How to be a conservation garden?

Jin CHEN

Director

Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences (**XTBG**)

Chairman

Chinese Union of Botanical Gardens (**CUBG**)

5th Global Botanic Gardens Congress, New Zealand

20-25 October, 2013

XTBG

Botanic gardens are institutions holding documented collections of living plants for the purposes of scientific research, conservation, display and education.

BGCI

Types of BGs (Wyse Jackson 2000)

1. ‘Classic’ multi-purpose gardens
2. Ornamental gardens
3. Historical gardens
4. Conservation gardens
5. University gardens
6. Combined botanical and zoological gardens
7. Agro-botanical germplasm gardens
8. Alpine or mountain gardens
9. Natural or wild gardens
10. Horticultural gardens
11. Thematic gardens
12. Community gardens

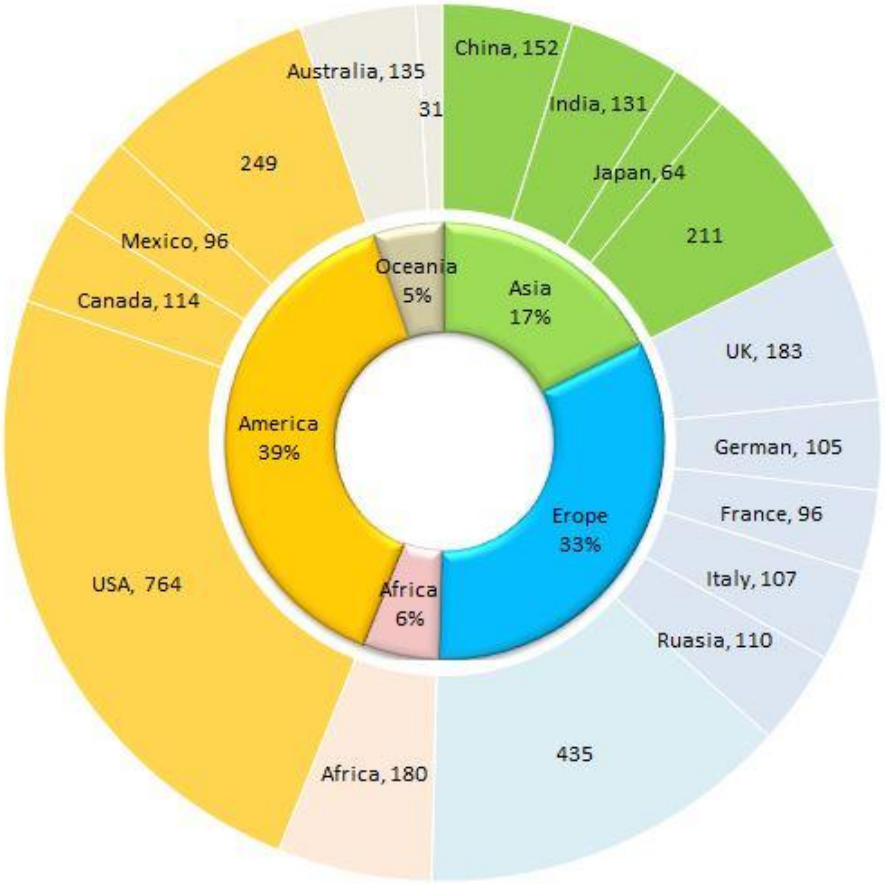
PART ONE

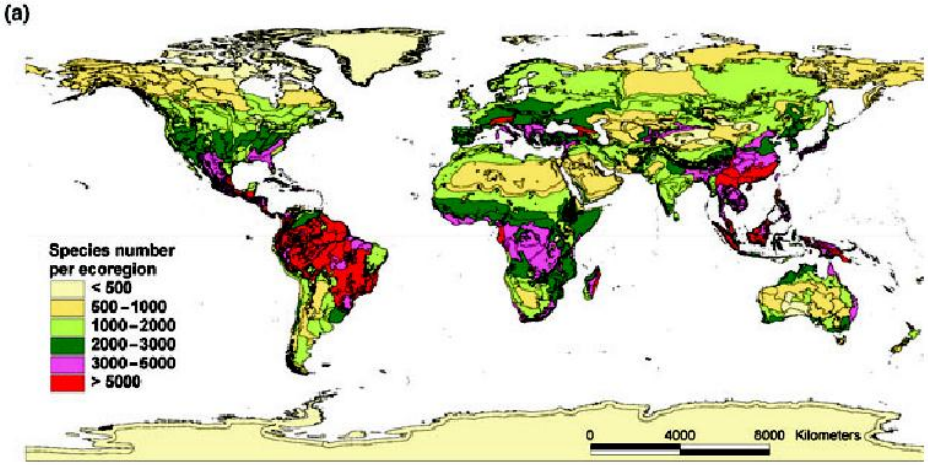
Why conservation oriented garden needed?

- From BGs ‘ developmental history, the original purpose for setting up botanical gardens was not for conservation
- The distribution for botanical gardens worldwide is not in cording to plant diversity
- Today, the new BGs (in China) set up are often still city garden and display oriented gardens
- Climate change call for new actions by conservation gardens
- It still needs more discussion on the principles, guideline and practices on conservation oriented BGs

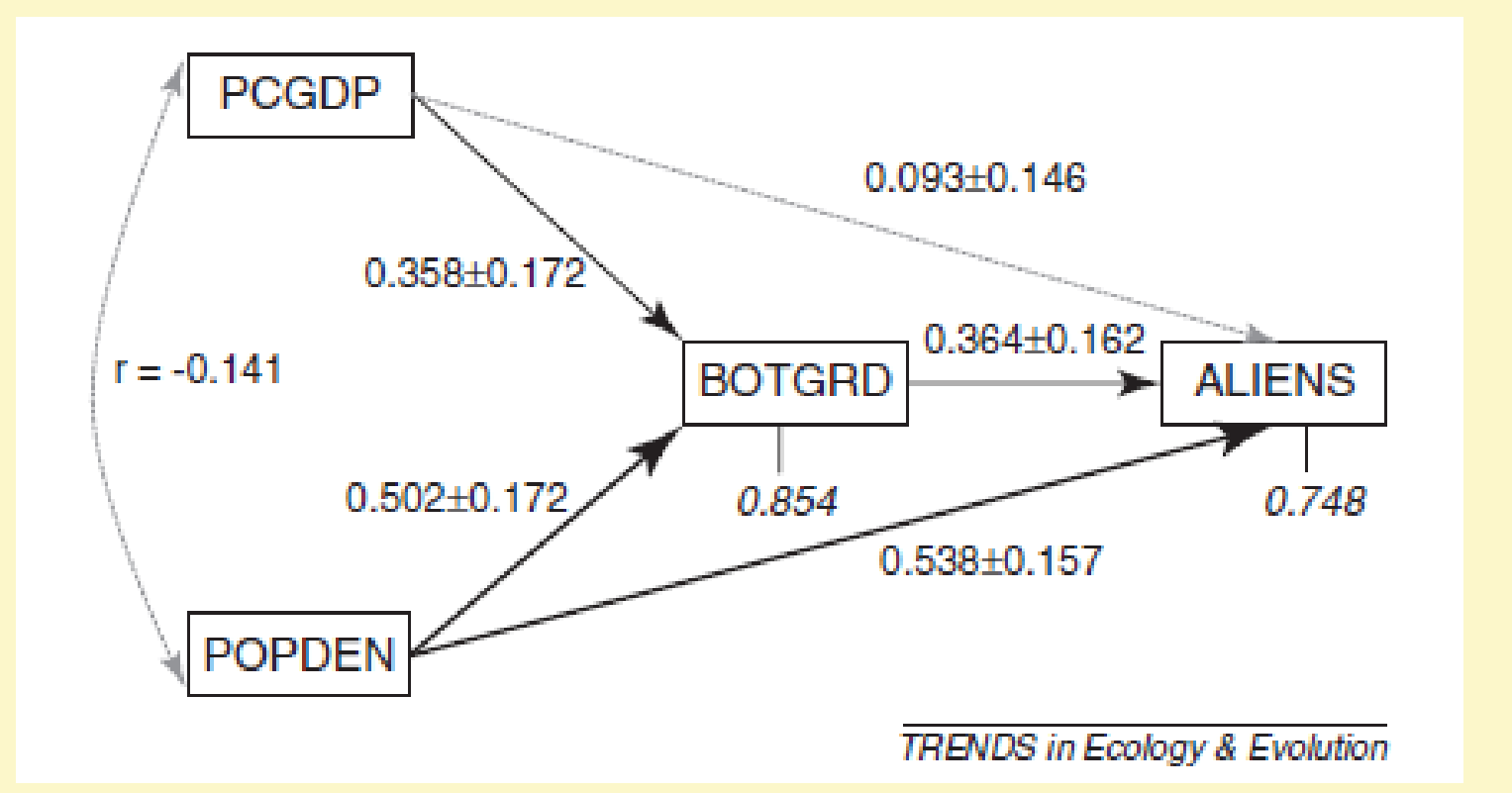
XTBG

Kier et al. (2005)
J. Biogeogr.





From BGCI website, totally 3163 BGs



Hulme, P.E. (2011) Trends in Ecology & Evolution

Over 300 botanists working out a new version for the Red list plants in China, **3767** (11%) of native plant species (35610) in the in Red list (CR, EN,VU）

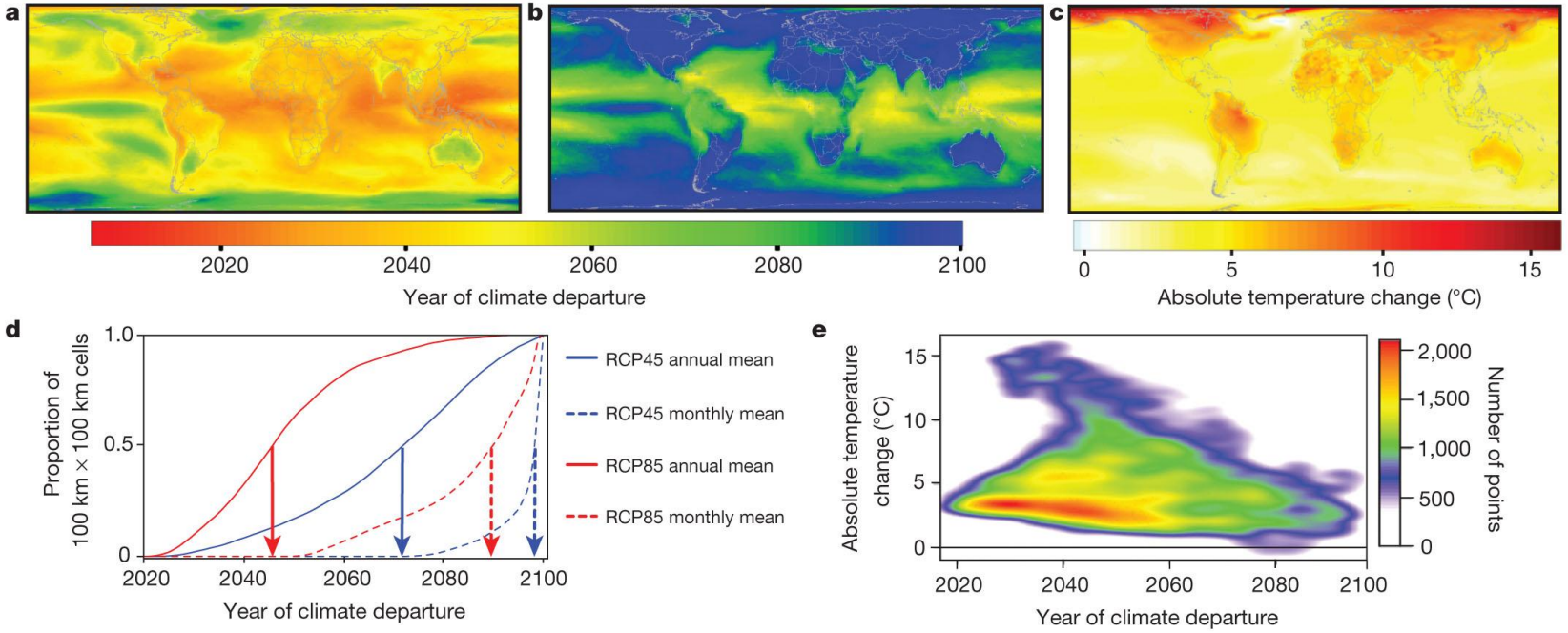
Source: http://www.zhb.gov.cn/gkml/hbb/bgg/201309/t20130912_260061.htm

‘HIPPO’ was still the major drivers for causing plant species endangered in China

Factors	Number of species	% of total endangered species
Habitats loss or degradation	2116	60
Over harvest	963	27.3
Environmental pollution	17	0.5
Nature disaster and climate change	39	1.1
Biological characters	357	10.1
Species interaction	33	0.9

Source: http://www.zhb.gov.cn/gkml/hbb/bgg/201309/t20130912_260061.htm

Ecological and societal disruptions by modern climate change are critically determined by the time frame over which climates shift beyond historical analogues. Here we present a new index of the year when the projected mean climate of a given location moves to a state continuously outside the bounds of historical variability under alternative greenhouse gas emissions scenarios. Using 1860 to 2005 as the historical period, this index has a global mean of 2069 (±18 years s.d.) for near-surface air temperature under an emissions stabilization scenario and 2047 (±14 years s.d.) under a 'business-as-usual' scenario. Unprecedented climates will occur earliest in the tropics and among low-income countries, highlighting the vulnerability of global biodiversity and the limited governmental capacity to respond to the impacts of climate change. Our findings shed light on the urgency of mitigating greenhouse gas emissions if climates potentially harmful to biodiversity and society are to be prevented.



C Mora *et al. Nature* **502**, 183-187 (2013) doi:10.1038/nature12540

nature

Review

Cell PRESS

Will plant movements keep up with climate change?

Richard T. Corlett[1] and David A. Westcott[2]

[1]Center for Integrative Conservation, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Menglun, Mengla, Yunnan 666303, China
[2]CSIRO Ecosystem Sciences, PO Box 780, Atherton, QLD 4883, Australia

In the face of anthropogenic climate change, species must acclimate, adapt, move, or die. Although some species are moving already, their ability to keep up with the faster changes expected in the future is unclear. 'Migration lag' is a particular concern with plants, be-

habitat. The need for plant movements, however, is not currently included in global vegetation models, which only estimate the potential future vegetation, assuming there are no limitations on plant movements (Box 1). In this review, we assess the ability of plants to keep up with

The answer is unfortunately: NO

XTBG

Extinction risk from climate change

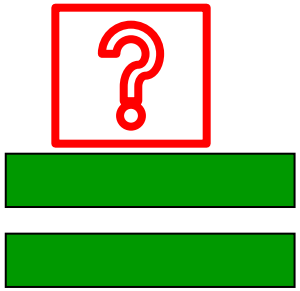
Chris D. Thomas[1], Alison Cameron[1], Rhys E. Green[2], Michel Bakkenes[3], Linda J. Beaumont[4], Yvonne C. Collingham[5], Barend F. N. Erasmus[6], Marinez Ferreira de Siqueira[7], Alan Grainger[8], Lee Hannah[9], Lesley Hughes[4], Brian Huntley[5], Albert S. van Jaarsveld[10], Guy F. Midgley[11], Lera Miles[8]*, Miguel A. Ortega-Huerta[12], A. Townsend Peterson[13], Oliver L. Phillips[8] & Stephen E. Williams[14]

Nature 2004, 427:145-148

Climate change over the past ~30 years has produced numerous shifts in the distributions and abundances of species[1,2] and has been implicated in one species-level extinction[3]. Using projections of species' distributions for future climate scenarios, we assess extinction risks for sample regions that cover some 20% of the Earth's terrestrial surface. Exploring three approaches in which the estimated probability of extinction shows a power-law relationship with geographical range size, we predict, on the basis of mid-range climate-warming scenarios for 2050, that 15–37% of species in our sample of regions and taxa will be 'committed to extinction'. When the average of the three methods and two dispersal scenarios is taken, minimal climate-warming scenarios produce lower projections of species committed to extinction (~18%) than mid-range (~24%) and maximum-change (~35%) scenarios. These estimates show the importance of rapid implementation of technologies to decrease greenhouse gas emissions and strategies for carbon sequestration.

XTBG

- Wolfs are really coming!
- It is estimated climate change would be the top one reason that causing species extinction
- If human being make ourselves ready to meet this challenges?
- Can BGs(especially conservation gardens) act as Noah's Ark for plant conservation in this planet?



Climate change: new challenges & Opportunities for BGs

New Phytologist

Review

Tansley review

The role of botanical gardens in climate change research

Author for correspondence:
Richard B. Primack
Tel: +1 617 353 2454
Email: primack@bu.edu

Received: *12 December 2008*
Accepted: *20 January 2009*

Richard B. Primack[1] and Abraham J. Miller-Rushing[2,3]

[1]Biology Department, Boston University, 5 Cummington St., Boston, MA 02215, USA; [2]USA National Phenology Network, 1955 East Sixth St., Tucson, AZ 85719, USA; [3]The Wildlife Society, 5410 Grosvenor Lane, Bethesda, MD 20814, USA

Climate research and education

- Phenology
- Physiology and anatomy
- Invasive species
- Public awareness
- Assisted migration

Review

Special Issue: Plant science research in botanic gardens

Botanic gardens science for conservation and global change

John S. Donaldson[1,2]

[1]SANBI, P/Bag X7, Claremont 7735, South Africa
[2]Botany Department, University of Cape Town, South Africa

Biodivers Conserv (2011) 20:221–239
DOI 10.1007/s10531-010-9781-5

ORIGINAL PAPER

Assisted migration, can it work?

The role of botanic gardens as resource and introduction centres in the face of global change

Vernon H. Heywood

…They comment that ‘With migration rates of -0.1-5 km per year required for geographic ranges to track climate change over the next century, we expect nurseries and gardens to provide a substantial head start on such migration for many native plants. While conservation biologists actively debate whether we should intentionally provide “assisted migration”, it is clear that we have already done so for a large number of species’

The 3rd Xishuangbanna International Symposium

First Announcement

January 13-16, 2014

Xishuangbanna, China

Botanical Gardens and Climate Change

PART II

How to design and run a conservation garden?

Location

Conservation gardens should be more located in those region with

1) **high α and ß plants diversity**
2) **high possibility of climate change**
3) **highly human disturbance**

Distribution of endangered species across China (IUCN category: CR+EN+VU)

Source: http://www.zhb.gov.cn/gkml/hbb/bgg/201309/t20130912_260061.htm

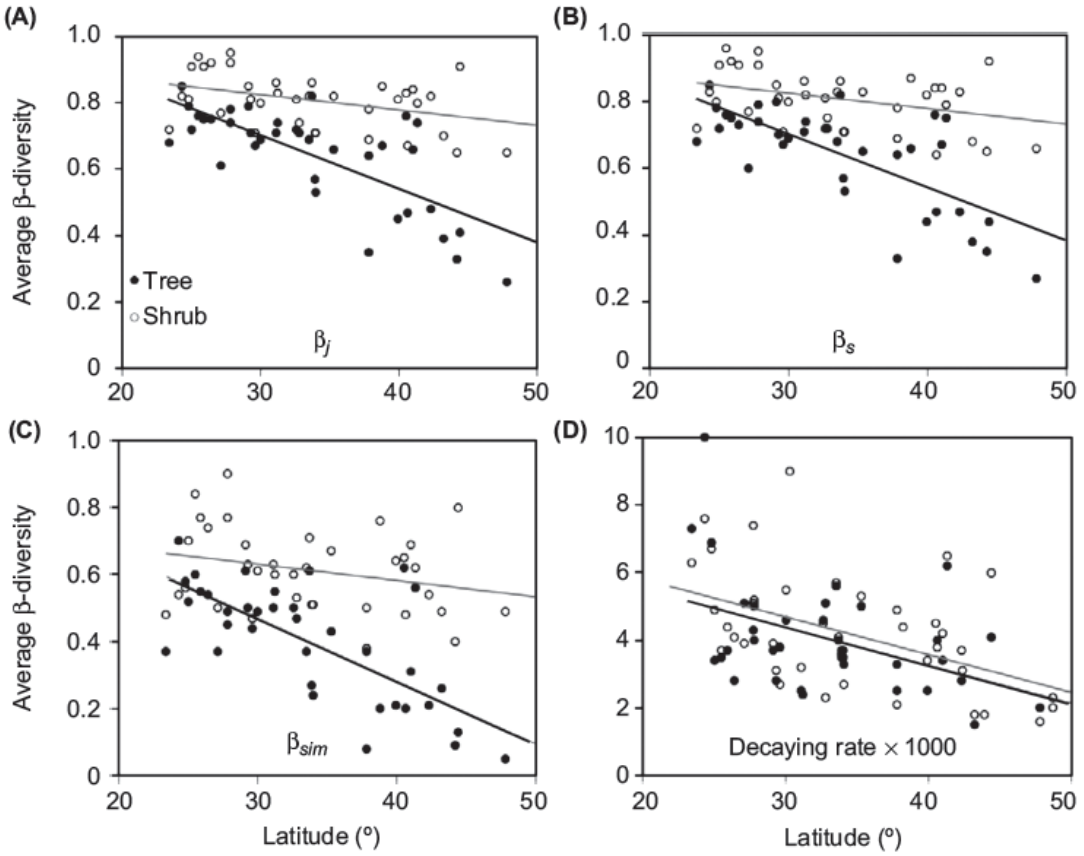
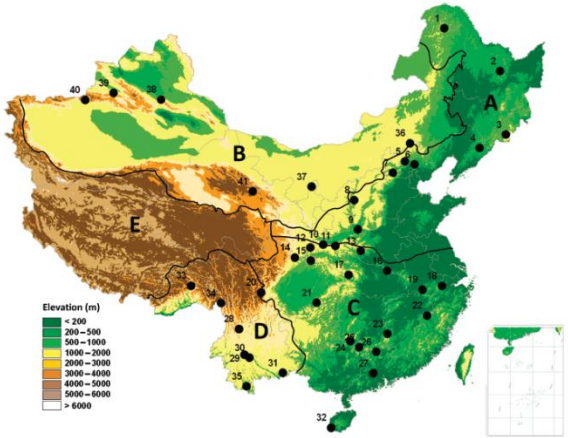


Figure 2. Latitudinal patterns of mean (A) β_j, (B) β_s, (C) β_{sim}, and (D) decaying rate of similarity across China's mountains. Solid dot and black line represent β-diversity of trees, and open dot and grey line represent that of shrubs.

Tang, Z. et al. (2012) Ecography



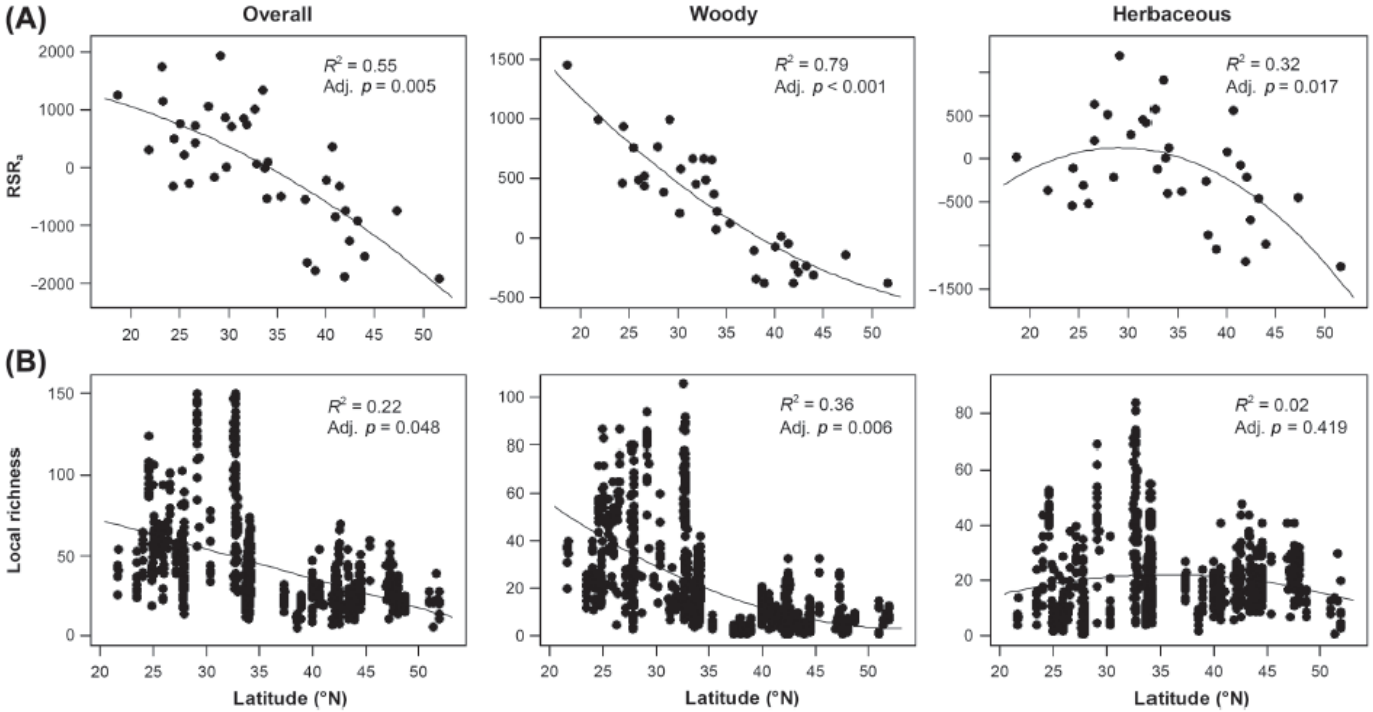
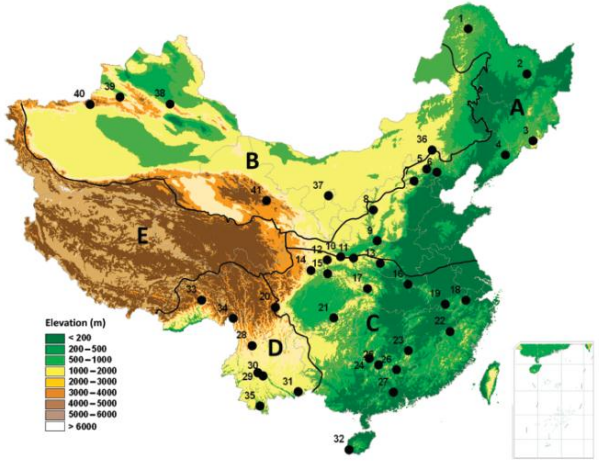


Figure 2. Latitudinal changes in regional (row A) and local (row B) species richness for woody, herbaceous and all species together. Regional richness (RSR_a) was area-adjusted here. The quadratic term of latitude was included in the initial models, and the final models were selected based on Bayesian information criterion. For each species group, the model R^2, significance [Adj. p, evaluated with the modified t-test of Dutilleul et al. (1993)] were reported.

Wang X.P., et. Al. (2012) Ecography



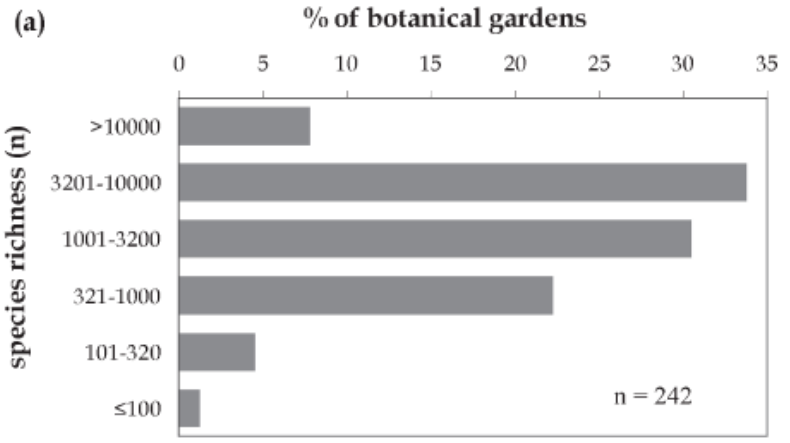
Sites

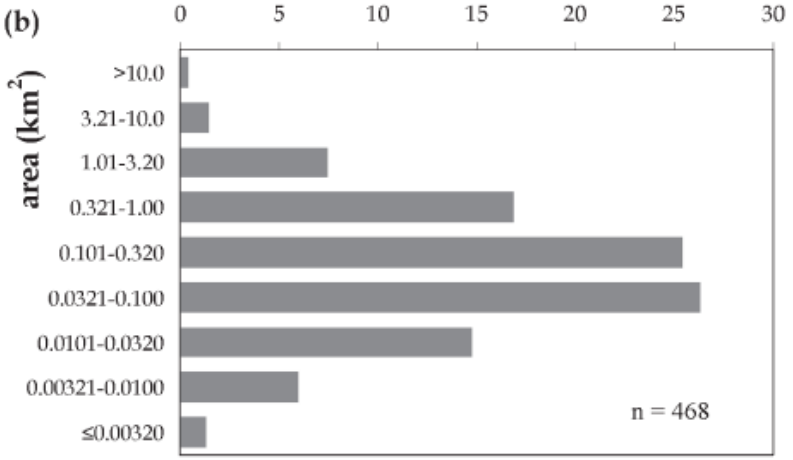
- ✓Free of being urbanized, ideally surrounding by natural forest or natural habitats
- ✓ Relatively large area
- ✓Microhabitats diversity
- ✓Other components for a general garden(deep soil, water supply, logistics, etc.)
- ✓ For existing BGs, their conservation function could be enhanced by add new satellite gardens

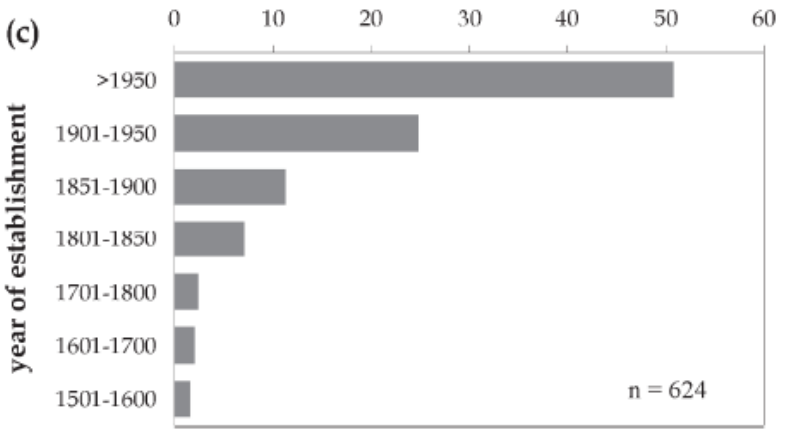
XTBG

Less than 10% of BGs with area > 100 ha, while more than 70% of BGs with area < 30 ha.

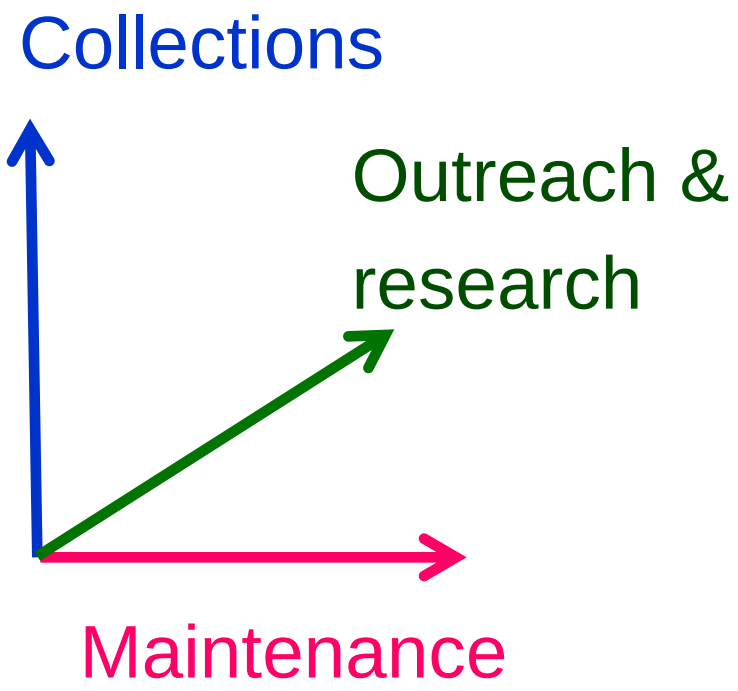
Pautasso & Parmentier (2007) **Bot. Helv**.







