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COMMENTARY

Conflict between biodiversity conservation and economic growth: insight into rare plants in tropical China

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Abstract
Biodiversity managements are always hot topics in China that harbors so much hyper-biodiversity. However, biodiversity loss is continuing as economic growth is accelerating during recent decades. Questions that need to be addressed with regard to the conflict between biodiversity conservation and economic growth are: how much conservation effort is required and what measures are necessary to reconcile conflicts. Here we evaluate the phenomenon and conservation status of representative of the rare plants with important economic values in tropical China. They are facing the danger of extinction, even are disappearing as they are discovered. This topic enables us to propose conservation measures to resolve the dilemma that continued biodiversity loss is linked closely with economic growth. A combination of ex situ conservation, in situ conservation and in-depth surveys, is necessary to protect biodiversity in the tropical China. Insights gained from current conflict will permit a greater understanding of the rare plants with significant evolutionary and ecological roles but which are threatened by economic development, thus enabling the relevant departments to develop and implement appropriate conservation policies.

Keywords Biodiversity conservation · Economic growth · Rare plants · Tropical China · Recommendations

Introduction

Biodiversity is essential to human well-being and enhances many of nature's benefits to people, but people have been reduced biodiversity throughout human history, even is driving the sixth mass extinction in Earth's history (Isbel et al. 2017; Johnson et al.

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2017). Undoubtedly, human activities are exerting a far-reaching influence on biodiversity with the ongoing development of human societies and economies. Currently, biodiversity is being lost at a 100- to 1000-fold higher rate than during the geological past (Pimm et al. 1995). China, is recognized as one of the world's centers of biodiversity hotspots and a region of conservation priority globally (Myers et al. 2000), where is associated with four global biodiversity hotspots as identified by Conservation International (http://www.cepf.net/resources/hotspots/Pages/default.aspx). Accordingly, conserving China's biodiversity is important not only for China, but for the entire world (Ma et al. 2017). However, China's huge population and rapid economic growth pose serious threats to its biodiversity. Such conflicts between continued loss of biodiversity and the development of economic growth are, of course, not unique to China, but common globally. Under such scenarios, many nature reserves have been established, and legislation has been proposed to protect China's biodiversity. However, the situation regarding biodiversity in China is not optimistic, and species continue to be lost at an alarming rate. Therefore, conservation communities, including authorities, institutes and scholars, need to re-examine the assumptions and practices upon which the current conservation endeavors have been sustained, particularly in tropical China that harbor hyper-diverse plant species.

Biodiversity is organized into complex ecological networks of interacting species in local ecosystems (Hagen et al. 2012). Species is the fundamental to biology and the first step in exploring biology, providing the most practical metric for distinguishing habitats and tracking progress of the Earth's biodiversity (Costello et al. 2013). Historical as well as current data on species distributions are used to track changes in biodiversity (Boakes et al. 2010), and discovering species before they become extinct is important. Therefore, species are of considerable concern to biologists and conservationists in biodiversity research and conservation planning.

Globally, there are ca. 500,000 species of land plants, most of them are concentrated in the humid tropics (Corlett 2016); and almost two-thirds can be found in tropical latitudes (Pimm and Joppa 2015). In comparison to animals, the conservation of plant diversity has received considerably little attention, perhaps because plants lack the popular appeal of many animal groups (Goettsch et al. 2015). This is particularly the case in the tropics where, despite traditionally being considered as regions of high biodiversity, the risk of disappearance and extinction has been largely ignored. In moist species-rich forests, especially in the tropics, most species are rare and common species are likely to dominate ecosystem function (Corlett 2016). Additionally, the rare species in high diversity ecosystems support the most distinctive and vulnerable functions, making a disproportionate contribution to the potential range of functions that can be provided by the ecosystem (Mouillot et al. 2013; Corlett 2016). Moreover, rare species with narrow distribution and small populations are more vulnerable to environmental changes or unpredictable threats.

