

MINI REVIEW

Germplasm and conservation of rare and endangered tree species endemic to east China

Liu Jun and Jiang Jingmin ✉

Abstract

There are plenty of native tree species in east China, including 16 rare and endangered tree species belonging to 11 genera in 10 families. Because of narrow distribution area, weak qualitative competitiveness and reduced natural regeneration, the number of these tree species are decreasing substantially. Thus, it is necessary to protect endangered species endemic to the region. In this paper the basic data on germplasm, geographical distribution, biological characters, endangered status and current conservation strategies of rare and endangered species endemic to east China are presented. The gap areas were identified and accordingly implications were made on the future work on the native rare and endangered tree species in east China should focus on the basic research of conservation biology, establishment of the information system, solution of problems in reproductive biology and more emphasis on the key regions for protecting biodiversity.

Keywords: east China; rare and endangered; germplasm; conservation

Introduction

East China is a geographical region having an area of 65.86 square kilometres that covers the south-eastern coastal zone of China, including provinces of Zhejiang, Jiangsu, Shandong, Fujian, Jiangxi, Anhui and Shanghai (Wu & Wang, 1983; Liu *et al.*, 1995). Most of this region is

part of northern and mid-subtropical monsoon region with superior nature conditions, annual rainfall about 1100mm, flush precipitation and moderate climate. Hence east China is one of the key biodiversity regions in the world (Gao *et al.*, 2002; Ma, Tian, & Hu, 2010). With the global industrial expansion and the increase in urban population, the biodiversity of the world is decreasing rapidly and east China region is not an exception to this fact where ecological system is severely damaged and a large number of plant species have become extinct or endangered (Xue *et al.*, 1991; Hao *et al.*, 2000; Hu, Ding, & Chen, 2002; Zheng & Jin, 2008).

Due to special geographical environment and climatic conditions, there are so many rare and endangered tree species endemic to east China, such as *Abies beshanzuensis*, *Sinocalycanthus chinensis*, *Ostrya rehderiana* and *Magnolia cylindrica*. Because of narrow distribution area, weak qualitative competitiveness and slowness in natural regeneration, the number of these tree species are reduced substantially. Thus, it is necessary to take immediate measures to protect endangered species endemic to the region in the background of global climate change. In this paper the basic data on germplasm, geographical distribution, biological characters, endangered status and current conservation strategies of rare and endangered species endemic to east China were reviewed.

Wild germplasm of rare and endangered tree species endemic to east China

There are 16 rare and endangered tree species endemic to east China belonging to 11 genera in 10 families (Table 1). Two tree species of them are national first class protected wild tree species, including *Abies beshanzuensis* and *Carpinus putoensis* (Fu, 1992; Wang, An, & Leng, 2004). Number of national secondary and third class protected endangered tree species is seven and five in east China, accounting for 43.8% and 31.3% respectively. The last two tree species, including *Carpinus tientaiensis* and *Tilia miqueliana*, are not listed in the China red list of threatened plants. The two species are worth to study for their endangered status (Tang & Tang, 2007; Tang, Peng, &

Received: 06 May 2014 / Accepted revised version: 18 August 2014 /
Published online: 01 October 2014

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CITATION

Jun, L., & Jingmin, J. (2014). Germplasm and conservation of rare and endangered tree species endemic to east China. *Plant Science Today*, 1(4), 183-187. <http://dx.doi.org/10.14719/pst.2014.1.4.46>

AUTHOR'S AFFILIATION

Research Institute of Subtropical Forestry, Chinese Academy of Forestry,
Fuyang, Zhejiang 311400, PR China

CORRESPONDENCE

✉ Dr. Jiang Jingmin, Tel.: +86 571 6331 0915; Fax: +86 571 6331 0915;
Email: jiang_jingmin@163.com

Table 1. Number and distribution of rare and endangered tree species endemic to east China

Species	Protection grade	Wild individual number	Distribution area /hm ²	Distribution and Habits
<i>Abies beshanzenensis</i>	1	4	0.1	Zhejiang province, Alt. (altitude) 1700m in beach forest
<i>Carpinus putoensis</i>	1	1	0.05	Zhejiang province, Alt.240m, in zhoushan island
<i>Torreya jackii</i>	2	7000	56	Zhejiang and Fujian province, Alt. 200-800m in steep shady slope or evergreen forest along both sides of valley
<i>Sinojackia xylocarpa</i>	2	0	0	Jiangsu province, Alt.300-800m in forest edge
<i>Ostrya rehderiana</i>	2	5	0.4	Zhejiang province, Alt.160m along both sides of valley
<i>Neolitsea sericea</i>	2	130	10	Zhejiang, Shanghai and Jiangsu province, Alt.150-350m in evergreen forest of gully
<i>Sinocalycanthus chinensis</i>	2	60000	500	Zhejiang province, Alt. 600- 1000m understory along both sides of valley
<i>Ulmus elongata</i>	2	300	20	Zhejiang and Fujian province, Alt.400-800m in open forest
<i>Phoebe chekiangensis</i>	2	3000	200	Zhejiang, Jiangxi and Fujian province, Alt.1500-1000m in open forest of gully
<i>Magnolia cylindrica</i>	3	8600	600	Zhejiang, Anhui, Jiangxi and Fujian province, Alt.600-1700m in open forest of gully
<i>Magnolia amoena</i>	3	12000	900	Zhejiang, Anhui, Jiangxi and Jiangsu province, Alt.200-1000m in evergreen or mixed forest
<i>Ulmus gaussonii</i>	3	30	10	Anhui province, Alt.60-100m along both sides of brook
<i>Magnolia zenii</i>	3	18	5	Jiangsu province, Alt.180-230m in north slope of Baohua mountain
<i>Acer yangjuechi</i>	3	1	1	Zhejiang province, Alt.240- 500m, in mixed forest of Tianmu Mountain
<i>Carpinus tientaiensis</i>	None	21	0.3	Zhejiang province, Alt.800-1000m, in forest of Tiantai Mountain
<i>Tilia miqueliana</i>	None	500	10	Jiangsu, Zhejiang and Anhui province, Alt.180-300m in broadleaf forests

Tang, 2008; Chen, Ke, Yang, & Yan, 2010), hence they are listed in this article.

Zhejiang province is located in the Mid-East of east China, so biodiversity in this zone is very rich (Hu *et al.*, 2002; Wang & Zhu, 2004). There are 13 rare and endangered tree species endemic to east China, which account for 81.3% of the total number of species. Therefore, Zhejiang province is very important in protection of biodiversity of east China. There are 6 endangered tree species endemic to Zhejiang province, such as *Carpinus tientaiensis*, *Abies beshanzenensis*, *Carpinus putoensis*, *Ostrya rehderiana*, *Sinocalycanthus chinensis* and *Acer yangjuechi*. So there is serious need for conservation of rare and endangered tree species in Zhejiang province. Five endangered tree species endemic to east China have been found in Jiangsu province, two of them are endemic to Jiangsu province, including *Magnolia zenii* (Wang, Ding, Zhao, Cheng, & Shen, 2008; Sun, Dou, Liu, & Liu, 2008) and *Sinojackia xylocarpa* (Chen, 1957; Jia & Shen, 2007). *Neolitsea sericea* is the only one endangered tree species in Shanghai.

Great differences in the number of wild individuals among the tree species were observed. There were only less than 10 individuals reported for *Abies beshanzenensis* (Ai, Qiu, Yu, Chen, & Ding, 2005), *Carpinus putoensis* (Li *et al.*, 2010), *Sinojackia xylocarpa*, *Ostrya rehderiana* (Wang *et al.*, 2008) and *Acer yangjuechi* (Lou, Zhao, Yang, & Pang, 2004). Especially for *Sinojackia xylocarpa*, no natural distribution was found in Jiangsu province recently (Jia & Shen, 2007).

Reasons why the tree species became endangered

Reasons for the tree species endemic to east China becoming endangered are various, such as narrow natural distribution area, low level of genetic diversity, habitat changes, poor natural regeneration and weak population competitiveness (Oldfield, Lusty, & MacKinven, 1998). Some factors are extrinsic to the life history of the species in their distribution area and habitats, while others are intrinsic and reflect fundamental biological attributes that may constrain distribution and abundance (Pavlik, 1994; Hao & Liu, 2007). When efforts are made on their

conservation and recovery, it is important to assess main factors that result in the decline of their populations.

The low level of genetic diversity is the most important reason for endangering the tree species endemic to east China. Genetic diversity of *Abies beshanzuensis* and *Carpinus putoensis* is very low due to relatively less number of wild individuals in natural population (Ai *et al.*, 2005; He, 2009; Zhang, Wang, & Li, 2011). *Neolitsea sericea* also showed a low level of genetic diversity. The isolated distribution pattern of *N. sericea* among several islands is relatively recent (<9000 years). Shared common ancestry and similar selective regimes before the archipelago was separated from the mainland may account for the low level of genetic diversity seen in *N. sericea* (Schaal, Hayworth, Olsen, Rauscher, & Smith, 1998; Wang *et al.*, 2005). Although the wild individual number of *Sinocalycanthus chinensis* and *Torreya jackii* is more than thousands, the genetic variation is low for these two endangered tree species (Li & Jin, 2006; Li & Jin, 2007).

Plant species with restricted geographical distributions tend to be more threatened than the widespread plants (Gitzendanner & Soltis, 2000; Nybom & Bartish, 2000), so restricted geographical distribution is another reason for endangered tree species of east China. Low genetic diversity at population level in *T. jackii* could be attributed to restrictive geographical distribution and isolated populations. Two of the endangered tree species, such as *Ostrya rehderiana* and *Acer yangjuechi*, are only distributed in Tianmu Mountain. One population was found for these two species in this zone, and the distribution area is 0.4 and 1 hm², respectively (Hu *et al.*, 2002), therefore, population development was restricted by narrow geographical distribution.

Natural regeneration of plants is a complicated ecological process, which plays an important role in the multiplication, spread and continuation of plant populations and the stabilization and succession of plant communities (Li, Peng, & Dang, 2007). Therefore the poor natural regeneration ability will be one of reasons for the rare tree species of east China that became endangered as reported for many endangered tree species such as *Tilia miqueliana* (Tang *et al.*, 2008), *Ulmus elongate* (Jiang, 2003) and *Ostrya rehderiana* (Guan & Tao, 1988). The regeneration ability is related to seed vigour, seed dormancy, pollen viability and environment. The seed germination rate is very low based on indoor germination experiment (Zhang *et al.*, 1988). It is highly significant to note that no wild progeny seedlings were found under the trees in their natural habitats.

Population competitiveness can reflect the population dynamics and trends (Wang, An, & Zhu, 1998). If competitiveness is very strong for a tree species, it can be denoted as a dominant population. A dominant population

will be turned into an endangered population with competitiveness decreasing (Li, Su, & Xiang, 2002). The age structure of the populations were declining due to lack of seedlings for *Magnolia cylindrica* (Liu, Zhang, & Liu, 2010), *Tilia miqueliana* (Tang *et al.*, 2008) and *Abies beshanzuensis* (Hu, Shao, Qian, & Zhou, 2004).

Population declines are often attributed to habitat changes (Evans, 2004). The endangered tree species exhibited habitat specificity as reported for *Abies beshanzuensis* (Wu, Zhou, & Chen, 2009) and *Ostrya rehderiana* (Guan & Tao, 1988). These two tree species may be extinct owing to habitat changes. According to field observations, populations of *T. jackii* are dramatically shrinking in China due to heavy deforestation and extensive habitat loss in the past decades (Gao, 1996). Due to gradual fragmentation of the habitat, *T. jackii* is gradually limited to small isolated areas, and eventually fragmented into island-like small populations (Li & Jin, 2007).

Conservation status of these rare and endangered tree species

The conservation efforts must be given high priority for the endangered tree species endemic to east China. With the development of economy in east China, the governments have been realizing the importance of protecting biodiversity. Fourteen of these endangered tree species have been listed in China red list of threatened plants (Fu, 1992). The first law for protecting wild plants was published by the state council officially in 1996 (Wu, Huang, & Ding, 2004). Studies on conservation biology and genetics were carried out by the main research centres in east China. The research contents cover genetic diversity assessment, population structure, flowering and fruit characteristics, artificial propagation, conservation strategies and so on.

It is necessary to have some background knowledge of the population genetic diversity when one want to know the threatened level of a rare species. Half of the endangered tree species endemic to east China were undergone genetic diversity assessment. The genetic diversity of *T. jackii* at species level was relatively high, whereas the genetic diversity at the population level was relatively low (Li *et al.*, 2007), and the same results were found for *S. chinensis* (Li & Jin, 2007). Genetic diversity and genetic differentiation were examined in six populations of the insular endangered plant *N. sericea* in Zhoushan archipelago using random amplified polymorphic DNA (RAPD) markers. The results indicated that *N. sericea* had a lower level of genetic diversity than other insular plants (Wang *et al.*, 2004). Population pattern and diversity of the communities of many endangered tree species endemic to east China have also been studied. For example, the structure of diameter class of *T. miqueliana* population

appeared as on inverted pyramid and the population was declining with the survival curve of Deevey III and was unstable at seedling stage with a high death rate of the saplings. The regeneration modes of the population were seed germination and vegetative propagation, and the later played an important role in keeping population size (Tang & Tang, 2007).

Until 2010, 47 national nature reserves have been constructed in east China. All the endangered tree species endemic to east China have been protected in these natural reserves. Because of the narrow habitat specificity of the endangered tree species such as *Abies beshanzuensis* and *Ostrya rehderiana*, *in situ* conservation should be considered as the most important management activity for these species, and natural regeneration should be promoted (Jin, Yu, & Ding, 2002; Ma *et al.*, 2010). *Ex situ* conservation is very useful for the endangered tree species which are easy to propagate, such as *S. xylocarpa* and *P. chekiangensis*.

Conclusion and future prospects

The germplasm of endangered tree species endemic to east China is an important part of the biodiversity of the region. Protection of these threatened bioresources are given high priority and worth studying due to their ancient origin, endemism, population bottlenecks and for developing suitable conservation approaches.

The basic research work on conservation biology including analysis of distribution range and pattern, size and structure of populations, characteristics of habitats, reasons for species becoming endangered and so on have to be carried out. An information system on endangered tree species endemic to east China needs to be established based on these data which would assist to develop conservation strategies. Studies on reproductive biology are important for tree species that are difficult to propagate, such as *Ostrya rehderiana*, *Carpinus tientaiensis* and *Tilia miqueliana*. No seedlings of *Ostrya rehderiana* were found in natural forest or on market. Hence one must study seed dormancy and germination process, and advanced seedling technologies have to be introduced to solve the problem. *In vitro* techniques have been found beneficial for ensuring the conservation of threatened plants in recent years and this trend will likely to be continued.

There are 13 endangered tree species endemic to east China in Zhejiang province. Conservation of endangered tree species in Zhejiang province is more important than that in other provinces in east China. Based on distribution characters of endangered tree species endemic to east China, Zhoushan archipelago, Wuyi mountain, Xitianmu mountain, Baohua mountain and Dabie mountain are the key regions for protecting biodiversity. Conservation sites have to be established at regions where higher numbers of

tree species are on the edge of extinction.

Acknowledgments

We want to express our sincere thanks to Prof. Zong-xiu Sun and Prof. Shao-qing Hu. This work was supported by National Natural Science Foundation Project (Grant number: 31100487).

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