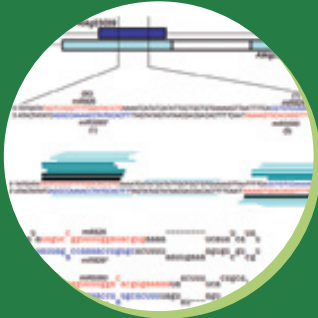




中国科学院  
热带植物资源可持续利用  
重点实验室  
(2013DP173084)

Key Laboratory of Tropical Plant Resource  
and Sustainable Use, Xishuangbanna Tropical  
Botanical Garden, Chinese Academy of Sciences



# Annual Report 2013



**Xishuangbanna Tropical Botanical Garden  
Chinese Academy of Sciences**



Cover photos, anti-clockwise:

1. The earliest fossil bamboos of China;
2. CAS Key Laboratory of Tropical Plant Resource and Sustainable Use unveiled;
3. The molecular mechanism of WRKY transcription factor in biotic and abiotic stress and the functions of plant miRNAs;
4. The Chinese Union of Botanical Gardens;
5. Signed MoU between XTBG, CAS and Department of Forest of the Department of Environmental Protection and Forestry, Myanmar;
6. Summer school for graduate students;
7. Summer camp experiment.

*Photo by LIU Qiang*



# **Annual Report 2013**

Xishuangbanna Tropical Botanical Garden  
Chinese Academy of Sciences

March 20, 2014



Xishuangbanna Tropical Botanical Garden (XTBG), Chinese Academy of Sciences is a non-profit, comprehensive botanical garden involved in scientific research, plant diversity conservation and public science education, affiliated directly to the Chinese Academy of Sciences.

**XTBG's vision:**

Desirable base for plant diversity conservation and ecological studies.

Noah's Ark for tropical plants.

**XTBG's mission:**

Promote science development and environmental conservation through implementing scientific research on ecology and plant diversity conservation, horticultural exhibition, and public education.





# CONTENTS

<b>SCIENCE</b> .....	2
Project Development .....	4
Research Progress and Outreach Highlights .....	6
Improvement of Research Facility .....	20
Conferences and Symposia .....	23
<b>HORTICULTURE</b> .....	30
<b>PUBLIC EDUCATION</b> .....	34
<b>PARTNERSHIP</b> .....	38
Domestic .....	39
Abroad .....	42
<b>TALENT TRAINING AND TEAM BUILDING</b> .....	46
Postgraduate Education .....	47
Talent Training .....	48
Team Building .....	53
<b>VISITS</b> .....	56
Other Visitors .....	60
<b>FINANCIAL REVIEW</b> .....	62
<b>PUBLICATIONS</b> .....	64



A full-page photograph of a peacock standing in a lush forest. The peacock is positioned in the lower half of the frame, facing right. It has a dark blue head with a crest, a long blue neck, and a body with iridescent blue and green feathers. Its tail is long and features many 'eye' patterns in shades of blue, green, and gold. The peacock is standing on a ground covered with dry leaves and twigs. To the left of the peacock is a tree with dark brown bark and green leaves. Several clusters of bright orange, star-shaped flowers are visible on the tree branches. The background is a dense forest with green foliage, some of which is out of focus. A white rectangular box is overlaid on the right side of the image, containing the word 'Science' in white text.

# Science

Photo by LIU Guang-Yu



In 2013, XTBG received 47.22 million Yuan in research funds from 71 new projects:

26 projects funded by the National Natural Science Foundation of China;

1 project supported by the Ministry of Science and Technology;

1 project supported by other Ministries in China;

17 projects supported by the Chinese Academy of Sciences;

6 projects funded by the CAS “Light in Western China” program;

9 projects funded by Yunnan Provincial Fund for Natural Sciences;

11 projects funded by local government, enterprises and international agencies.

XTBG researchers achieved the following:

149 research articles published in internationally peer-reviewed scientific journals (Source Journals of ISI Web of Science);

51 research articles published in other international or Chinese refereed journals;

6 published monographs;

9 patented inventions;

7 registered trademarks.

# Project Development

## “One Major Orientation, Three Significant Breakthroughs, and Five Important Fostering Directions” Project

“One Major Orientation, Three Significant Breakthroughs, and Five Important Fostering Directions” Project (“1-3-5” project for short) was launched in 2012 and has been carried out smoothly in 2013. Every team that worked on this strategy got promising results. XTBG successfully promoted the planting of *Plukenetia volubilis* in more than 3,300 ha in Yunnan, Laos, Thailand and some others. XTBG acquired the Rainforest Xing Oil Enterprise, and registered this business (Q/XBZKY 0001 S-2013). An oil squeezing pilot shop for *P. volubilis* was tested successfully, the first draft of *P. volubilis* Planting Technique Manual was finished, highly-productive transgenic *P. volubilis* plants were developed, and XTBG applied for patent rights for the technology to increase flowering and fruiting rates. XTBG has also provided *P. volubilis* seedlings to desertification control projects in

the Hekou region of Yunnan Province and the Xingyi region of Guizhou Province. The “Environmentally friendly rubber plantation” program has drawn high attention from

the Yunnan provincial government, and the Xishuangbanna government. The XTBG proposed plan, entitled “Promoting environmental friendly rubber plantation, realizing sustainable development of rubber industry”, was made official by the provincial government. Xishuangbanna Prefecture plans to build 6,600 ha of environmentally friendly rubber plantations each year.

The success of the 1-3-5 project is also indicated by numerous of research findings have been published in the top journals, such as *PNAS*, *Plant Cell*, etc. The fostering directions have also been obviously strengthening in the research capacity.

On February 6, XTBG organized the ‘Workshop on XTBG Development Strategy’, as well as the ‘1-3-5’ process review



Rainforest Xing Oil (*P. volubilis* oil) and other *P. volubilis* products.



TOP: Environmentally friendly rubber plantation;

BELOW: Approval of promoting “Environmentally friendly rubber plantation” program by the prefectural government.

meeting. During the meeting, innovation points, goals and supporting measures of each team were further defined. In December, a 1-3-5 strategy– mid-evaluating meeting was held within XTBG. XTBG gave bonus and rewards to those teams that have made conspicuous achievements in 1-3-5 projects.



ABOVE: Workshop on XTBG Development Strategy;  
BELOW: 1-3-5 strategy – mid-evaluating meeting.





## Final report of QCAS project

Supported by Queensland Government, Australia and Chinese Academy of Sciences, China's Joint Biotechnology Fund (QCAS), and after three year's collaboration, the project "Biodiversity distribution and processes across adjacent climates: the key to prediction and monitoring of responses to climate change" achieved its goal. The final report of this project and conclusive workshop was held in Griffith University, Australia from October 14 to 18.

A total of 60 sites, each 20×20 m, were organized and



*QCAS final report and conclusive workshop.*

established in three altitudinal transects in Yunnan Province, China, with the purpose of monitoring the responses of species in different ecosystem types to environmental change. Tree species, epiphytes, canopy arthropods (moths, ants, beetles) and soil fauna were surveyed, ecological processes including litter decomposition, pollination and functional traits were monitored. To date, 18 research articles were published on internationally peer-reviewed journals by XTBG. Both sides agreed to work together to produce more synthetic and comparative results using data collected from both Chinese and Australian transects. Future bilateral/multilateral collaboration is expected.

## New project on biodiversity dynamics research in Southeast Asia

Co-hosted by XTBG, Kunming Institute of Botany, Kunming Institute of Zoology, and collaborated with Southern Institute of Ecology, Vietnam, Forest Research Institute of Malaysia, and Mulawaman University, Indonesia, "Research on Biodiversity Dynamics in Southeast Asia Countries" project has been initiated smoothly. This project aims to build field monitoring network on biodiversity dynamics in Southeast Asia countries, and help local research institute build capacity. Workshop on Biodiversity Research in Southeast Asia was held on October 18 to 20 in Kunming. 31 participants from

China, Vietnam, Singapore, Malaysia, Indonesia, Thailand, and Japan met to discuss the significance of biodiversity research in Southeast Asia, and urged understanding and cooperation in future.

The project was supported by Bureau of International Co-operation, Chinese Academy of Sciences.

## CAS strategic priority research program

Prof. YU Di-Qiu's research group has been selected to participate in the research project on "innovation systems of designer breeding by molecular modules", a strategic priority research program of Chinese Academy of Sciences. YU Di-Qiu's team will conduct study on dependable crop and high yield of rice and analysis of molecular modules. Prof. YU Di-Qiu is principal investigator (PI) and the co-PI is Prof. LI Lai-Geng of Shanghai Institute of Plant Physiology and Ecology. The objective of the project is to keep and improve rice productivities by integrating multiple prominent molecular blocks into the same rice species.

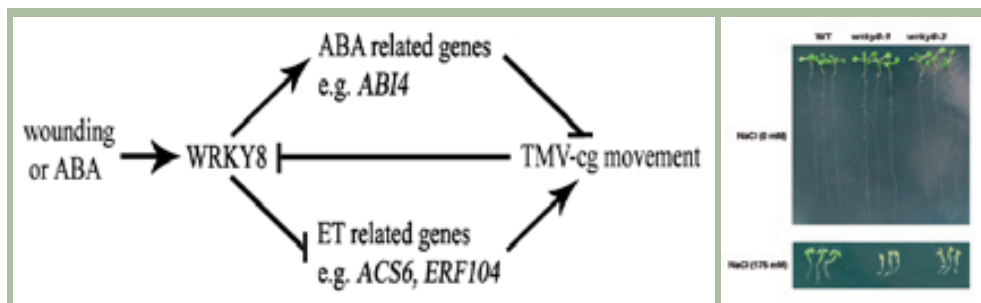
YU Di-Qiu's research interest focuses on the functions of plant WRKY transcription factors in response to biotic (bacterium and fungi) and abiotic (salt, hot, cold, *etc.*) stresses. Recently, their research work has been published in *PNAS*, *Plant Cell*, and *Plant Journal*. Abiotic stresses have become the major limitation factor for crop productivities.