In an era of rapid global changes, the growing realization that biodiversity and human well-being are inextricably linked, has led to the adoption of numerous environmental policies (Gasparatos and Willis 2015). However, economic growth inadvertently impacts biodiversity conservation globally, particularly in developing countries. Biodiversity conservationists invariably face the dilemma that global efforts to maintain biodiversity increasingly run into conflict with those to reduce poverty (Sanderson and Redford 2003), and the decline of wildlife populations, extinction of species, and habitat transformation demand urgent actions (Palumbi 2001). Thus, the conflict between economic growth to alleviate poverty and biodiversity conservation is widely recognized in sections of academia and sometimes acknowledged in political circles (Czech 2008).

In China, ca. 31,000 species of vascular plant survived through the climate changes from the Miocene and Pleistocene glaciations (Li 2008). However, habitat degradation and resource exploitation have seriously eroded natural vegetation over many centuries (Sang et al. 2011). Areas with a tropical climate in China have much hyper-biodiversity. These regions include southeastern Xizang (Tibet), southwestern to southeastern Yunnan, southwestern Guangxi, southern Guangdon, southern Taiwan, and Hainan island (Zhu 2017). And in tropical China (Fig. 1), e.g., Xishuangbanna tropical rainforest with so much hyper-biodiversity, is suffering the same dilemma.

A population of the primitive fagaceous species, *Trigonobalanus verticillata* was found in the Xishuangbanna tropical rainforest (Fig. 1) during the field survey in 2016, which is the first record in mainland China. The adult individuals of *T. verticillata* were ca. 200. However, during the survey in June 2017, the species is disappearing and the number of adult plants of *T. verticillata* had fallen to ca. 30 and the species now faces extinction in the region due to the expansion of the tea cultivation. Locally, the tea trade represents the major income for local residents. However, the trees of *T. verticillata* and their associated habitats are considered as a resource of no value, leading to the trees and habitats were severely destroyed to ensure that tea population have more spaces, light and soil nutrients (Fig. 2). Under this scenario, the excessive pursuit of economic benefits is impacting on biodiversity with rare plants that are more susceptible to

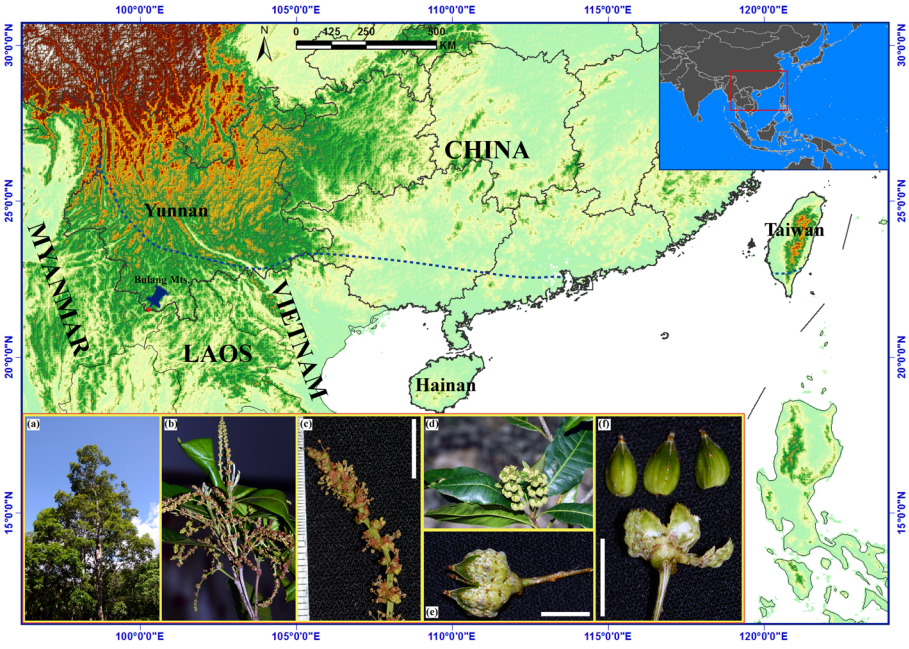

Fig. 1 The boundary of the tropical China, i.e., the tropical areas in south and southeastern China (adopted from Zhu 2017), and the geographic coordinates of *Trigonobalanus verticillata*. The blue dashed line indicates the northern boundary of tropical China; and the blue pointer and red dot indicate the sample locality in the Bulang Mountains, Xishuangbanna, Yunnan, China. **a** An adult tree of *T. verticillata*. **b** A branchlet of *T. verticillata* with staminate inflorescence. **c** A staminate inflorescence of *T. verticillata*, scale bar = 1 cm. **d** A branchlet of *T. verticillata* with fruit. **e** The fruits of *T. verticillata*, scale bar = 1 cm. **f** The seeds of *T. verticillata*, scale bar = 1 cm. (Color figure online)

Fig. 2 *Trigonobalanus verticillata* is growing in a tea garden where the natural habitat has been severely destroyed by the recent boom in the tea trade. Red arrows indicate plants of *T. verticillata* and yellow arrows indicate tea trees. **a** Many native trees were felled in order to ensure that the tea trees grow well; however, some *T. verticillata* trees on the edge of the tea garden survived the deforestation. **b** Destruction from slash-and-burn cultivation. The author (H.-H. Meng) is surveying the destroyed habitats. **c** The bark of many *T. verticillata* trees was stripped off mechanically; a new green shoot is seen sprouting from the damaged stem. **d** Trees of *T. verticillata* that died from being bark-stripped. **e** and **f** The expansion of tea trees, resulting the death of *T. verticillata*. (Color figure online)

extinction. Thus, it is necessary to highlight the conflicts so that appropriate conservation strategies can be developed.

Globally, economic growth using natural resources can alleviate poverty in under-developed regions and countries with rich biodiversity. Thus, excessive economic growth will inevitably have negative repercussions for biodiversity. However, rare plants with few individuals or restricted distributions are at risk under the pressures of economic growth and neglect of biodiversity conservation. In some case, the rare plants, such as *T. verticillata*, are disappearing and becoming extinct as they are discovered. Actually, there are some rare plants are facing the same fate and disappearing before they have been described or named. Reconcilable or not, the basic conflict between biodiversity conservation and economic growth is not well understood in broader society, and therefore is seldom incorporated into public policy, particularly with regards to the macroeconomic policies that influence rates of economic growth (Czech 2008). Thus, given the current acceleration of China's economic growth, understanding the conflict is not only necessary and urgent, but is also essential for effective conservation planning, as it is based on the current situation and the influences of environmental changes.

Herein, we initially present an overview of the status of *Trigonobalanus* in China; then describe the conservation status and conflict between economic growth and biodiversity

conservation of the rare plants in tropical China. Finally, we provide insights into the basic conflict between economic growth and biodiversity conservation. Only when the conflict is well understood can there be the potential for raising conservation awareness of rare plants in tropical China and alleviating the conflict.

Overview of the status of *Trigonobalanus* in China

Trigonobalanus shows many ancestral features within the *Fagus-Quercus* phyla (Forman 1964; Nixon and Crepet 1989), which is important for understanding of the phylogeny and biogeography of Fagaceae in relation to continental drifts, climatic shifts, and past global environment.

There are three extant species, *T. doichangensis*, *T. verticillata* and *T. excelsa* (Nixon and Crepet 1989). *T. doichangensis* and *T. verticillata* are distributed in Tropical Asia, while *T. excelsa* is distributed in Columbia, Central America. *T. doichangensis,* is restricted to northern Thailand; and south Yunnan, China, i.e., Ximeng, Menglian, Lancang, Cangyuan, (Hsu et al. 1981). However, the species is rare in China and thus poorly represented in herbaria. Because of heavy exploitation for fuel wood, house building, agricultural tools, and habitat degradation caused by clearing for agriculture, *T. doichangensis* has been pushed to the verge of extinction (Sun et al. 2006), and it has been recorded as endangered in the China Species Red List (Wang and Xie 2004).

A biodiversity survey of the Yinggeling area in Hainan Island, 2005, reported the presence of *T. verticillata*, a species previously known only from Malaysia and Indonesia (Ng and Lin 2008). More recently, a population of *T. verticillata* is discovered firstly in mainland China, i.e., the Bulang Mountains (22°35.32′N, 100°26.36′E; alt. 1179 m), Xishuangbabna, Yunnan (Fig. 1). The occurrence of *T. verticillata* is considered to provide reasonable evidence that Hainan Island might locate adjacent to northern Vietnam and Guangxi in geological history (Zhu and Zhou 2017). The population of *T. verticillata* in this area was narrowly distributed and contained ca. 200 adult individuals when we found and identified them the first time in 2016. Unfortunately, during the field survey in 2017, most of habitat of *T. verticillata* has been severely damaged by local residents in the course of establishing a tea garden (Fig. 2). Many adult trees were felled (Fig. 2a) or burned to death (Fig. 2b); with trees that were too large to cut down easily, were ring-barked (Fig. 2c, d). As a result, several withered trees now remain at the periphery of the tea garden, as testimony to the desolation caused by the tea boom in this region (Fig. 2e, f).

The local residents in this region are minority communities (i.e., Bulang and Dai), for whom tea farming is their livelihood, but who still practice slash-and-burn cultivation that severely destroys pre-existing habitats in the tropical rainforests of this region. The region produces many famous teas with excellent quality that fetch high prices; for example, Menghai Tea can cost up to $ 300 per kg (according to investigation in 2017). The widespread expansion of the tea trade is thus a major source of economic growth for the region, resulting in wildlife habitats being rapidly converted into tea gardens. This situation is progressively worsening. Actually, in many protected areas there is a failure to prevent the exploitation of valuable plants or animals and large areas also are subject to encroachment by farmers for slash-and-burn cultivation. Let along the rare plants not include in nature reserve, such as the new occurrence of *T. verticillata* is outside of the protected areas. Outsider of the nature reserves, the situation is worse, as the destruction can proceed virtually unimpeded, and land exploitation outside of natural reserve is legality permitted in China.

So, such region including this kind of rare plants should be considered in a conservation network, and this is necessary. Inevitably, when biodiversity conservation needs to make concessions to economic growth, the loss or extinction of biodiversity will follow.

Conservation status of the other rare plants in tropical China

The tropical China referred in this study, i.e., south Yunnan, Guangxi, Guangdong, Taiwan and Hainan, see Fig. 1, has many localities that are regarded as biodiversity hotspots with high plant diversity as well as many rare plants with narrow distributions and small populations. We reviewed the records of the other rare plants in tropical China from both International Union for Conservation of Nature's (IUCN) Red List of Threatened Species (http://www.iucnredlist.org/) and China Species Red List (Wang and Xie 2004). Then, several rare plants are selected as examples to illuminate the conflict between biodiversity conservation and economic growth (Table 1).

Based on their conservation assessments and status, rare plants in tropical China fall into several categories: (a) intrinsic and important economic value, such as *Myristica yunnanensis* and *Horsfieldia pandurifolia*, of which are used in medicine, and industrially for oil; (b) the habitats of rare plants are cleared for cash crops and agriculture for development of local economy, e.g., *Saccopetalum prolificum*, *Oncodostigma hainanense*, *Helicia shweliensis*, and *Bretschneidera sinensis*; (c) the habitats are lost through urbanization or construction, such as *Magnolia phanerophlebia* and *Cycas changjiangensis*; (d) lack of conservation awareness for rare plants, where local residents traditionally use them for excellent timber or firewood, such as *Alseodaphne rugosa*, *Phoebe nanmu* and *Pterocarpus indicus*. Additionally, the decline of the rare plants is still continuing in the three generation for the development of economy and society, especially the numbers of population have reduced to 30%, even to 80% (Table 1). More than that, though, some taxon with small geographic distribution and just have one population, such as *Cycas changjiangensis* and *Pterospermum menglunense*, need to be paid more conservation attention.

More importantly, the rare plants are also considered to be more susceptible to environmental change due to their narrow distribution ranges and small number of individuals dispersed in isolated populations. When rare plants are further identified as having economic value, the situation can become much worse if they are not got more conservation attention. For example, according to the IUCN Red List of Threatened Species, *Pterocarpus indicus* is extinct in Vietnam and undetectable in Sri Lanka, due to relentless harvesting of its valuable timber. Meanwhile, the habitat loss is unavoidable in which agriculture, cash crops, industry and urbanization are given priority for economic growth, making the conflict between biodiversity conservation and economic growth very difficult to reconcile.

The disappearance of rare plants not only affects potential resources for medicine or other economic uses, but also prevents tracking the evolutionary and biogeographic history of the plant as well as information about past climate change and any future implications. In addition, although only a small number of plant species have been exploited by humans, many others play important roles in natural ecosystems and rare species may also have novel traits that could be useful in the future. Thus, the impacts of economic development on rare plants and their habitats, particularly where rare species are disappearing almost as they are discovered, needs to be recognized and addressed before these potential resources are lost forever.

Table 1 The other rare plants are affected by the economic growth in tropical China, which are selected from both IUCN and China Species Red List as examples to illuminate the conflict between biodiversity conservation and economic growth

Rare plant species	Conservation statuses[a,b]	Economic value	Current situation according to China Species Red List
Acer duplicato-serratum	Vulnerable	Illegal removal of whole trees for the ornamental plant trade	Endemic in Taiwan, China; the decline is still continuing in the three generation, and the numbers of population have reduced to 30%
Alseodaphne hainanensis	Vulnerable	A slow-growing tree with high-quality wood, susceptible to overexploitation	Subordinate distribution region in China; the decline is still continuing in the three generation, and the numbers of population have reduced to 30%
Alseodaphne rugosa	Endangered	As per *A. hainanensis*	Endemic in Hainan, China; the decline is still continuing in the three generation, and the numbers of population have reduced to 50%
Bretschneidera sinensis	Endangered	Habitat loss and logging for medicine	Subordinate distribution region in China; the decline is still continuing in the three generation, and the numbers of population have reduced to 30%
Cycas changjiangensis	Endangered	Severely populations affected by habitat destruction through urbanization	Just one population in Hainan, China; and the distribution area is less than 100 Km^2
Dalbergia odorifer	Threatened	Illegal logging and overexploitation of the excellent timber is a serious problem	Endemic in Hainan, China; the decline is still continuing in the three generation, and the numbers of population have reduced to 80%
Helicia shweliensis	Endangered	Serious risk of extinction; habitat loss from logging and clearance for agriculture	Minor range in China, the habitats are less than 10 localities; and the habitats suffer serious threats
Hopea hainanensis	Critically Endangered	Illegal logging and overexploitation of the excellent timber for boats and industry	Minor range in Guangxi, China, the decline is still continuing in the three generation, and the numbers of population have reduced to 80%
Horsfieldia pandurifolia	Endangered	Over-collection of seeds for commercial oil and bark for medicine	Endemic in Yunnan, China; the decline is still continuing in the three generation, and the numbers of population have reduced to 50%
Litsea dilleniifolia	Endangered	Large trees harvested for their valuable timber	Endemic in Yunnan, China; the decline is still continuing in the three generation, and the numbers of population have reduced to 50%

Table 1 (continued)

Rare plant species	Conservation statuses[a,b]	Economic value	Current situation according to China Species Red List
Magnolia phanerophlebia	Endangered	Grows in unprotected forests and heavily exploited for firewood and timber	Endemic in Yunnan, China; the decline is still continuing in the three generation, and the numbers of population have reduced to 30%
Malania oleifera	Vulnerable	Seeds for oil, wild populations reduced by logging and habitat clearance	Endemic in Yunnan and Guangxi, China; the decline is still continuing in the three generation, and the numbers of population have reduced to 30%
Myristica yunnanensis	Critically Endangered	Seeds used for medicine, spices and commercial oil	Endemic in Yunnan, China; the decline is still continuing in the three generation, and the numbers of population have reduced to 50%
Oncodostigma hainanense	Vulnerable	Rapid population decline and habitat loss by logging and clearing for cultivation	Endemic in Hainan and Guangxi, China; the decline is still continuing in the three generation, and the numbers of population have reduced to 50%
Phoebe nanmu	Endangered	The timber is excellent for building construction and furniture	Endemic in Yunnan and Tibet, China; the decline is still continuing in the three generation, and the numbers of population have reduced to 50%
Pterospermum menglunense	Critically Endangered	Illegal cutting for the valuable timber and medicine	Just one population in Yunnan, China; and the distribution area is suffering serious threat
Rhoiptelea chiliantha	Vulnerable	Bark and leaves used as medicine; wood as a substrate for mushroom farming	Endemic in Yunnan Guangxi, China and N Vietnam; the decline is still continuing in the three generation, and the numbers of population have reduced to 30%
Saccopetalum prolificum	Vulnerable	Habitat decline through logging for timber and clearing for agriculture	Endemic in Hainan, China; the decline is still continuing in the three generation, and the numbers of population have reduced to 30%

[a]The International Union for Conservation of Nature's (IUCN) Red List (http://www.iucnredlist.org/) assessments of the conservation statuses

[b]China Species Red List (Wang and Xie 2004)

Recommendations

There are many rare plants in tropical China but their habitats are destroying in the wake of accelerating economic growth and there is an urgent need to prevent further losses. According to the current status and/or phenomenon that the new occurrence of *T. verticillata* is disappearing, integrating the conservation assessments of the rare plants in tropical China, and our experience in biodiversity conservation, we propose three approaches to increase public awareness of biodiversity protection and conservation as follows. The demands of conservation advocates for greater awareness and understanding of the loss biodiversity, as a consequence of the development of economic growth, are both necessary and urgent. There is no reason why any more plants should disappear or become extinct!

Ex situ conservation

It is widely acknowledged that a "safe site" is a basic and necessary requirement for the survival of rare or endangered plants. Ex situ conservation is one of the targets of the updated Global Strategy for Plant Conservation (GSPC; https://www.cbd.int/gspc/targets.shtml), which advocates that at least 75% of threatened plant species be maintained, with at least 20% are available for recovery and restoration programs. According to the targets of the GSPC, ex situ conservation may be a useful and practical approach to provide "safe sites" for rare plants via the conservation of seeds and adult trees. For most angiosperms, ca. 75–80%, have "orthodox" seeds that can be dried and then stored at low temperatures for a varying length of time (Walters et al. 2013; Corlett 2016). As such, ex situ seed storage not only underpins global agriculture and food supplies, but also enables the conservation of thousands of wild species within national and international facilities (Li and Pritchard 2009). Accordingly, ex situ seed is a potentially attainable target for the conservation of rare plants, and it will be possible to adopt this measure for seed preservation.

In a partnership with the world's largest seed bank, i.e., the Millennium Seed Bank (MSB) Project at Kew Royal Botanic Gardens (http://www.kew.org/msbp/index.htm), the Germplasm Bank of Wild Species (GBOWS; http://www.genobank.org/) was established in Kunming for biodiversity conservation. The GBOWS project shows that biodiversity schemes have taken root in China (Cyranoski 2003). Thus, similar to the seeds of genetic individuals of other species, it is possible to maintain the seeds of rare plants in the GBOWS.

At present, the simplest ex situ conservation strategy for rare and endangered species is to transplant living collections from the wild to botanical gardens, arboreta, or other similar facilities. With consideration of the concerns regarding the impact of changes (i.e., climate, environment and society changes) on floristic diversity, Xishuangbanna Tropical Botanical Garden (XTBG), the Chinese Academy of Sciences, has developed a conservation plan titled the Integrative Conservation for Zero Extinction project (ICZE) in Xishuangbanna, which entails ex situ conservation, reintroduction, ecological restoration, and education to prevent native plant extinction in this region (Liu et al. 2015). XTBG is committed to achieving zero plant extinction in Xishuangbanna, and the primary on-going focus of ICZE is to assess and protect China's entire native flora. Therefore, development of an ex situ conservation strategy will be the ultimate goal of ICZE. However, given the current status of *T. verticillata* that once occurred in the Xishuangbanna tropics and is at risk of

disappearance or extinction, and the current conservation situation of rare plants in tropical China, which will be a major challenge to the ICZE.

Additionally, the Science & Technology Basic Resources Investigation Program of China: Survey and Germplasm Conservation of Plant Species with Extremely Small Populations in South-west China, is implementing a project to save threatened species in southwestern China. Parts of this project being undertaken by the authors, will provide an opportunity to protect the rare plants in tropical China using an ex situ conservation strategy. To this end, the plant materials, including seeds and living collections of rare plants, will be transplanted to "safe sites".

In situ conservation

A common approach to conservation involves attempting to preserve large areas of natural populations of trees species is in situ conservation. However, to be effective, in situ conservation requires species-level monitoring to ensure that viable populations of rare and threatened species persist within protected areas, e.g., nature reserves. For example, the natural habitat of *T. verticillata,* which is now predominantly occupied by tea trees plantation, and is ca. 2 km outsider the Bulong Nature Reserve, which has not been recorded anywhere else in mainland China. Such an area of local endemism should be catalogued as irreplaceable and given high priority for conservation (Cavieres et al. 2002; Gao et al. 2014). Accordingly, as much of the remaining habitat of *T. verticillata* as possible should be added to Bulong Nature Reserve, if the local authorities made aware the importance of the new occurrence of *T. verticillata*. Similarly, biodiversity of other rare plants can be considered to protect within the native habitats if they are not encompassed within the local nature reserve, because the nature reserve can prevent the over-exploitation and illegal exploitation again the background of the economic growth took precedence over the other things. In this way, in situ measures can protect multiple species within whole ecosystems, unlike ex situ approaches that aim primarily to conserve single species.

Neverthless, effective implementation of such measures will be enormously challenging. The first crucial challenge is to convince the agribusiness sector of the potential gains from protecting habitat of rare plants that are not in nature reserves. Added to this is the problem that agribusiness has historically taken advantage of relatively weak local-level enforcement in order to develop the local economy and alleviate poverty by converting natural systems to economy, although the enforcement of law protecting natural reserves has recently intensified in China. Moreover, economic growth invariably increases the gross domestic product and brings benefits to the local people, which is not only promotes local development, but is also the achievements and performance appraisal of local government. Thus, the economic growth generated from exploiting the resources and habitats of rare plants in these regions may be seen as an effective approach to alleviate poverty.

Because of this economic imperative, expanding the protected habitat of rare plants not currently in nature reserves is likely to give rise to a certain degree of conflict with negative consequences impacting on local residents. That is, protection of the habitats of rare plants will cause income loss of the local residents.

Biodiversity loss and poverty are interlinked problems, conservation and poverty reduction need be tackled together in a collaborative framework, although the success of such integrated strategies is typically elusive (Adams et al. 2004). For example, the eviction of occupants or right holders from land or resources to create new reserves can exacerbate of poverty, as well as contravene laws or human rights (Wells 1992). Additionally,

organizations committed to the preservation of species and those creating sustainable rural livelihoods based on natural resource use are likely to approach the issues of poverty and biodiversity in very different ways (Adams et al. 2004). At the local scale, policies need to reconcile the conflicting interests of different stakeholders for the sustainable long-term management of natural resources of biodiverse ecosystems (Kepe et al. 2004). The end goal thus becomes allowing society to meet its potential and share the fruits of economic growth, while sustaining a biosphere that not only sustains full ecological functions, but also retains diversity for the continued use by future generations.

Thus, the policies of local governments, i.e., adding the habitat of unprotected rare plants that to nature reserves, in tandem with implementing relative poverty relief policy, and promoting a growing awareness of conservation, will help to preserve rare plants and the other species of their ecosystem in situ, because rare and endangered species are generally more susceptible to environmental changes in the face of economic development.

In-depth surveys

The major reason why the rare plants such as *T. verticillata* have only been discovered relatively recently is the lack of in-depth surveys. The conflict between biodiversity conservation and economic growth is rising with increasing social development, but less attention has been devoted to in-depth surveys that can provide clarifications on the extent and value of biodiversity. Recently, there has been growing despair that many species will probably become extinct before they are even discovered (Costello et al. 2013). It is certainly true that many rare plants as *T. verticillata* will disappear if their habitats are destroyed. Although conservation awareness of rare plants is growing, the long-term survival is not optimistic in the environment of high speed economic development. If rare plants are not discovered, in time to save them, they (and any benefits they may have) will disappear in silence. Thus, the situation of rare plants in tropical China is of great concern.

Species number is conventionally used as a measure of biodiversity (May 1988), and understanding the extent of species diversity is crucial to studies of extinction, conservation, biodiversity hotspots, bio-prospecting, and ecosystem function (Scotland and Wortley 2003). Rare plants are always distributed in narrow or small habitats, and with small number of individuals. Thus, rare plants are important in the diversity studies designed to answer the question of how many species there are on earth, in part through helping refine estimates of the numbers described or undescribed species (Costello et al. 2013; Govaerts 2001; Scotland and Wortley 2003). This is because, species which are rare, undescribed, or data deficient face severe challenges as ongoing development often threatens their habitats before they are recognized and conserved.

A model applied to the description rate of 112,000 plant species predicts that a further 30% of species remain to be discovered, although some experts suggest a lower figure of 18% (Joppa et al. 2011). Either way, species description rates may well not keep pace with the rate species extinction (Costello et al. 2013), although this could be offsetted by proportionally more taxonomic effort being devoted to less well-studied localities and taxa. However, because it is more difficult to find rare plants in vegetation survey, it highlights the urgent need for in-depth biodiversity surveys to identify and protect rare plants before they become extinct. The problem is exacerbated by the fact that the numbers of plant taxonomists is decreasing rapidly from in many of the countries that formerly led in this field (Office 2008). Moreover, even where taxonomy is well understood, conservationists are rarely able to preserve all the species or habitats under threat, if only for lack of funding

(Myers et al. 2000). Problems facing currently, conservation efforts are plagued much in China.

The current shortage of trained taxonomists in China is an incontrovertible fact, largely as work evaluations, promotions, and reward systems are linked closely to the number of (high) science citation index (SCI) papers that authors produce, but these metrics do not recognize the importance of traditional taxonomic research on plants (Ma 2014). As a result, over-reliance on SCI-ranked papers undermines the study of biodiversity (Valdecasas et al. 2000), and influences the development of taxonomy. Neverthless, biodiversity conservation is based on recognizing plants with the result that major obstacles to in-depth surveys for biodiversity conservation are emerging. Many plants remain undescribed because they go unrecognized due to a shortage of qualified taxonomists and thus cannot receive targeted protection. In China, the status of only a small percentage of known taxa has been assessed, particularly in the hyper-diverse humid tropics, such as the Xishuangbanna tropical rainforest. Such a lack of plant inventories will inevitably hinder efficient protection or effective, sustainable utilization. Therefore, the establishment of special funding, possibly through collaboration with and education of those seeking to develop these regions to get the benefits of identifying and conserving rare plants and habitats as resources, and the need for in-depth surveys of biodiversity, will protect more rare plants for future generations.

Conclusions

Biodiversity conservation is inextricably linked with human social economic development and thus, ecological damage and poverty alleviation seem to be two sides of the same coin. Over the past few decades, the need for an emerging awareness of biodiversity conservation has been reinforced as resources are increasing depleted and natural environments progressively deteriorated. Conflicts between biodiversity conservation and economic growth are not only globally important topics, but also influence the standard of living of local communities, sustainable development and a moderately prosperous society in all respects.

The combination of ex situ conservation in "safe sites," a well-managed system of protected areas for in situ conservation and in-depth surveys to identify species and habitats in need of management, are necessary to protect rare and endangered plants. Numerous challenges still remain if the current situation of biodiversity conservation is to be paid more attention. Among these are the following extremely urgent challenges: (a) appropriate alleviation of the poverty of local residents coupled with an understanding of the need to conserve natural environments; (b) reconciliation of current conflict between biodiversity conservation and economic growth, partly by seeing conservation as a long-term sustainable resource management option; and (c) addressing the lack of in-depth biodiversity surveys and the shortage of talented taxonomists so that conservation issues can be identified before it's too late to address them.

The shared mission of conservation provides strong incentives for developing a community of practice in more effective managements.

Firstly, local governments should develop policies to protect biodiversity under the condition that high priority is given to economic growth, so that non-environmentally destructive poverty relief policies can relieve some of the pressure on biodiversity conservation. Furthermore, the government should provide education and guidance to local residents, so

that biodiversity can co-exist in harmony with the development of tertiary industries such as the tourism industry.

A further important component is building a conservation community from the Conservation Management Bureau, e.g., the Bulong Nature Reserve and the Xishuangbanna National Nature Reserve, in which the staff can survey and protect the maximum extent of biodiversity in tropical China. Moreover, public support for conservation will be essential for the success of the ICZE at XTBG. Educational activities, e.g., training courses and discussion meetings focused on biodiversity conservation and involving nature reserve staff, local people, middle school and college students, are significant advances in biodiversity conservation. In this respect, publishing an accessible peer-reviewed literature with detailed information about the rare plants in a certain region, e.g., geographical distributions, localities, descriptions and illustrations, can aid in identifying rare and endangered plants and their value, which will make an important contribution to in-depth surveys. Finally, more professional staffs are necessary for participation in biodiversity conservation efforts to engage private, governmental and academic communities better in the worthy cause of biodiversity conservation.

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