How to run a conservation garden



Collections

- Focus on local plant species
- More strict control for quality of samples
- Species distribution modeling and climate change effect
- Genetic markers used for capture genetic diversity and understanding genetic introgression in collections

ELSEVIER

Biological Conservation 106 (2002) 151–156

BIOLOGICAL CONSERVATION

www.elsevier.com/locate/biocon

Ex situ genetic conservation of endangered *Vatica guangxiensis* (Dipterocarpaceae) in China

Qiaoming Li[a,b], Zaifu Xu[a], Tianhua He[c,*]

[a]*Xishuangbanna Tropical Botanical Garden, the Chinese Academy of Sciences, Mengla 666303, People's Republic of China*
[b]*Kunming Institute of Botany, the Chinese Academy of Sciences, Kunming 650204, People's Republic of China*
[c]*Laboratory of Systematic and Evolutionary Botany, Institute of Botany, the Chinese Academy of Sciences, Beijing 100093, People's Republic of China*

Received 22 June 2001; received in revised form 10 September 2001; accepted 27 September 2001

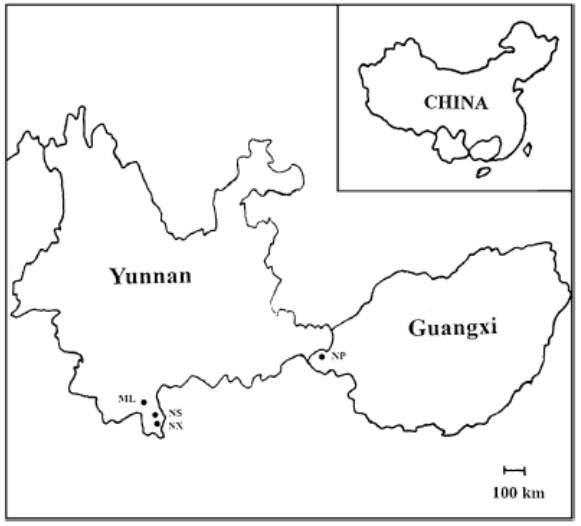


Fig. 1. Population locations of *Vatica guangxiensis* (NS: 21°30′ N, 101°35′ E, 800–1100 m Alt.; NP: 23°07′ N, 105°42′ E, 500–600 m Alt.; NX: 21°37′ N, 101°50′ E, 750–1000 m Alt.; ML: 21°54′ N, 101°18′ E, 600 m Alt.).

RAPD indicated 88.3% of genetic diversity in wild has been captured in XTBG collection

Conservation Biology

Contributed Paper

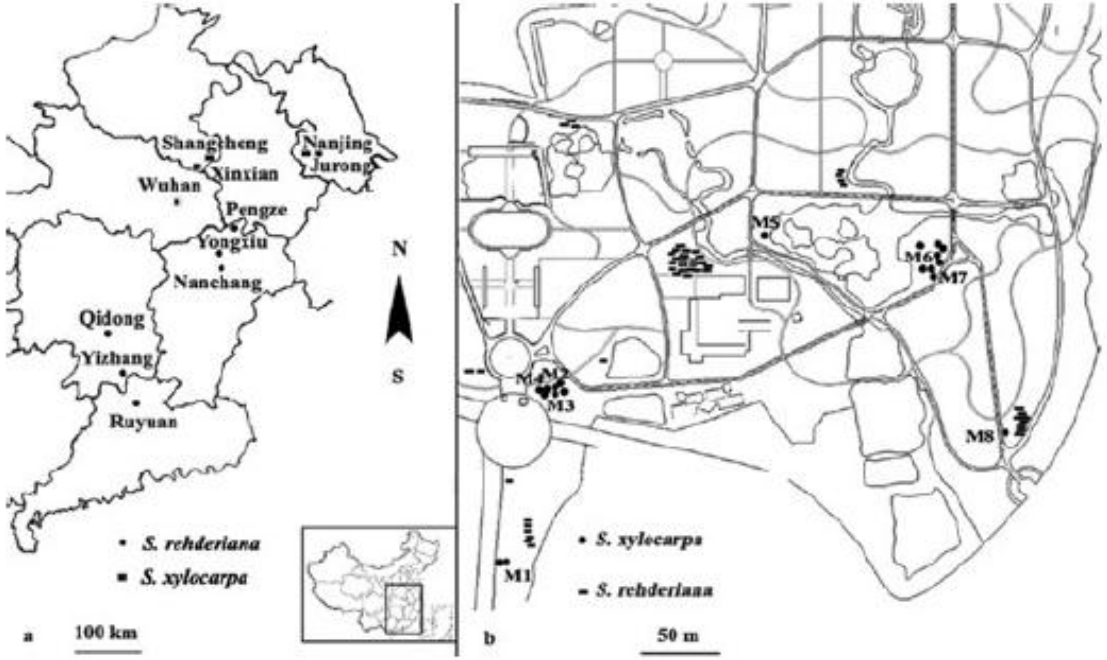
Spontaneous Interspecific Hybridization and Patterns of Pollen Dispersal in Ex Situ Populations of a Tree Species (*Sinojackia xylocarpa*) that is Extinct in the Wild

JIN-JU ZHANG,*§ QI-GANG YE,*§ XIAO-HONG YAO,*‡ AND HONG-WEN HUANG*†‡

*Wuhan Botanical Garden/Wuhan Institute of Botany, Chinese Academy of Sciences, Wuhan 430074, Hubei, China

†South China Botanical Garden/South China Institute of Botany, Chinese Academy of Sciences, Guangzhou 510650, China

Interspecific hybridization events were detected in seven out of eight maternal trees of *S. xylocarpa*, and an average of 32.7% seeds collected from maternal trees of *S. xylocarpa* were hybrids



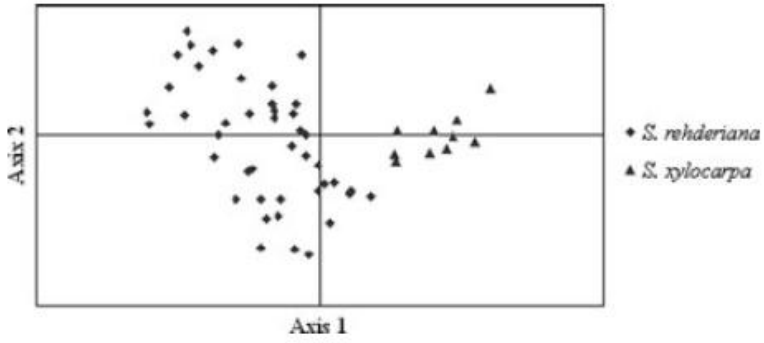


Figure 2. Two-dimensional plot of the principal coordinate analysis showing genetic relatedness between S. xylocarpa *and* S. rehderiana. *Axis 1 and axis 2 explain 35.66% and 16.91% of the total variance, respectively.*

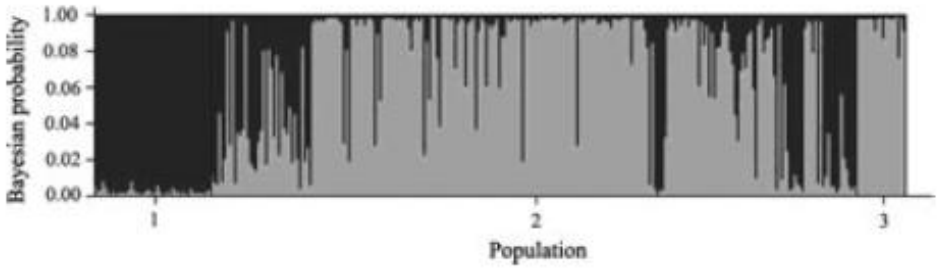
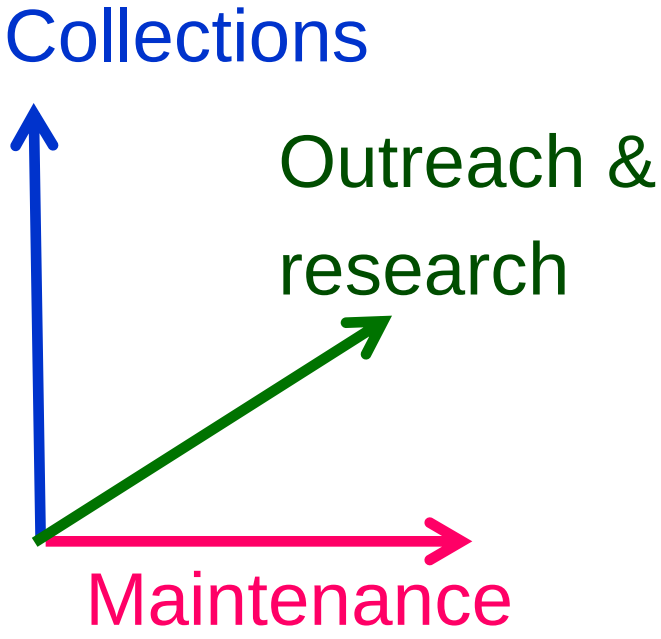


Figure 3. Bayesian probability of assignment of 313 individuals to a cluster (K = 2) *on the basis of multilocus microsatellite genotypes. Populations 1, 2, and 3 are from* S. rehderiana, *progenies, and* S. xylocarpa, *respectively.*

How to run a conservation garden



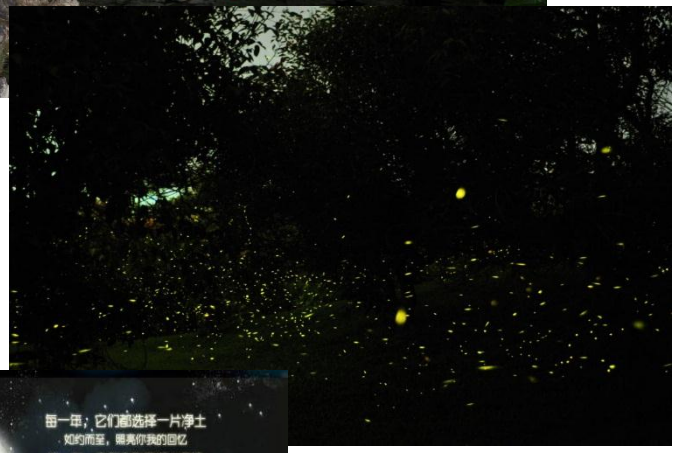
Maintenance

- Always organic and recycling approach, making the garden more ‘noisy’ and ‘wild’
- Proper intensity of horticulture
- Landscape architecture approach attracting visitors
- Conservation garden is a good place to environmental education and nature experiencing

XTBG

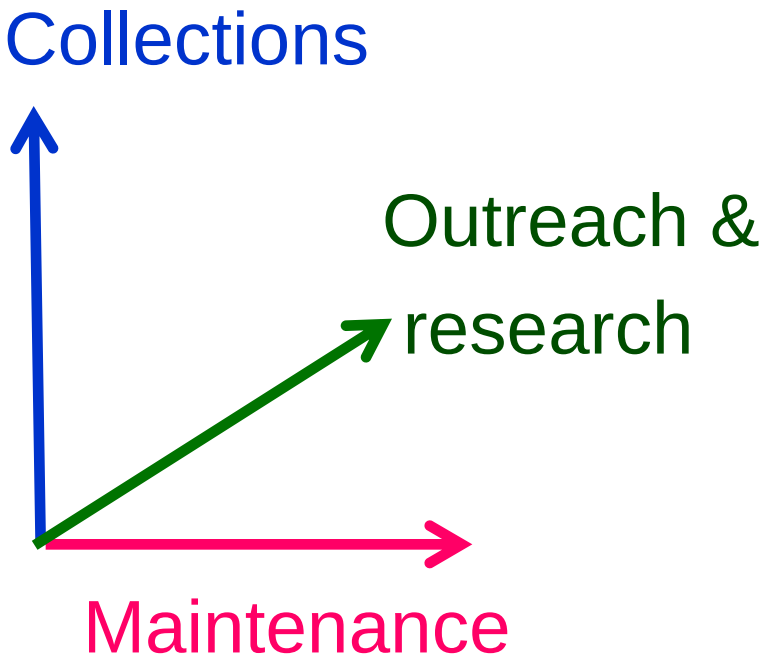
Flower garden in XTBG, a landscape approach

Bird watching has been conducted in several BGs in China, such as South China BG, Wuhan BG, Xia Men BG, Fairy Lake BG



Night watching has becoming a attracting natural experiences program to kids in many Chinese BGs, such as XTBG, Chensan BG, Zhongsan BG, etc.

How to run a conservation garden



Outreach & research

- Provide leadership in local biodiversity conservation, creating collective efforts
- Be relevant to all stakeholders, especially decision makers, from both local, regional, and national
- Knowledge innovation center for conservation science

PART III

BGs based conservation in China: New Initiatives

Xishuangbanna

- ✓ **19000 Km^2**
- ✓ **1.2 million population**
- ✓ **Tropical to subtropical**
- ✓ **Tropical rainforest**
- ✓ **Biodiversity:1/6(plant), ¼ (animal) of China**
- ✓ **Cultural diversity:12 ethnic groups**

‘Zero extinction’ program in xishuangbanna

1. Developing a **theoretical understanding** of the problems facing the native flora;
2. Identifying **practicable solutions** to these problems, using all the available tools;
3. Building the **capacity and public support** needed for their effective implementation.

Overall, we wish to create a flagship conservation program for XTBG and a model for using the entire ‘conservation toolbox’ for regional biodiversity conservation

Research priorities:

1. **Assessing the conservation status** of all native plant species in Xishuangbanna and **setting priorities** for conservation.

2. **Prioritizing forest fragments** for ***in situ*** protection.

3. ***Ex situ* conservation** of endangered plant species, by seed storage and as growing plants.

4. **Reintroduction** of rare and endangered species to natural habitats.

5. Enhancement of the effectiveness of **environmental education**.

In November, 2012, we did an 1-week **expert assessment** of the conservation status of the 4200 flowering plant species native to Xishuangbanna.

Category	Life form					Total
	Bamboo	Liana	Herb	Shrub	Tree	
EX			1			1
CR		4	20	6	13	43
EN		10	78	26	26	140
VU	5	94	176	151	164	590
LC	24	435	1216	687	532	2894
DD	17	87	198	151	79	532
Total	46	630	1689	1021	814	4200

Field survey

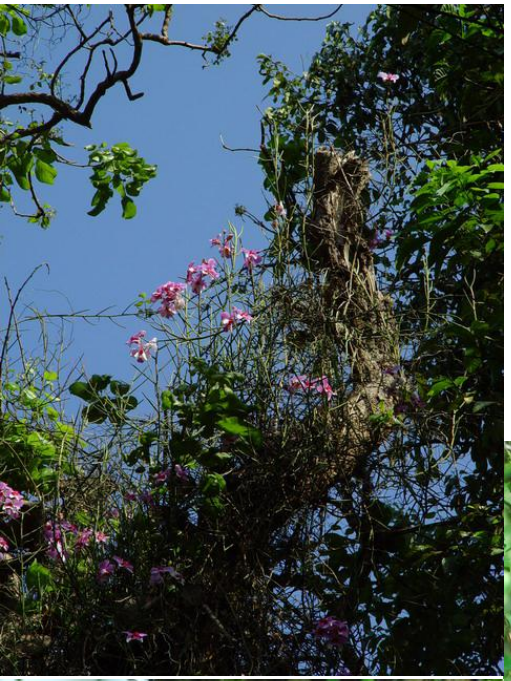
- ✓ Verify the distribution information about species categories 1-3 based on the discussion and herbarium information
- ✓ Reporting
  - Distribution of target species
  - Adjust the degree of categories
  - Proposal for new protection area
  - New species, new distribution

Next steps:

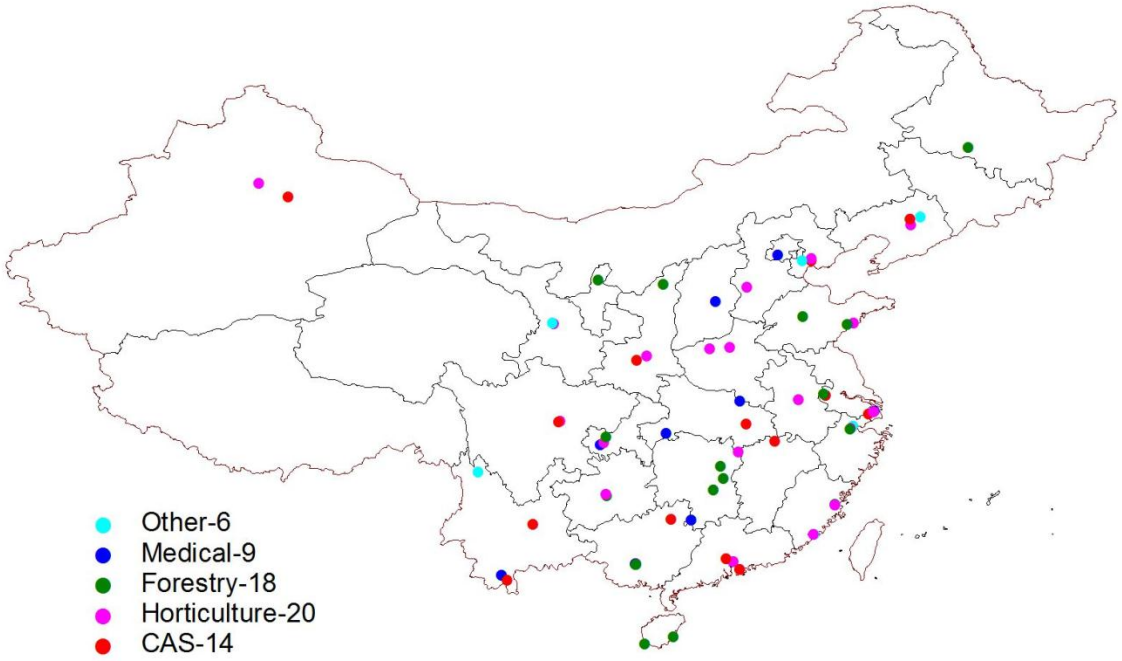
- Proposal for new protected area(community based management) to government based on species distribution of category 1-3
- Living collection ex-situ conservation for 1-3 with possible consideration for population diversity, seed storage for all category 1-4(except recalcitrant seeds)
- Reintroduction program for category 1-2
- Species distribution model and climate change taking into account for category 1-4
- E-flora and community participatory restoration program

Reintroduction for orchids

Totally over 100 species of orchids under reintroduction program among 429 native orchid species



From **zero extinction** to cover-all protection initiative



Totally, 67 BGs has registered as CUBG members

- 2013-2015
  - Extending to 4 BGs and areas
- 2016-2022
  - Extending 25-30 BGs throughout the country

In Conclusion

- Conservation oriented BGs may differ in its criteria and management strategies to traditional BGs
- Under the scenario of climate change, conservation gardens may bring BGs community into a new ere of development, allowing BGs providing much more critical role in ensuring the sustainability of the planet

Thanks

- Conference committee for inviting this talk
- My colleagues, Richard Corlett, Zhou H, Gao JY, Tao GD, Ferry Slik, etc. for co-developing the zero extinction idea
- Photos from Duan QW, Xu YK, He H
- Hu HB for preparing some of the figures

Thanks for your attention!

http://www.xtbg.ac.cn