## Research Progress and Outreach Highlights

### The molecular mechanism of WRKY transcription factor in biotic and abiotic stress and the functions of plant miRNAs

The WRKY gene family has been suggested to play important roles in the regulation of transcriptional reprogramming associated with plant stress responses. Prof. YU Di-Qiu and his team at XTBG have been engaged in studying the functions of *A. thaliana* WRKY DNA-binding protein for many years. Recently, they reported that WRKY8 functions as a positive regulator during TMV-cg's (tobacco mosaic virus) systemic infection by mediating crosstalk between the phytohormone ethylene (ET) and abscisic acid (ABA) signaling when plants are infected by TMV-cg. The study, entitled "WRKY8 transcription factor functions in the TMV-cg defense response by mediating both abscisic acid and ethylene signaling in *Arabidopsis*", has been published in *Proceedings of the National Academy of Sciences of the United States of America*. Although WRKY8 transcription factor plays a key role in plant antiviral defense, the involvement of WRKY8

protein in abiotic stress responses and the possible regulatory mechanisms of these responses remain largely unclear. To clarify the potential functions of *Arabidopsis* WRKY8 gene in abiotic stress, the researchers further explored and revealed that the VQ9 protein acts as a repressor of the WRKY8 factor to maintain an appropriate balance of WRKY8-mediated signaling pathways to establish salinity stress tolerance. This





study, entitled “*Arabidopsis* transcription factor WRKY8 functions antagonistically with its interacting partner VQ9 to modulate salinity stress tolerance”, has been published in *The Plant Journal*.

Leaf senescence is regulated by diverse developmental and environmental factors. Recently, Prof. YU and his group found that as a repressor in JA-induced leaf senescence, WRKY57 functions as a node of convergence for jasmonic acid- and auxin-mediated signaling in jasmonic acid-induced leaf senescence. The study, entitled “*Arabidopsis* WRKY57 functions as a node of convergence for jasmonic acid- and auxin-mediated signaling in jasmonic acid-induced leaf senescence”, has been published in *Plant Cell*.

Besides the function of WRKY transcription factors, the function of miRNA also is a focus of Prof. YU Di-Qiu and his group. They conducted a study to reveal the function of miR396 in flower development and revealed the function of miR396 in reducing the formation of the GRF/GIF complex, which regulates pistil development. The study, entitled “Molecular mechanism of miR396 mediating pistil development in *Arabidopsis thaliana*”, has been published in *Plant Physiology*.

Moreover, they identified a new miRNA (miR5090) from the complementary

transcript of the MIR826 gene. Similar to miR826, miR5090 is induced by nitrogen starvation. Further study revealed a mechanism by which *Arabidopsis thaliana* regulates the synthesis of glucosinolates to adapt to environmental changes in nitrogen availability. The study, entitled “Two young MicroRNAs originating from target duplication mediate nitrogen starvation adaptation via regulation of glucosinolate synthesis in *Arabidopsis thaliana*”, has been published in *Plant Physiology*. The plant hormone jasmonate is ubiquitous in the plant kingdom and is required for regulation of multiple physiological processes. In recent years, Prof. YU and his group have started research in the regulation role of jasmonate. This year, they investigated jasmonate’s role in freezing stress in *Arabidopsis*. They provide evidence that jasmonate functions as a critical upstream signal of the ICE-CBF/DREB1 pathway to positively regulate *Arabidopsis* freezing tolerance. The study, entitled “Jasmonate regulates the INDUCER OF CBF EXPRESSION–C-REPEAT BINDING FACTOR/DRE BINDING FACTOR1 cascade and freezing tolerance in *Arabidopsis*”, has been published in *Plant Cell*.

These researches were supported by the Science Foundation of the Ministry of Agriculture of the Peoples’ Republic of China Grant 2009ZX08009-066B, Natural Science Foundation of China Grants (90817003, 31200915, 30771223, 31300255, 31100186, 31171183 and U1202264) and the Science Foundation of the Chinese Academy of Sciences 135 program XTBG-F04.

FROM LEFT:

A simplified model for the function of WRKY8 during TMV-cg-*Arabidopsis* interaction;

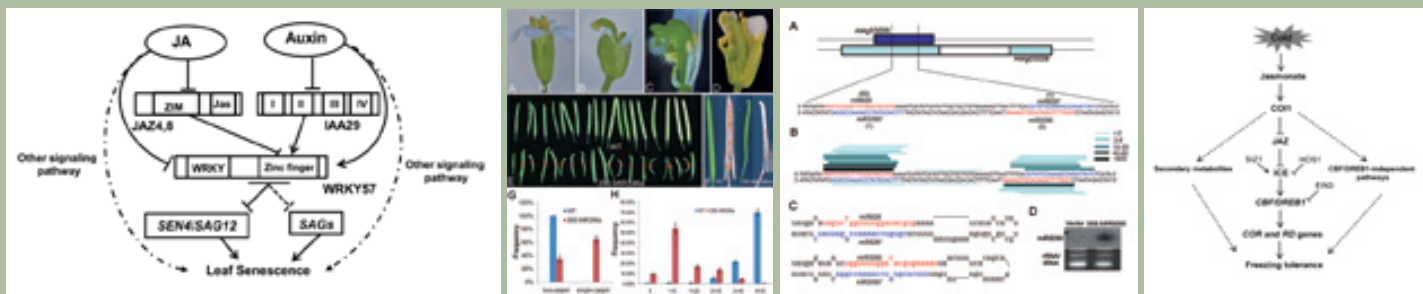
Phenotypic characterization of the wrky8 mutants in response to salt;

The working model of WRKY57 functions in JA-induced leaf senescence;

Phenotypes of 35S-MIR396a plants;

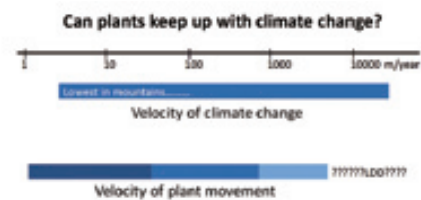
Identification of miR509;

Model for Jasmonate-Regulated Cold Signaling Pathway in *Arabidopsis*.



## Will plant movements keep up with climate change?

Each population of a species has a limited range of tolerance to climatic variables: its 'climate envelope'. As climate changes this envelope moves across the Earth's surface and populations must shift their ranges in order to stay within it. While 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, since it could threaten both biodiversity and carbon storage. Species that cannot track regions of suitable climate across the landscape are doomed to eventual extinction while future forests could be dominated by fast-moving, low-carbon pioneers. Plant movements are not realistically represented in models currently used to predict future vegetation and carbon-cycle feedbacks, so there is an urgent need to understand how much of a problem failure to track climate change is likely to be. Prof. Richard CORLETT of XTBG and David WESTCOTT of CSIRO in



*Most plant species in most places will not be able to keep up with the rates of climate change predicted for 2013-2100.*

Australia therefore compared how fast plants need to move with how fast they can move; i.e. the velocity of climate change with the velocity of plant movement. The resulting review is entitled 'Will plant movements keep up with climate change?' and has been published in *Trends in Ecology and Evolution*.

## Density of large trees and aboveground biomass closely correlated with climatic variables

Large trees whose diameter at breast height (dbh) is greater than or equal to 70 cm store large amounts of biomass. Prof. Ferry SLIK of XTBG and his international colleagues conducted a study to evaluate how much of the global variation in aboveground biomass can be explained by the density of large trees, and to identify the potential drivers of observed differences in the density of large trees and variation in aboveground biomass across the tropics.

They used a pan-tropical tree inventory data set from 120 old-growth lowland tropical moist forest locations containing 192,308 stems ( $\geq 10$  cm stem diameter) to address the above-mentioned topics at continental and pan-tropical scales.

They found that big trees (d.b.h.  $\geq 70$  cm) functioned as drivers of variation in aboveground biomass. Pan-tropical variation in density of large trees and AGB was associated with soil coarseness (negative), soil fertility (positive), community wood density (positive) and dominance of wind dispersed species (positive), temperature in the coldest month (negative), temperature in the warmest month (negative) and rainfall in the wettest month (positive), but results were not always consistent among continents.

They concluded that density of large trees and aboveground biomass were significantly associated with climatic variables, indicating that climate change would affect tropical forest biomass storage. Species trait composition would interact with the future biomass changes as they were also affected by a warmer climate. Given the importance of large trees for variation in aboveground biomass across the tropics, and their sensitivity to climate change, they emphasized the need for in-depth analyses of the community dynamics of large trees.

The study entitled "Large trees drive forest aboveground biomass variation in moist lowland forests across the tropics" has been published in *Global Ecology and Biogeography*.





### Three factors act in concert to promote invasion by *Chromolaena odorata*

Prof. FENG Yu-Long and his team at XTBG conducted a study to test the evolution of increased competitive ability (EICA) hypothesis and the novel weapons hypothesis (NWH), by comparing the performances of *C. odorata* plants collected as seeds from different populations in their native and nonnative ranges and then grown in common gardens in Mexico and China. They compared interactions between *C. odorata* and *Eupatorium japonicum*, *E. stoechadosmum*, and *E. heterophyllum*, which are native to China, and *E. ligudrinum*, which is native to Mexico.

They asked whether *C. odorata* plants from populations in the nonnative range differed in size, competitive ability, and herbivore defense from plants from the native range, and whether species from the nonnative range of *C. odorata* differed in susceptibility to the effects of *C. odorata* leaf leachates from species from the native range of *C. odorata*. Their study found that *C. odorata* plants from the native range demonstrated superior competitive ability against species native to the range it invaded, showing innate competitive advantages. Also, native species from the invasive range in China were more vulnerable to allelochemicals presumably present in the leachate made from *C. odorata* than natives from the native range in Mexico, which is consistent with the



*C. odorata* become one of the most invasive species in southern China.



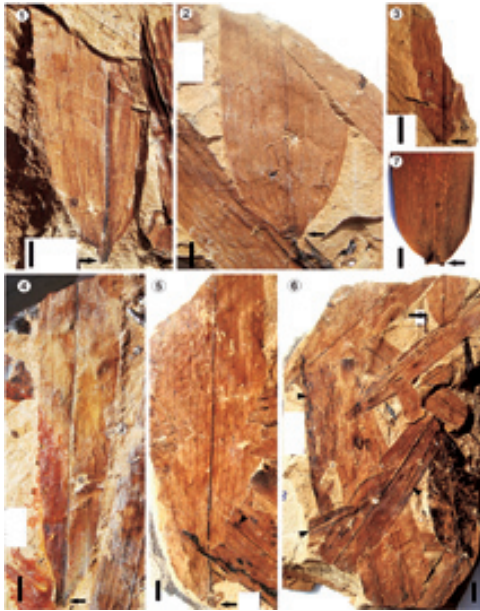
*C. odorata*.

NWH. Plants from invasive populations of *C. odorata* demonstrated a superior competitive ability and inferior defensive ability against natural enemies compared with plants from native populations, which is consistent with the EICA hypothesis.

The research results indicated that the three factors, *i.e.* evolution of increased competitive ability, innate competitive advantages, and novel biochemical weapons, might act in concert to promote invasion by *C. odorata*, and emphasized the importance of exploring multiple, non-mutually exclusive mechanisms for invasions.

The study entitled “The evolution of increased competitive ability, innate competitive advantages, and novel biochemical weapons act in concert for a tropical invader” has been published in *New Phytologist*.

## The earliest fossil bamboos of China

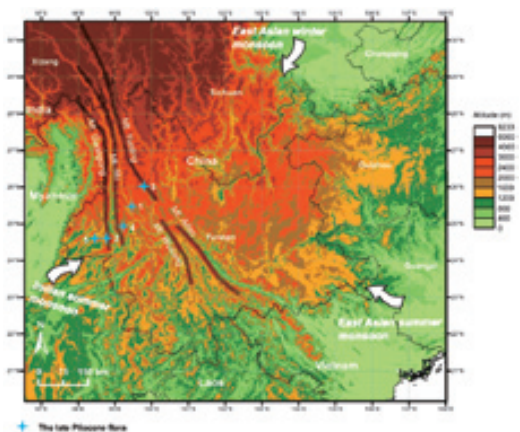


*Bambusium latifolia* L.Wang & Z.K.Zhou, the earliest fossil bamboo record of China.

WANG Li, post-doctoral fellow of XTBG, described the earliest fossil bamboos of China. Fossils were retrieved from the middle Miocene deposits of Sanzhangtian, Zheyuan County, Yunnan. He described four new species: *Bambusium angustifolia* and *Bambusium latifolia* correspond to fossil leaves, *Bambusiculmus latus* and *Bambusiculmus angustus* correspond to fossil culms. These fossils indicate that bamboos in Yunnan began to diversify no later than the middle Miocene. Because Yunnan is one of the biodiversity centers of modern bamboos, these fossils provide new insights into bamboo biogeography. The results, entitled “The earliest fossil bamboos of China (middle Miocene, Yunnan), and their biogeographical importance”, have been published in *Review of Palaeobotany and Palynology*.

## Palaeoclimate of western Yunnan, China

SU Tao, assistant professor of XTBG, reconstructed the palaeoclimate of *Longmen megaflora*. This fossil flora is located in Yongping County, western Yunnan, and dates from the late Pliocene. Using several leaf physiognomy methods, he reconstructed a warm and humid climate, consistent with results from other fossil floras in the region. The monsoon was significantly lower than at present. The change in precipitation regime between the late Pliocene and the modern conditions is attributed to the continuous uplift of mountains in western Yunnan, as well as to the intensification of the eastern Asian winter monsoon. The study, entitled “Post-Pliocene establishment of the present monsoonal climate in SW China: evidence from the late Pliocene *Longmen megaflora*”, has been published in *Climate of the Past*.



The Asian monsoon system in Yunnan nowadays and the late Pliocene floras in western Yunnan.





## Plant growth regulator treatment significantly increases the seed yield of the biofuel plant *Jatropha curcas*

*Jatropha curcas* seed content is about 30–40% oil, which is an ideal feedstock for producing biodiesel. At present, however, seed yield of *Jatropha* is poor and insufficient for the biodiesel industry. As a cross-pollinated perennial shrub with monoecious flowers, one of the most possible reasons for the poor yield is *Jatropha* flowers at a very low female to male ratio, which is only about 3–7%.

Prof. XU Zeng-Fu and his team of XTBG have been engaged in the study of increasing seed yield of *Jatropha*. Dr. PAN Bang-Zhen, a young scientist from Prof. Xu's team, investigated the effects of exogenous application of plant hormones on *Jatropha* flowering, and found that 6-benzyladenine (BA, a synthetic compound with cytokinin activity) significantly promoted female flower tendency from 6.96% to 20.4%, and also increased the number of flowers per inflorescence from 215 to 784, and thus resulted in a 3.5-fold increase in fruit number (from 13 to 58 per infructescence) and a 2.6-fold increase in seed yield (from 24.024 g to 85.376 g per infructescence).

XTBG was recently granted a patent for the method of increasing *Jatropha* seed yield by the State Intellectual



LEFT: Certificate of invention patent;  
RIGHT: Notice of PCT patent registration application acceptance.



Benzyladenine treatment increases the seed yield of *J. curcas*.

Property Office of the People's Republic of China. This technology has also been applied for patents in Brazil and India, and the applications are currently under review. The technique for increasing seed yield has been popularized and applied to *Jatropha* plantation in Guizhou and Hainan provinces, which works well and helps to increase *Jatropha* yield.



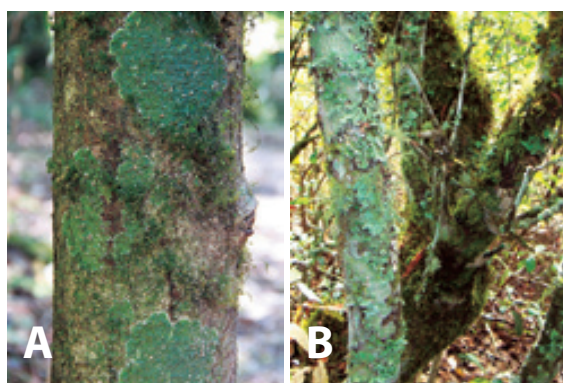
The technique for increasing seed yield has been popularized and applied to *Jatropha* plantation in Guizhou province.

## Epiphytic lichens in subtropical forest: response to anthropogenic disturbance

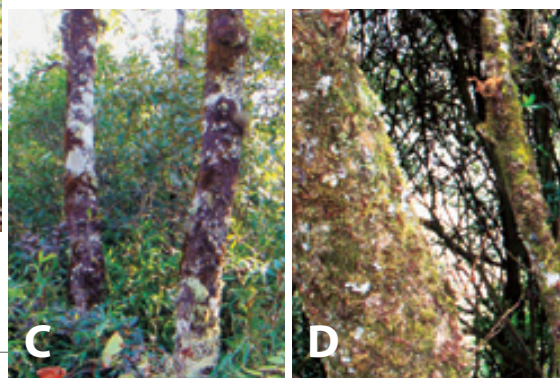
XTBG PhD candidate LI Su and his supervisor Prof. LIU Wen-Yao conducted a study to test the response of epiphytic lichens to environment change associated with anthropogenic disturbance in subtropical forests of the Ailao Mountains, Yunnan Province, Southwest China. They asked how does epiphytic lichen richness response to anthropogenic disturbance, and which lichen species/functional group is the most responsive indicator of environment change.

They found that primary forests were important for lichen epiphyte conservation, and a mosaic of extensive primary forests and small secondary forest fragments could promote the biodiversity conservation of epiphytic lichens in subtropical regions. Habitat variables such as canopy openness, host diversity, forest age, tree size, the size of the largest tree, tree density, and basal area significantly influence lichen community. Moreover, they found that epiphytic lichens, in terms of cover, diversity, species composition and functional traits can be used

as effective indicators for large-scale and long-term forest monitoring. Sixty-one bole lichens were indicators associated with particular forest types. The narrowly lobed foliose group was the best candidate indicator of environmental conditions in this region. The combined application of lichen indicator species and functional groups seemed to be a more reliable and more powerful method for monitoring forest dynamics in subtropical montane ecosystems. The results entitled “Epiphytic lichens in subtropical forest ecosystems in southwest China: Species diversity and implications for conservation” and “Bole epiphytic lichens as potential indicators of environmental change in subtropical forest ecosystems in southwest China” have been published in *Biological Conservation* and *Ecological Indicators*.



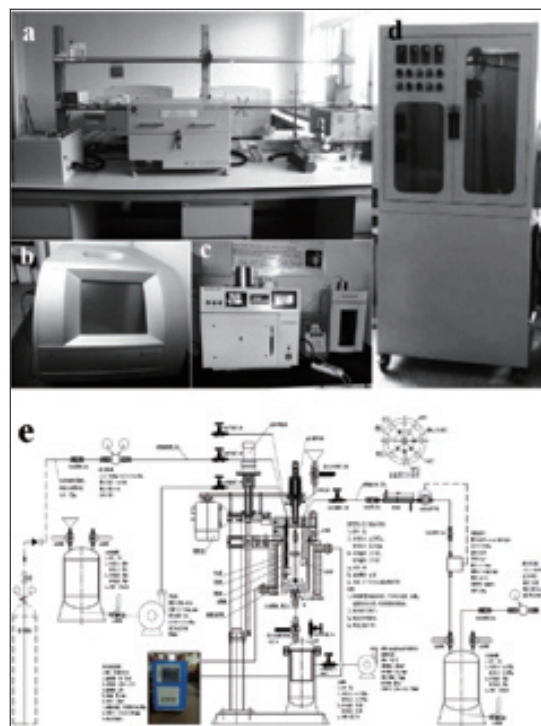
Epiphytic lichens in primary forest (A), secondary oak (B), *Populus* (C) and *Alnus* (D) forests in the subtropical Ailao Mountains, Yunnan Province.





## Engineering intensification in biofuel production

High-efficient transformation of raw and complex biomass materials to biofuels and value-added products depends much on the intensification of reaction process. In 2013, Prof. FANG Zhen and his biomass group of XTBG conducted a series of works to deeply study the engineering intensification of biomass conversion, both in theory and in practice. Previous researches have proved that quickly liquefaction could efficiently convert solid and insoluble lignocellulose to liquid products, and sharply reduce most of unwanted secondary reactions. Based on this knowledge, biomass group applies for and receives one experimental equipment manufacturing project from Chinese Academy of Sciences, and new small-scale batch and flow reactors is begin to be built. The two self-made reactors use nontoxic, low-melting-point and nonvolatile metal alloy to quick heat the biomass reactions, with a temperature rise rate up to tens of centigrade in one second, and satisfies the need in chemical reaction, mechanistic stirring and online analysis meantime at 150-400 °C and > 10 MPa. A new continuous hydrolysis reactor is designed and in development for the CAS 135 program, which could be used for lignocellulose hydrolysis and the subsequent fermentation. The new developed reactor with a scale of 5 L will provide consecutive biomass feeding and consecutive ejection of the liquid products. This reactor uses magnetic nanoparticles to catalyze lignocellulose hydrolysis, and the magnetic catalysts are easy to be recycled and reused after reactions. Accordingly, some modifications of the reactor configuration are made to adapt the realization of this advanced experimental technology. These equipments have been granted for patents. Biomass group also investigates the use of advanced energy technologies (microwave and ultrasound) in the intensification of several biomass treatment such as lignocellulose pretreatment, cellulose hydrolysis, sugar degradation and transesterification of inedible *Jatropha* oil, with several achievements already published in internationally recognized journals. In 2013, a masterwork reviewing the progresses on the application of ultrasound in biofuels was completed by biomass group. The review entitled “Solid



Design and application of process-intensified instruments for biomass conversion (a, flow liquefying reactor (test model, self-made by biomass group); b, Simple module microwave synthesis system Monowave300 (Anton Paar); c, Microwave/ultrasound/UV combined reactor MC8S 1000 (Huiyan in Nanjing); d, batch liquefying reactor (test model, self-made by biomass group); e, continuous hydrolysis reactor (drawing, designed by biomass group)).

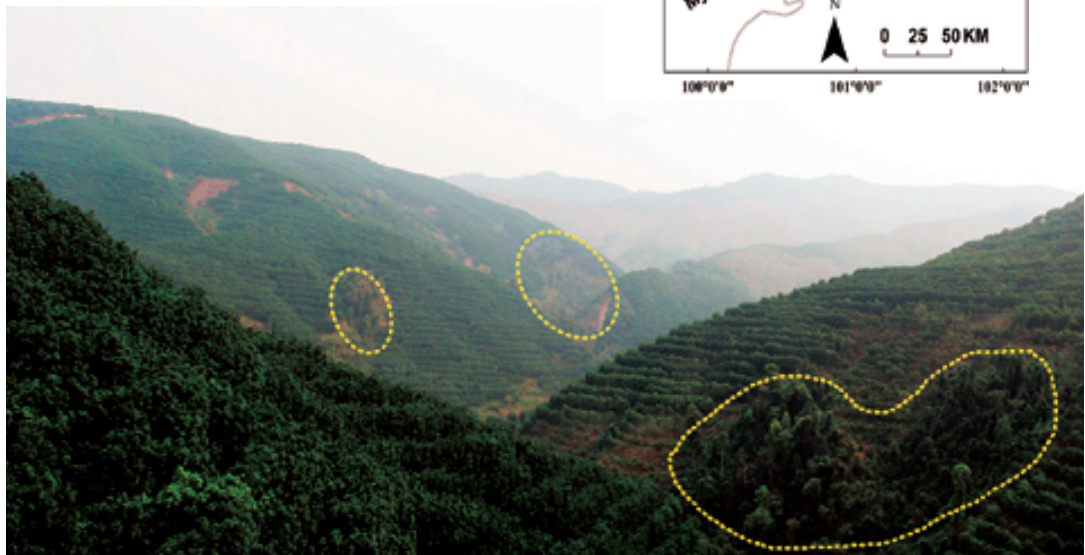
Acid Mediated Hydrolysis of Biomass for Producing Biofuels” has been published online in *Progress in Energy and Combustion Science*. It is believed that the comprehensive and smart use of advanced engineering technologies including continuous flow reaction, microwave and ultrasound will bring a promising future for the high-efficient manufacturing of biofuels and biomass products.

## Bird conservation in extremely small tropical rainforest patches in southwest China

Chang Xue, master candidate of XTBG, and her supervisor Prof. QUAN Rui-Chang, surveyed bird diversity in extremely small lowland tropical rainforest of Xishuangbanna. In this region, rubber (*Hevea brasiliensis*) plantations have replaced most of the original forest, but numerous small fragments of forest remain. To assess the value of these fragments to avian diversity, they classified the fifteen selected remnant forest patches into three size categories, < 1 ha, 1-3 ha, and 3-6 ha, and conducted avifauna surveys. They found that 97 bird species inhabit the fragments and that bird diversity increases with patch area. The resident species composition similarity index was low among forest patches, both within and across size categories, and also low between the wet and dry seasons. Ground insectivores, frugivores and large bird species were the most vulnerable to habitat fragmentation.

Their study encouragingly shows that fragments can play an important role in bird conservation in regions that now lack large tracts of natural forest; however, current patches are too small to support stable annual populations of some species, while others are more tolerant of fragmentation.

They discuss these findings and provide conservation strategies to improve bird conservation within rubber plantations in southern China. The study entitled “Bird conservation in extremely small tropical rainforest patches in southwest China” has been published in *Biological Conservation*.



Location of study site (above) and photographs of three forest fragments in a rubber plantation landscape (bottom). Circles are forest patches used for bird surveying. All patches used for bird surveying were completely surrounded by rubber plantation.





## Response of tropical plants to regional climate change: from XTBG 25-year phenological data

Plant phenology is demonstrated to be vulnerable to climate change in high latitude and temperate areas. Yet, the phenological responses of tropical plants to climate change are still unclear, due to the lack of long-term (>10 years) observations. ZHAO Jun-Bin, a PhD candidate of XTBG together with his supervisor Pro. ZHANG Yi-Ping using XTBG historic phenological data presented how tropical plants in SW China respond to the regional climate change. In the study, temporal trends (1973-1999) of four phenological events (budburst, growing season, flowering and flowering duration) were studied in 21 plant species in XTBG (south-western China). Fourteen species (67%) showed significant phenological trends during the study period. Seven species (33%) presented delaying trends in budburst (average  $1.4 \text{ d y}^{-1}$ ) and such trend was more likely to be presented in those that started budburst earlier in the dry season. Four species (19%) showed trends of extension in growing season (average of  $3.5 \text{ d y}^{-1}$ ). These vegetative events appeared to be mainly influenced by increasing temperature. Rainfall showed little effects directly, however, the effects of temperature seemed to largely depend on the moisture condition. Flowering duration of five species (24%) was shortened by average  $2.1 \text{ d y}^{-1}$  which was most likely to be the result of the decline in sunshine duration during the

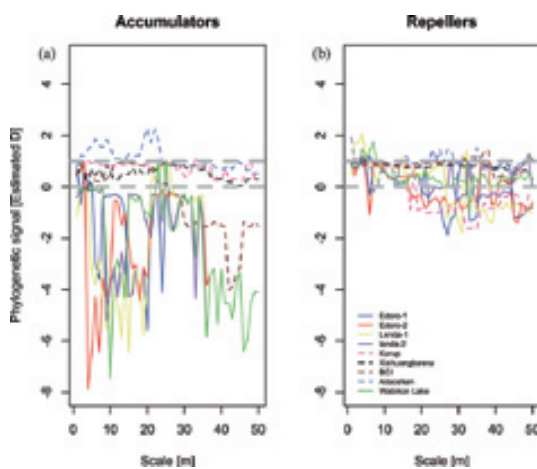


*Dipterocarp plantation.*

rainy season. The study suggests that the phenology of tropical plants has changed significantly in response to the regional climate change but these reactions are somewhat different from those of temperate plants. The result was published in *Journal of Tropical Ecology*.

## A phylogenetic perspective on the individual species-area relationship in temperate and tropical tree communities

Ecologists have historically used species-area relationships (SARs) as a tool to understand the spatial distribution of species. XTBG has extended SARs to focus on individual-level distributions to generate individual species area relationships (ISARs). The ISAR approach quantifies whether individuals of a species tend have more or less species richness surrounding them than expected by chance. By identifying richness ‘accumulators’ and ‘repellers’, respectively, the ISAR approach has been used to infer the relative importance of abiotic and biotic interactions and neutrality.



The phylogenetic signal of species diversity accumulators and repellers on each scale from 0–50 m in the nine forest dynamics plots.

A clear limitation of the SAR and ISAR approaches is that all species are treated as evolutionarily independent and that a large amount of work has now shown that local tree neighborhoods exhibit non-random phylogenetic structure given the species richness. We use data from nine tropical and temperate forest dynamics plots to show there is no clear trend in ISARs from the temperate zone to the tropics and that the phylogenetic diversity surrounding the individuals of species is generally only non-random on very local scales. Interestingly, the distribution of species accumulators and repellers was non-random on the community phylogenies, suggesting the presence of phylogenetic signal in the ISAR across latitude. The study entitled “A Phylogenetic Perspective on the Individual Species-Area Relationship in Temperate and Tropical Tree Communities” has been published in *PLoS ONE*.

## Yunnan Provincial Natural Science Award

An awards ceremony of the “Yunnan Science & Technology Awards” was held on May 23 in Kunming, Yunnan. Among the award winners, Prof. FENG Yu-Long and his team at XTBG were granted with the Second Class of Yunnan Provincial Natural Science Award for their contribution to understanding of the mechanisms of nitrogen allocation in invasive plants. The hypothesis of nitrogen allocation in the evolution of invasive plants revealed a new invasion mechanism of plants. Related research results were published in *PNAS*, *Plant Ecology*, *Weed Science*, *Planta*, *Biological Invasions*, *Physiologia Plantarum*, and *Oecologia*.



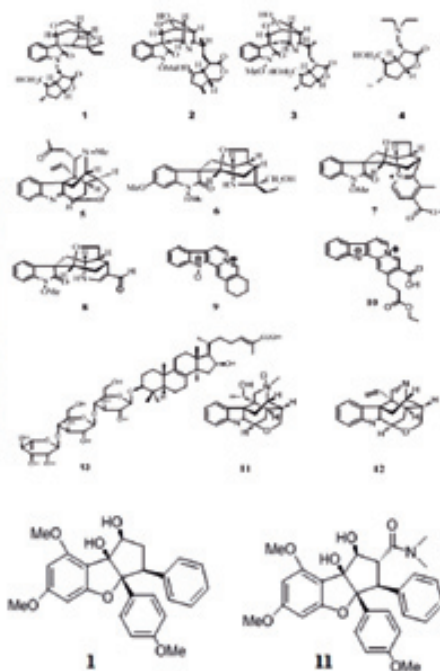
Certificate of Award.





## New compounds from ethnic medicinal plants

XTBG has conducted phytochemical and pharmacological research on indigenous medicinal plants, such as *Nothapodytes pittosporoides*, *Nothapodytes nimmoniana*, *Garcinia* sp, *Flemingia* sp, *Dracaena cochinchinensis*, *Gelsemium elegans*, and *Uncaria sessilifructus*. As a result, nearly 300 compounds, including more than 40 new ones, have been isolated. 60 compounds were found to possess bioactivity by preliminary activity screening, in which 22 compounds showed cytotoxic activity against human cancer cell lines. Two benzofuran isolated from *Aglaia odorata* exhibited significant antitumor activity (their IC<sub>50</sub> value equivalent to taxol). Importantly, their structure is greatly different from taxol, a famous drug in the treatment of cancer, and their mechanism is also different, suggesting they may be a new class of cancer treatment drugs.



New compounds from *Gelsemium elegans* (above) and *Aglaia odorata* (below).

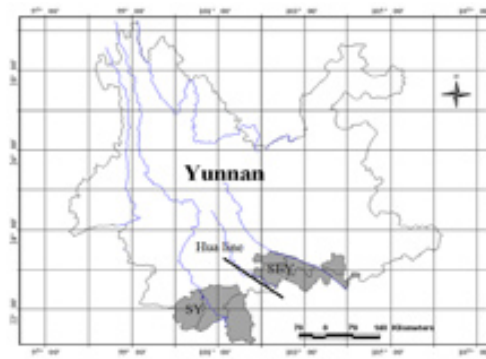
Eight compounds showed significant antitumor activity (the IC<sub>50</sub> value equivalent to cis-platin), PGC-1 alpha activation (metabolic regulation, lipid-lowering hypoglycemic), NO inhibited enzyme activity, T/B lymphocyte immune suppressed (enhanced) activity and the acetylcholinesterase inhibitory activity.

The study on bioactivity of these novel compounds can help to find lead compounds that have low toxicity and high efficacy, as well as clarify the material basis for the efficacy of indigenous medicinal plants, and determine their active ingredients. The ultimate goal is to provide the scientific foundation for the Dai medicine based indigenous drug and pharmaceutical industry development.

## Studies on biogeography

Prof. ZHU Hua of XTBG has undertaken researches on vegetation and flora of Yunnan and tropical China for more than 20 years. He is basically a plant taxonomist, but has broad interests on ecology, biogeography and geological history of China and SE Asia. Recently, he summarized the distribution patterns of geographical elements of seed plants and suggested the boundary of the tropical zone in China. Though comparison of the floras of southern and tropical southeastern Yunnan and divergent geological histories of these two regions, he found a significant biogeographical line between tropical southern and southeastern Yunnan. These viewpoints have been published in *Palaeogeography, Palaeoclimatology, Palaeoecology* and *PLoS ONE*.

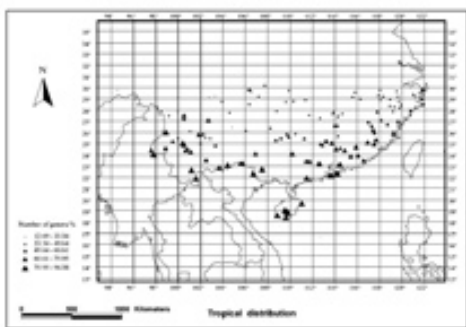
The distribution patterns of geographical elements of seed plants from 135 regional floras that cover southern China were used to reassess the extent and boundaries of the tropical zone. The areas for which tropical genera account for >80% of the total genera in the flora are south of 22°30'N in southern and southeastern China, which corresponds



*Hypothetical biogeographical line (Hua line) between southern and tropical southeastern Yunnan.*

closely to the northern boundary of the tropical monsoon forest and rain forest in southeastern China. The line at c. 22°30'N is therefore suggested to be the northern biogeographical boundary of the tropical zone in south and southeastern China. This line exceeds the northern boundary of marginal tropical climate, which implies that the tropical zone could have extended further north in the geological past than it does today. The study supports the suggestion from palaeoecological studies that tropical and subtropical broadleaved evergreen forests in eastern China shifted north during the mid-Holocene. It also shows that there are climatic and biogeographical disparities between southeastern and southwestern China due to their different topography and geology.

The southern and tropical southeastern regions of the Yunnan Province in southwestern China have similar monsoonal climates and lowland tropical rain forest vegetations. The floras of both regions are dominated by tropical floristic elements (78.3% in southern Yunnan and 68.83% in southeastern Yunnan), and both belong to the Indo-Malaysian flora at the northern margin of tropical Asia. However, some plant families characteristic of temperate East Asia are well represented in the flora of tropical southeastern Yunnan, while families characteristic of tropical Asia are well represented in the flora of southern Yunnan. Additionally, there are 14 mainly East Asian families in tropical southeastern Yunnan that are not found in southern Yunnan. The flora of tropical southeastern Yunnan is more closely related to Eastern Asian flora, while the flora of southern Yunnan is more closely related to Indo-Malaysian flora. The Lixianjiang River is considered a hypothetical biogeographical line between tropical southern and southeastern Yunnan, named the "Hua line". The divergence of the flora is well supported by the geological history of the region; the flora of tropical southeastern Yunnan was mainly derived from the South China Geoblock, while the southern Yunnan flora derived from the Shan-Thai Geoblock.



*Frequency of genera with Tropical distributions.*





## New invention patents

Prof. GAO Jiang-Yun and his team of XTBG have received two Chinese invention patents, “A method for obtaining effective fungus on symbiotic seed germination of *Cymbidium mannii*” (No. ZL 201210097484.7) and “A method for obtaining effective fungus on symbiotic seed germination of *Dendrobium cucullatum*.” (No. ZL 201210097505.5).

The No. ZL 201210097484.7 invention refers to an *ex situ* seed baiting technique, which uses a mixture of dead twigs, fallen leaves, bark, moss and humus collected from maternal habit of *Cymbidium mannii* as the culture medium. Protocorms are induced by *ex situ* symbiotic germination by putting the seed on the surface of the culture medium. The surface of each obtained protocorm is sterilized and planted with artificial culture medium under sterile conditions. When the endophytic fungi appear from the protocorms, purification must be done to obtain a pure colony. Symbiotic germination with a control is conducted to test the effectiveness of promoting germination. The fungus has been identified by molecular sequences and stored in CGMCC (China General Microbiological Culture Collection Center). The No. ZL 201210097505.5 invention refers to an *in situ* seed baiting technique. In this protocol, seeds of *Dendrobium cucullatum* by outcross are harvested after artificial pollination for 130 days and stored at -20°C after absorption by CaCl<sub>2</sub> in sealed glass



LEFT: Certificate of invention patent;  
RIGHT: *Cymbidium mannii*.

containers. After seeds are packed into seed bags, the bags are placed near the adult plant roots of *D. cucullatum*, with moss covering the tops of the pockets. Once protocorms are formed, all seed bags are recycled and taken to the lab. Endophytic fungi can be obtained in the same way as with *Cymbidium bicolor*. After culturing in potato dextrose agar (PDA), the mycelium are cut with a sterilized inoculating needle, and transferred to obtain a pure strain. The method further involves preparing a uniform suspension by adding the seed suspension pocket lip dendrobe seed into sterile water, followed by cultivating resin base, sealing by sealing film, classifying the protocorm seed germination and growth, and selecting effective symbiotic fungus for the *D. cucullatum* seed germination.



LEFT: *Dendrobium cucullatum*;  
RIGHT: Certificate of invention patent.



# Improvement of Research Facilities

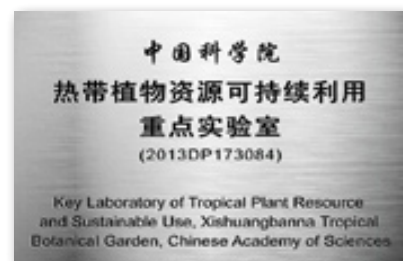
## CAS Key Laboratory of Tropical Plant Resource and Sustainable Use unveiled

Key Laboratory of Tropical Plant Resource and Sustainable Use, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences was established on December 13. The first Academic Committee Meeting of the Key Lab was held at XTBG on the same day.

The Academic Committee Meeting was chaired by CAS Academician SUN Han-Dong. XTBG director CHEN Jin gave a welcome speech. Prof. XU Zeng-Fu, director of the key lab, gave a presentation on the positioning, lab layout, research directions, as well as short or mid-term development plan of the Lab. Afterwards, members of the Academic Committee proposed suggestions to the academic development and administrative operation of the Key Lab.

Academician SUN Han-Dong together with Prof. CHEN Jin unveiled the plaque for the Key Laboratory of Tropical Plant Resource and Sustainable Use.

The CAS Key Laboratory of Tropical Plant Resource and Sustainable Use was officially endorsed by the Chinese Academy



of Sciences in early May. The orientation of this lab is applied basic research. With woody energy plants, woody edible oil plants, and ethnic medicinal plants as its focal study objects, the lab collects and preserves germplasm resources, breeds superior species, conducts research and development of high-yield cultivation techniques and comprehensive utilization. It aims at providing key technical support for sustainable use and development of tropical plant resources.



ABOVE LEFT: Members of the Academic Committee;  
BOTTOM LEFT: Academic Committee meeting;  
RIGHT: SUN Han-Dong and CHEN Jin unveiled the plaque for Key Lab.







*Instruments of the microscopic observation system in Central Laboratory.*



*The Scanning electronic microscope (SEM) in Central Laboratory.*

## The establishment of the microscopic observation system

The microscopic observation system is essential in biological research fields. In March 16, an advanced microscopic observation system was established in the Central Laboratory of XTBG, which is one of the main parts of the research experimental platform of the comprehensive exploitation and utilization of resource plants. The system includes four microscopes made by Carl Zeiss: Confocal laser scanning microscope (Zeiss LSM710, Zmager Z2), Scanning electronic microscope (Zeiss EVO LS10), Ultra-high resolution automatic stereo fluorescence microscope (Zeiss SteREO Discovery V20) and Upright fluorescence microscope (Zeiss Axio Imager A2). In order to prepare the samples suitable for the SEM or light microscope observation, XTBG Central Laboratory also provides several instruments such as Critical point drier (Quorum K850), Versatile sputter coater (Q150R S), Thermo Scientific rotary microtome (HM325), Tissue embedding center (EC360), Water bath (FT100) and Slide drier (FT200). The microscopic observation system can be used to observe and

research various subjects, from sub-cellular structures to centimeter level organisms, from living cells to fossils. In 2013, more than ten XTBG research groups, ecology stations and other Chinese institutions or universities have used this microscopic observation system. The research samples include leaves, woods, flowers, fruits, seeds, pollen and spores, leaf cuticles, bacteria, microalgae, plant fossils, activated carbon and so on. The establishment of the microscopic observation system provides favorable conditions for many scientific research fields, like plant morphology and anatomy, molecular biology, ecology, palaeoecology.

## Installation of a water extraction system for soil and plants

An extraction system for extracting the combination water of soil and plant materials has been independently installed at the end of 2013 in XTBG Central Laboratory. The establishment of this system is supported by the program "Functional Development of Isotope Mass Spectrometer Measurement of Soil/Plant Water Stable Isotopes" of Kunming Biological Diversity Regional Center of Instruments, Chinese Academy of Sciences. This device is a 10-channel water extraction system with two vacuum pumps. It can extract the combination water fast and completely from a large quantity of soil and plant materials. After the device was installed, members from Group of Restoration Ecology have used it more than 17 times. Their extracted materials include 90 soil samples

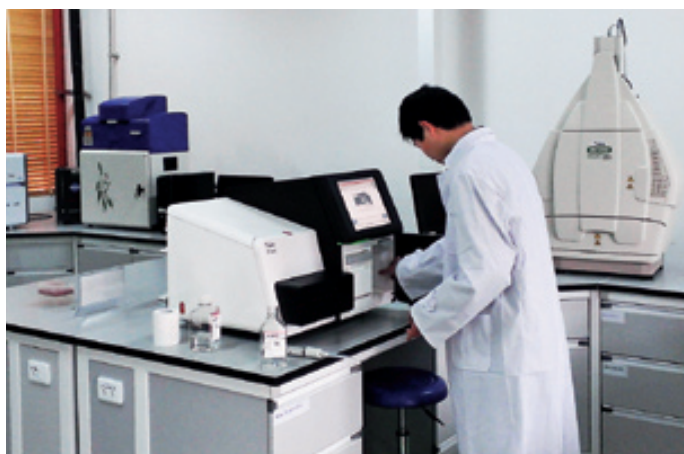
and 27 plant samples. The system is now becoming a helpful supplementary tool for water stable isotope analysis.



*Operator manipulating the extraction system for extracting the combination water of soil and plant.*

## The development of molecular biology research experimental platform

The Molecular Biology Research Experimental Platform (Institute-level platform) has been developed significantly this year. One of the major services of the platform is gene sequencing. A total workflow platform of gene manipulation is constructed and perfected, including plant material culture, DNA or RNA extraction, gene qualification and quantification, qualitative observation of gene expression and



*A piece of equipment of the molecular biology research experimental platform, showing operator manipulating the Illumina Miseq Gene Analyser.*

gene sequencing. The platform has performed and consulted on molecular experiments for many XTBG research groups, such as Molecular Breeding Energy Plant Research Group, Ecology Evolution Research Group, Nutritional Immunology and Functional Foods Research Group, Soil Ecology Group, Ecology & Evolution of Plant Animal Interaction Research Group, and so forth. Many trainings and technical method lectures also have been held for students and researchers. The installation of the Molecular Biology Research Experimental Platform creates a centralized system of advanced research equipment that can serve as an important foundation for XTBG in its mission to become a regional biodiversity conservation center and an internationally renowned scientific research institution.

## Establishment of the next generation internet platform

In March, XTBG established a next generation internet platform based on IPv6 communications protocol, which became one of the Chinese scientific IPv6 network nodes. Export bandwidth has been improved from 60M to 155M. The next generation internet platform has been extended to the scientific user's desktop, and this process met the expected construction goal that people both at home and abroad can visit and share IPv6 international resources. The IPv6 internet platform of XTBG reflects the advancement and preponderance of the next generation internet, and promises further development in the future.



*XTBG-IPv6 network topology.*







## Conferences and Symposia

### Sino-German symposium

From March 19 to 25, XTBG co-organized the Sino-German symposium “Late Cenozoic Environment Change in Eastern Eurasia and its Impact on Past and Present Biodiversity” at XTBG with the Senckenberg Gesellschaft für Naturforschung. Forty-two participants from China, Germany, England, USA, Austria and Switzerland, representing 22 research institutes gave 39 high quality scientific presentations. Main discussions concerned: new methods for palaeoclimatic reconstruction, use of isotopes as palaeoclimate proxies, combination of phylogenetic analysis and palaeobotany, high-resolution palaeoclimate reconstructions, and biodiversity response to past

climate changes. This symposium was supported by the Sino-German Center for Research Promotion of National Natural Science Foundation of China. The symposium was co-chaired by Prof. ZHOU Zhe-Kun of XTBG and Prof. Volker MOSBRUGGER of Senckenberg Gesellschaft für Naturforschung.



*The participants of the Sino-German Symposium.*

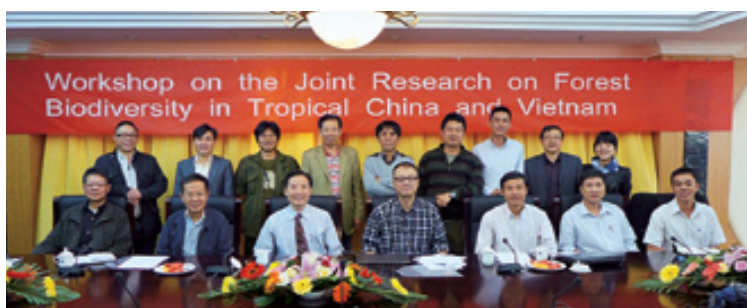
## Workshop on the joint research on forest biodiversity in tropical China and Viet Nam

Workshop on the Joint Research on Forest Biodiversity in Tropical China and Viet Nam was held on February 27 in Chengjiang, Yuannan, China. 12 researchers from Xishuangbanna Tropical Botanical Garden, CAS, China, Southern Institute of Ecology, Viet Nam, and Cat Tien National Park, Viet Nam gathered together to discuss the cooperation between the two sides of China and Viet Nam.

After presentations and discussion, the workshop reached

the following plan: to further deepen and expand cooperation on forest biodiversity research in southern Viet Nam, establish forest dynamics plots and build a long-term ecosystem monitoring network, strengthen academic exchange, start to explore the feasibility of building a botanical garden and herbarium in Cat Tien National Park, promote graduate training courses and build mid-term diploma training capacity.

The workshop further clarifies the objectives and areas of bilateral cooperation, enhanced mutual understanding and interests, and also further promoted the implementation of the 2011 MoU.



*China-Viet Nam workshop on forest biodiversity research.*

## Workshop on biodiversity research in Southeast Asia

31 researchers from China, Vietnam, Singapore, Malaysia, Indonesia, Thailand, and Japan met in Kunming to discuss the significance of biodiversity research in Southeast Asia during November 18-20. The “Workshop on Biodiversity Research in Southeast Asia” was hosted by XTBG together with Kunming Institute of Botany, CAS and Kunming Institute of Zoology, CAS.

The three day workshop provided a platform for the participants to have academic exchanges and discussions. It was composed of 14 presentations and discussions. Scientists from all Southeast

Asian countries shared ideas about studies on plants, animals, ecosystem diversity, and conservation, and urged multilateral understanding and cooperation. Multiple channels are expected to be formed in order to jointly promote biodiversity conservation and research in Southeast Asia.



*Workshop on biodiversity research in SE Asia.*





## The 5<sup>th</sup> global botanic gardens congress

The 5<sup>th</sup> Global Botanic Gardens Congress (CGBC), hosted by the Dunedin Botanic Garden in New Zealand, was held during October 20-25. A wide-ranging mixture of plenary addresses, symposia and workshops covered the challenges and achievements of botanic gardens and partner organizations around the world. Prof. CHEN Jin, director of XTBG and also chairman of the Chinese Union of Botanical Gardens, was invited as one of the 17 plenary speakers to deliver a speech entitled “How to be a conservation garden?”

The Global Botanic Gardens Congress is the premier international event for botanic gardens, held every three years. The theme of the 5<sup>th</sup> CGBC was “Celebrating success – the influence and appeal of botanic gardens”. Botanic gardens influence and appeal to us throughout our lives, from early childhood through to adulthood. Information generated by botanic gardens contributes to environmental advocacy, and provides a source of knowledge and expertise in political debating chambers and the development of international agendas.

There was a significant depth of discussion and range of



TOP: Chinese representatives at the 5<sup>th</sup> CBGC.

BELOW: The plenary session.

topics to engage all attending, from sustainability and climate change, biodiversity conservation, ecosystem restoration, and plant collections management, to community well-being, social relevance, industry innovation and education.

Over 30 representatives of China participated in the congress, including XTBG.

## How to be a fig

On April 2, the Center for Integrative Conservation of XTBG organized a one-day meeting to bring together all research groups working on *Ficus*. The theme of the seminar was “How to be a fig”.

Nineteen presentations were made by professors and students. Professors YANG Da-Rong, PENG Yan-Qiong, WANG Rui-Wu, Yann SURGET-GROBA, and Richard CORLETT made presentations entitled “Geographic and morphological variation of *Ficus auriculata* in China”, “Absence of host sanctions promotes the evolution of pollinator wasp cheating in Eupristina wasps associated with two Asian *Ficus* species”, “Asymmetric selection in fig-fig wasp mutualism”, “Genomic adaptations to

environmental factors in tropical trees: *Ficus auriculata* as a model species”, “Threats to figs in equatorial Singapore”, respectively.

The seminar covered such research topics relevant to figs such as: systematics, biogeography, ecology, physiology, ethnobotany, paleoecology, frugivory, cultivation, *in-* and *ex-situ* conservation, etc.



Prof. YANG Da-Rong(left) and Prof. Richard CORLETT(right) making presentations.



## The joint 50<sup>th</sup> anniversary meeting of ATBC•OTS



*XTBG participants at ATBC-OTS 2013.*

The ATBC annual meeting 2013 and also the Joint 50<sup>th</sup> Anniversary Meeting of the Association for Tropical Biology and Conservation (ATBC) & Organization for Tropical Studies (OTS) was held in San José, Costa Rica from June 23-27. ATBC•OTS 2013 was a meeting to celebrate five decades of scientific research and education fostered by ATBC and OTS. The theme of the meeting was “New frontiers in tropical biology: the next 50 years”. More than 1,000 tropical biologists and conservation scholars gathered together to discuss the future of tropical biology and conservation. Eleven scientists from XTBG including Professors CHEN Jin, CAO Min, Richard CORLETT, YANG Xiao-Dong, GAO Jiang-Yun made oral presentations in the meeting.

## Tropical biodiversity initiative workshop

The Organizations for Tropical Studies hosted a workshop “Tropical Biodiversity Initiative” in Costa Rica during June 18-22, which was attended by 27 tropical biologists from OTS, XTBG, and universities of Central America. The purpose of the workshop was to set priorities for biodiversity research and ecosystem valuation. The workshop was one of the two planning meetings to establish collaborative research, education and training priorities, which was supported by the NSF Office of International Science and Engineering (OISE) and the Division of Environmental Biology – Dimensions of Biodiversity program.

The meeting focused on the three core



*XTBG scientists communicating with colleagues from La Sleva Biological Station.*



*Tropical biologists at the workshop.*

issues related to biological diversity: identifying biodiversity, quantifying ecosystem diversity, function and value, and integrating sustainability research into the study of tropical biodiversity. The tropical biologists reached common consensus on course plans for graduate level field courses in biodiversity science, draft documents detailing research exchanges among partnering organizations, and an outline of a research proposal in biodiversity science.

A follow-up meeting will be organized by XTBG and will take place in China in 2014. At the coming meeting partners will draft a strategic plan for long-term partnership, offer a proof-of-concept field course in biodiversity research for graduate students, and complete a report of recommendations for promoting sustainability research in the tropics.



## Annual meeting 2013 of Entomological Society of Yunnan

The annual meeting 2013 of Entomological Society of Yunnan (ESY) was held in Kunming during August 24-25. Over 130 entomologists and professionals from institutions and colleges in Yunnan Province gathered together to exchange scientific information and the latest research. The theme of the annual meeting was “Insect biodiversity conservation and construction of green economy province and ecological civilization in Yunnan”. Prof. YANG Da-Rong of XTBG was invited to



*Annual Meeting 2013 of Entomological Society of Yunnan.*

deliver a keynote speech entitled “Impact of global climate change on breeding capacity of resource insects”. His speech suggested that global warming could lead to changes in the life history of such resource insects as ‘insect herb’ *Hepialus armoricanus*, and fig wasps, etc., and further influence the yield of resources and the ecosystem. Two more presentations were given by XTBG researchers.

Prof. YANG Da-Rong was elected as ESY chairman. Prof. PENG Yan-Qiong of XTBG was elected as ESY secretary general. An insect photography exhibition was also held at that time. Many pictures taken by XTBG researchers won favorable comments.

## Annual academic meeting 2013 of Chinese botanic gardens

The Annual Academic Meeting 2013 of Chinese Botanic Gardens was held in Yinchuan Botanical Garden, Ningxia during August 22-24. 300 representatives from over 80 botanical gardens and international organizations attended the meeting. The theme of the meeting was “Beautiful China--- the Responsibility of Botanical Gardens”. The 57 presentations covered such topics as plant biodiversity conservation, public education and tourism, conservation and utilization of plant resources, management and the business model of botanical gardens, etc. Prof. CHEN Jin, chairman of the Chinese Union of Botanical Gardens and director of XTBG, made a keynote speech entitled “Zero extinction conservation plan for plants in Xishuangbanna: Is it a model for full-cover conservation of native plant species in China?”. The popular education programs of XTBG were also introduced at the meeting.



## Annual meeting 2013 of Union for Field Stations of SW China

The annual meeting 2013 of the Union for Field Stations of SW China was held in Lijiang, Yunnan on April 13-14. Over 50 representatives from field stations and institutions attended the meeting.

XTBG deputy director Prof. CAO Min, who's also vice chairman and secretary general of the Union for Field Stations of SW China, made a report entitled "Considerations on the joint research among field stations". Talking about problems in the organization of the Union, functions and types of field stations, index system, social influence, and scientific services, Prof. CAO put forward considerations on strengthening solidarity and cooperation in monitoring, scientific research, demonstration, service, and data sharing among the member stations. The Union for Field Stations of SW China was founded in 2011. It is a non-profit organization dedicated to providing a platform for staff of field stations to learn from each other,



*Prof. CAO Min making a report.*

and cooperate in data collection, management, and sharing, with special emphasis on long-term and comprehensive ecological research in SW China. Up to now, it has 19 members.



*Annual meeting 2013 of Union for Field Stations of SW. China.*





## Seminar on ecological progress and beautiful Yunnan

20 ecologists gathered together in Kunming to have the forum “Ecological progress and beautiful Yunnan” on June 14. The ecologists were from XTBG, Yunnan University, Yunnan Agricultural University, Honghe College, and Qujing Normal College.

Prof. CHEN Jin, director of XTBG and chairman of Ecological Society of Yunnan, delivered a keynote speech entitled “Inquiring into the concept of ecological progress”.

The participating ecologists made some other presentations, putting forward their understandings on ecological progress. Prof. CAO Min proposed that



*Participants of the seminar .*

the wisdom in ecological studies can be used to deal with the relationships of man and man, man and nature, man and the society, so as to realize biocentric equality.

## The 5<sup>th</sup> symposium on tropical forest ecology

During August 10-13, the 5<sup>th</sup> Symposium on Tropical Forest Ecology was convened in Boao, Hainan. The meeting brought together more than 130 researchers and students involved in ecology studies, from XTBG, Hainan University, Guangxi



*The participating ecologists.*

University, Hainan Normal University, and Guangxi Institute of Botany. The theme of the symposium was “Tropical forest biodiversity and human beings”. Prof. ZHOU Zhe-Kun, Prof. Richard CORLETT, and Dr. Eben GOODALE of XTBG were three of the seven keynote speakers.

14 scientists and young researchers of XTBG made presentations at the symposium. Their presentations were concerning palaeoecology, climate change, animal behaviors, epiphytic plants, plant physiology, soil ecology, biodiversity conservation, etc.





# Horticulture

Photo by DUAN Qi-Wu



## New progress achieved on plant introduction in 2013

In order to conform to the national strategy of germplasm resource conservation, to increase the amount of conserved species, and to cooperate with the Plan of Zero Extinction, XTBG put more effort into plant introduction in 2013. 1,098 species were successfully introduced, among which 572 species were domestic, mainly being introduced from south Yunnan with smaller numbers from Guangdong, Hainan, etc. The other 426 species were introduced from 11 countries, mainly from Southeast Asia.



*The staff dealing with the introduced seedlings.*







*The Vine Garden.*

## Vine Garden becomes a highlight of public scientific education

The new Vine Garden (7 ha) main construction work was completed in 2012. In 2013, efforts on plants management and maintenance were intensified in order to improve the landscape effect, as well as strengthen the work of species preservation. By building bamboo structures, artificial traction and trimming based on the plants' growth habits, most of the vines grew on the structures quickly. In order to meet the requirements of some special climbing lianas and optimize the landscape effect, seven new characteristic pergolas were constructed this year. Over 500 species are now displayed in the Vine Garden. The Vine Garden has become a highlight of public scientific education.

The Vine Garden was built on a previous residential complex of XTBG. According to the Master Plan, the western area of XTBG is centered on public science education and living collections display, featuring with the creativity and specialty of gardening art, tourism and cultural connotation. No residential area is available in the western part. To implement the Master Plan and keep the historical signs, a few buildings and walls are kept to support climbing plants. Dr. TANG Hong from Qingdao Tengyun Landscape Architecture Company was invited as chief designer for the Vine garden. From landscape architecture perspective, a theme termed as: "From city to countryside, climbing plants occurred everywhere" was developed. The construction of the Vine Garden well followed the theme.

## New metal marking machine makes plant tag production more efficient

A metal marking machine was purchased by XTBG in 2013. Used together with the plastic marking machine, the efficiency of marking has been highly increased. The employing of a metal marking machine ensures that the words on plant tags are legible and stable.



*Printed tags.*



## Vegetation reconstruction and the recovery of landscape after hail damage

A large hail disaster struck XTBG on December 26, 2012. The Shade Plant Collection and the Distinctive Flower Garden, which mainly contain herbaceous collections, were seriously damaged, with entire plantings of tropical plants wiped out. Relevant XTBG staff and workers were organized to investigate and archive the disaster and a detailed recovery plan was drawn up. After clean up, particularly seriously damaged plants were brought back to the nursery for conservation. For less affected plants, XTBG staff pruned and sprayed plant growth regulator, whereas bulbs were transplanted and replaced. XTBG staff returned 41



*The Araceae area in recovery.*

species back to the nursery and out-planted thousands of plants of 58 species, applying more than 300 bags of various organic fertilizers. The landscape has been mostly recovered after more than a half year's reconstruction.



*A corner of the Shade Plant Collection after restored.*



### Lotus exhibition in Kunming Daguan Park

XTBG participated in a Lotus Exhibition in Kunming Daguan Park in July. Royal water lily (*Victoria regia*) and other species of water lilies from XTBG attracted many visitors. The exhibition was kept in Daguan Park until late October. This exhibition was also a good promotion for XTBG in the Kunming area.

*Preparing Victoria regia seedling.*



# Public Education



*Photo by DUAN Qi-Wu*



## On-line education keep track in the edge

The cut-edge technology has been used for the on-line tropical plants education in XTBG. In some of the most popular websites such as Microblog, WeChat, and Douban, XTBG has set up a few e-stations to involve visitors in our daily information. The pictures, sounds, stories and news could be found in the e-stations and each had its own specialties, which have attracted many web surfers. XTBG also interact with visitors on line. The questions raised by visitors could be answered immediately and their suggestions could also be collected

to improve our work. At the end of 2013, XTBG's official Microblog has 17,3434 fans and has more than 600 posts in the whole year.



*WeChat Quick Response code.*

### Facts:

Total annual visitors to the Garden: 615,966

Total annual visitors to the museum: 320,570

Special educational programs: 54

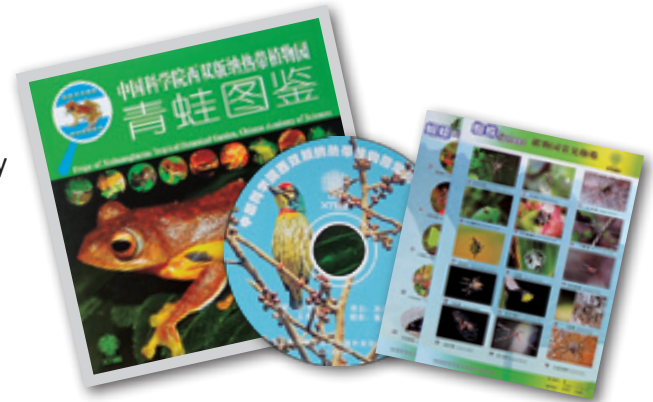
Total annual hits to the Garden website: 3,114,195

## XTBG is growing its social role

In order to engage with the local communities more effectively, XTBG has emphasized more educational activities in the local communities. A series of conservation-based lectures for local schools, *The Growing Parashorea*, which link the students' daily life with biodiversity conservation, was held on the second Thursday of each month and was welcomed by the students and teachers in Menglun Center Primary School. Hundreds of students attended the lectures in 2013. In the last quarter of 2013, as a part of the Direction 3 "Zero Extinction Project", XTBG started another educational project in Menglong town, where XTBG was established originally. This project's goal is to build a plant nursery and native arboretum on the existing "Holly Hill", in cooperating with the local schools and communities. Meanwhile, XTBG has produced educational materials for local schools about Xishuangbanna biodiversity, including *Common Birds, Butterflies, Dragonflies and Spiders ID Brochures*, *Birds' Songs CD in XTBG*, *The Tropical Rainforest Ecosystem Drawing* and *24 Frog Species Booklet in XTBG*.



*The Growing Parashorea.*



*Biodiversity educational materials.*



## Forest and Our Daily Life educational exhibition tour

As a National Environmental Protection and Science Promotion Base, XTBG organized an exhibition tour themed around "Forest and Our Daily Life" with funding from the Chinese Society for Environmental Sciences in September. In order to increase the students' and residents' concern about the surrounding environment, the exhibition has been shown to more than 4,000 students in nine different primary and middle schools and communities in Ailaoshan mountain, Simao, and Xishuangbanna regions of Yunnan Province. In addition to the exhibition, lectures focusing on biodiversity conservation and other nature-oriented activities were also carried out. The news about the exhibition tour was reported by Jingdong TV, Xishuangbanna TV and several newspapers in Yunnan.



ABOVE: Educational exhibition in Bulang village;  
BOTTOM: Educational lecture in Bulang village.







*Winter and summer camps.*



## Thousand students involved in winter and summer camps



*Rainforest trek.*

About 1,130 students from all over China participated in winter and summer camps in XTBG in 2013. Various activities have been prepared for the campers: rainforest treks, lectures, hand-in-hand learning with scientists, night hikes, and so on. More and more organizations and schools have contacted XTBG and sent their students for the science-based winter and summer camps. In the summer, a special two-week inquiry-based science education project was also developed with about 30 students each from 10 schools in Beijing.

Different from other camps, the project only recruited the students who showed strong interests in nature-related research. The project was welcomed by students and their teachers. At the same time, the activities for kids and parents were also popular. A national TV Station, CCTV10, sent their staff to shoot a documentary about nature-related camps for kids and their parents in XTBG.



*Night hike.*

## XTBG awarded title of National Base of Environmental Protection & Popular Science

According to an announcement by the Chinese Ministry of Environmental Protection, XTBG have been awarded the title of “National Base of Environmental Protection & Popular Science”. The title was awarded to nine units with outstanding achievements in environmental protection and science popularization this year.

The title of “National Base of Environmental Protection & Popular Science” was reviewed by an expert panel jointly organized by the Ministry of Environmental Protection and

the Ministry of Science and Technology starting in 2007. To be nominated, an institution needs to be an important carrier for environmental education and science popularization, play a leading role in promoting environmental protection and education, and promote the development of ecological civilization and disseminate environmental culture.





# Partnership

*Photo by LIU Guang-Yu*

## Domestic

### The Chinese Union of Botanical Gardens

The Chinese Union of Botanical Gardens (CUBG) was officially launched on June 6, 2013 in Beijing. The Union, jointly sponsored by the Chinese Academy of Sciences (CAS), State Forestry Administration, and Ministry of Housing and Urban-Rural Development, aims to construct a platform for botanical gardens and arboreta to have strategic cooperation, conduct technical exchanges, and share information. So far, 77 botanical gardens or arboreta have joined the Union.

The Secretariat of CUBG, based in XTBG, is responsible for the specific programs set out by the council. Over the past half year in 2013, CUBG took an active role in promoting cooperation among Chinese botanical gardens, such as preparing to establish the information data system of Chinese botanical gardens and building the website of CUBG. The objectives



Unveiling ceremony of Chinese Union of Botanical Gardens.

of CUBG were further clarified during the Board of Directors Meeting of CUBG. CAS vice president SHI Er-Wei encouraged CUBG to carry out its mission in an innovative way, with an overall long-term vision, and be exemplary and demonstrative in its function.



The Board of Directors Meeting of CUBG.



Chinese and English websites of CUBG ([www.cubg.cn](http://www.cubg.cn)).



## Xishuangbanna, Yunnan

On November 7, the eighth scientific cooperation and exchange meeting between XTBG and Xishuangbanna National Nature Reserve (XNNR) Bureaus was held in XTBG. Prof. CHEN Jin, Prof. LI Qing-Jun, Prof. ZHOU Zhe-Kun, Mr. LIU Lin-Yun, the deputy director of XNNR Bureaus and 42 others attended the meeting.

Prof. LI Qing-Jun, deputy director of XTBG, Mr. YANG Hong-Pei, director of Research Institute of XNNR and Prof. ZHOU Zhe-Kun, deputy director of XTBG, co-chaired the meeting. Prof. CHEN Jin delivered a welcome speech summarizing the effective cooperation between the two organizations. DENG Xiao-Bao, GUO Xian-Ming, SHI Feng-Ping, YU Dong-Li, QUAN Rui-Chang, and LIU Qiang delivered reports on topics such as forest canopy crane construction, investigation on the current situation of Xishuangbanna natural environment, Green Stone



Prof. CHEN Jin and Mr. LIU Lin-Yun signing Minutes of Meeting.

Forest touristic development, animal diversity investigation in the reserve area.

Both sides believed that annual meetings are vital to the cooperation. Collaboration between the two sides has been productive, and was represented by projects such as the book, *Orchidaceae in Xishuangbanna: Diversity and conservation*, written by Prof. GAO Jiang-Yun and Prof. YU Dong-Li, which is in press, as well as the construction of Bubeng 20ha plot, the construction of Bulong Nature Reserve, and further construction of XTBG Green Stone Forest. In the future, broader cooperation between two sides is envisioned. The meeting concluded that cooperation between the two sides for the next year will focus on the following specific projects: field monitoring of wildlife diversity in the nature reserves, comprehensive scientific investigation of the Yiwu-Heishuiliangzi Prefectural Nature Reserve, Orchidaceae re-introduction experiments and bionic cultivation, monitoring the impact of tourism on the ecological environment, scientific public education, communication and cooperation, and the “gun- prohibit and hunt- prohibit” public education program.





## Pu-er, Yunnan

On May 27, Prof. LI Qing-Jun, deputy director of XTBG headed a 7- person delegation to visit Pu-er Normal College, Yunnan. The delegation had deep discussions with teachers in the Department of Life Sciences on compiling textbooks and teaching plans.

Pu-er Normal College plans to create a curriculum on horticulture, while XTBG is dedicated to cooperating with higher education to create tropical horticultural courses and textbooks. Due to these shared goals, both sides decided to cooperate together on compiling textbooks.

Prof. LI Qing-Jun and Prof. CHENG Wen-Zhang, the president of Pu-er Normal College, discussed creating a Masters



*XTBG delegation visiting Pu-er Normal College, Yunnan.*

program on Horticulture, developing deeper academic exchange between the two institutions, staff training, and enhancing students' practical capacity. Partnership between XTBG and Pu-er Normal College has been on-going for more than 20 years. This visit broadened ways of cooperation between the two sides.

## Mengla, Yunnan

XTBG and Mengla County cooperation meeting was held on August 9. Officers of XTBG and Mengla County, as well as Menglun Tourism Administrators attended this meeting. Prof. CHEN Jin, director of XTBG, chaired the meeting. Mr. LI Hong-Wei introduced the history and development of XTBG, the plan of "Innovation 2020" project, as well as the new progress of the "One-Three- Five" project. Mr. YAN La, the magistrate of Mengla County, introduced the subjects of economic and social development, the infrastructure construction, education, new countryside construction and ecology development. Ms. WANG Jia-Ling, the Party Secretary of Mengla County and GAO Jiang-Quan, deputy



*XTBG and Mengla County cooperation meeting.*

magistrate of Mengla County, also delivered speeches on how to promote education and economic development, as well as their hope of getting support from XTBG to foster scientific innovation, public education, and construction of the foundation of poverty alleviation. Prof. CHEN Jin responded that XTBG would provide talent and technical support for local development. He suggested that plans should be drawn up to promote scientific public education and sustainable development of Menglun and XTBG. Topics such as technological support, talent training, ecological tourism development, and public education were discussed in-depth. Both sides expressed hope for collaboration. Signing a framework agreement in order to develop long-term cooperation was approved. The meeting enhanced connections between XTBG and local government.



*CAS delegation visiting University of Ruhuna.*

## Abroad

### Sri Lanka

Academician ZHANG Ya-Ping, vice president of CAS, headed a delegation to Sri Lanka during September 20-25. The delegation was composed of professors from XTBG, Kunming Institute of Zoology, and South China Sea Institute of Oceanology. The delegation visited the University of Ruhuna, the Peradeniya Royal Botanical

Garden, and the University of Peradeniya.

After the unveiling ceremony of the field observation station established with the aid of CAS, the CAS delegation and University of Ruhuna exchanged ideas on biodiversity conservation, personnel training, and international cooperation. Prof. CHEN Jin paid a special visit to Prof. Sarath KOTAGAMA at University of Colombo, a well-known specialist on Sri Lankan fauna and flora. They discussed the possibility of jointly carrying out field courses in Sri Lanka.





## Myanmar

From June 3 to June 7, a 3-person delegation headed by Nyi Nyi KYAW, the director of Department of Forest of the Department of Environmental Protection and Forestry, Myanmar visited XTBG.

At the forum between the Myanmar delegation and XTBG, Prof. CHEN Jin, director of XTBG, warmly welcomed the guests from Myanmar, Dr. FAN Ze-Xin introduced topics such as XTBG's current scientific research, species conservation, horticulture, postgraduate education, and international cooperation. The Myanmar delegation also introduced the current situation of the Department of Environmental Protection and Forestry. A memorandum of understanding (MoU) was signed between

the two sides after detailed discussion on future cooperation.

The Myanmar delegation visited XTBG Key Laboratory, Herbarium, