons* listed in the Red List in China.

Field surveys

Without financial support, our seven field surveys covering a total of seven provinces and 95 days (Table 1) were performed and focused mainly on *Rhododendrons* and providing key information on eight species that had been evaluated as endangered species the Red List of *Rhododendrons*, *R. balangense*, *R. roxieoides*, *R. mallotum*, *R. farinosum*, *R. changii*, *R. mianningense*, *R. magniflorum* and *R. platypodum* between 2011 and 2013. Our field surveys revealed a concordance with the potential threats that were identified in the Red List for *R. balangense*, *R. mallotum*, *R. magniflorum* and *R. farinosum* (Fig. 1a–d). Road construction and agriculture posed great threats to these four species.

Of these, *R. magniflorum* is probably most at risk as two of our surveys have indicated that there are less than 10 extant plants. Moreover, habitat suitable to *R. magniflorum* has been nearly lost as the only mountain on which it occurs has been seriously disturbed, at its base by road and coal mine construction, and at the top by walnut planting (Fig. 2a, b). On the contrary, *R. mianningense* (Fig. 1e) is not as seriously at risk as *R. magniflorum* as its habitat is not as disturbed. Field surveys also revealed that *R. changii* and *R. platypodum* were faring well on Jinfoshan, Chongqing (Fig. 1f, g) the only locality from which they are recorded, despite the impact of tourism. Furthermore, we found far more than the 50 mature plants of *R. changii* that were mentioned in the Red List. Another species that is more seriously threatened than previously reported is *R. roxieoides* (Fig. 1h). During the recent surveys in 2012, we only found 22 mature plants, occupying an area of less than 200 m^2 at the summit of the mountain from which the type specimen was collected

Table 1 Field investigations mainly focusing on current distribution of *Rhododendrons* from 2011 to 2013

Years	Investigation periods	Provinces (name of observed location)
2011	June 2–12	Shannxi (Taibai); Gansu (Yushui); Henan (Lingbao)
2011	Oct.12–23	Shannxi (Taibai); Gansu (Yushui); Henan (Paomaju)
2012	March 25–April 3	Yunnan (Baoshan, Gaoligong Mountain)
2012	April 24–May 8	Yunnan (Jingdong, Ninglang); Sichuan (Mianning, Hanyuan, Leshan); Chongqing (Yibin, Wushan, Jinfushan); Guizhou (Xushui, Zunyi)
2012	Sep.26–Oct.15	Guihzou (Xingren); Yunnan (Zhongdian, Lijiang); Sichuan (Balang); Chongqing
2013	March 25–April 16	Guihzou (Baili); Yunnna (Dali)
2013	July 29–August 1	Guihzou (Xingren)

Fig. 1 Some endangered species examined in our field surveys; **a** *R.magniflorum*; **b** *R. balangense*; **c** *R. mallotum*; **d** *R. farinosum*; **e** *R.mianningense*; **f** *R.changii*; **g** *R. platypodum*; **h** *R. roxieoides*; **i** *R. tsaii*; **j** *R. protistum* var. *gigantum*

Fig. 2 The threats facing some of these species. **a** typical habitat of *R. magniflorum* and **b** now a walnut monoculture in Guizhou; **c** *R. roxieoides* is restricted to an area of less than 200 m^2 at the peak of mountain where the type specimens was collected in Chongqing; **d** the habitat of *R. tsaii* is very likely to be disturbed at Zhaotong, Yunnan; **e** logging is common even in protected areas in the Gaoligong mountains, Yunnan

(Fig. 2c). It should be noted that *R. roxieoides* was a rediscovery species, as it had not been seen since it was first collected in 1958.

In addition to these nine species, categorized as endangered in the Red List, we also highlight a further two, *R. tsaii* and *R. vialii*, both of which were considered as vulnerable in the Red List. The localities at which both occur are relatively accessible, and both are threatened with extinction through habitat destruction. There is therefore a case for treating both as endangered in the wild. *R. tsaii* usually occurs at ca. 3,000 m altitude and is

restricted to two or three sites in NE Yunnan. Recent observations indicate that there are a limited number of known plants and the habitat (Fig. 2d) in which they occur is fragmentary (Jens Nielsen, personal observation). *R. vialii* occurs at 1,200–1,800 m altitude, in southern Yunnan and adjacent parts of Laos. Its range has apparently decreased over the past hundred years in China; it is now only known from three sites. At one of these there are reported to be less than 100 extant plants, and there is considerable habitat damage at the remaining two sites. The potential for ex-situ conservation of this species has been explored in case these populations deteriorate further (Zhang and Feng 1996).

Discussion

The conservation of species that generally occur at low altitudes should be given priority as there is no doubt that human activities in these areas pose the greatest threats to *Rhododendrons*. The rising demand on land for farming, construction of roadways, hydro-electric power stations and more recently developments associated with the tourist influx have collectively placed considerable pressure on *Rhododendron* species (Sekar and Srivastava 2010). Therefore, future field observations should be concentrated on *Rhododendrons* that occur at low altitude, as it is clear that the rate of loss there is rapid. From our investigations that were carried out in 1996, we predict that *R. vialii* will be extinct very soon if deforestation continues at its present rate, and there is no protection of the local habitat.

By 2013, the majority of even remote localities in China have been subject to some level of habitat disturbance (Ma et al. 2010, 2013). While areas at low altitude are most at risk, some species that occur at higher altitudes are also suffering from the impact of disturbance due to various natural and anthropogenic factors (Mao et al. 2001; Singh et al. 2003; Sekar and Srivastava 2010). Natural threats include landslides and forest fires. Most of the alpine and subalpine *Rhododendrons* are also facing severe problems from heavy snowfall (e.g. *R. protistum* var. *gigantum*, Ma et al. 2012). Young trees and seedlings are more vulnerable to avalanche damage as they have less resistance to the mass of moving snow. Heavy rainfall and greater run-off at higher altitudes also wash them away. Therefore, to address the natural and anthropogenic factors affecting the degradation of habitat, species richness and regeneration status, future field work will also need to focus on areas where the habitat is disturbed.

Priority for field investigation should also be given to those species that have been assessed as being Data-Deficient. Some of these have incomplete descriptions (for instance, flowers not seen), or are only known from the original specimens from which they were described. A lack of data may imply that a species has or had a very limited distribution, and is therefore at risk of extinction, or is indeed already extinct.

It is however also possible, even for a well-described species, that population studies at or near the locality from which that species was first described, will indicate that the type specimen is from a plant that is exhibiting extreme phenotypic modification or is a hybrid. A review of the type specimen may also show that it has been assigned an affinity that is wrong and misleading. Thus, field investigations should result in a proper assessment of the taxonomic status of each of these species, to confirm whether they are indeed rare, and what the potential threats to their survival are.

There is an urgent need for comprehensive field surveys particularly focused on endangered species. The Genus *Rhododendron* is represented by over 550 species in China, yet we are only aware of a single comprehensive field survey report on them (Duan et al. 1995).

The publication of the Red List of *Rhododendrons* has provided a valuable impetus, but it is only as good as the distributional information on which it is based. Some of it is out of date or not sufficiently detailed to provide the locations for some of the listed endangered species. The evaluation of the conservation needs of the species in the Genus *Rhododendron* will require a review of both, the taxonomic status of those species that are at risk, and the viability of their remaining populations. In the first instance this review will be dependent on large scale, properly resourced field investigations. An in depth study on those species for which there is any doubt concerning their taxonomic status should follow. This will require the use of the laboratory. The review will therefore be dependent on realistic funding and will almost certainly require substantial government support for both field and laboratory investigations. Once the results from this review are available, a strategy for conserving those species that are at risk can be drawn up. In-situ conservation, alongside the remaining populations, is of course preferable. For this, reproductive success in their natural habitats needs to be evaluated. However there are species that may have reached a point of no return. Two examples, *R. magniflorum* and *R. roxieoides*, have been discussed above. They are, as far as we know, reduced to such small populations, that are at extreme risk. Ex-situ conservation should then be carried out. Seeds can be conserved in the National Germplasm Bank of Wild Species that has been established at the Kunming Institute of Botany in Yunnan Province. Ex-situ conservation in gardens is in its infancy in China, though there are some good examples. These include the *Rhododendron* collections at Ma San Ping in Sichuan Province, at Baili in Guizhou Province and at the Kunming Botanical Garden of Kunming Institute of Botany in Yunnan. There is a need for a network of sites that will cover the climate ranges for the threatened *Rhododendron* species, if they are to be protected in ex-situ collections. This most certainly is not a trivial matter as the genus is represented from sea-level to at least 5,000 m, in the mountainous regions of the Sino-Himalayas, and from the subtropical regions of south China to the cold temperate regions in the north.

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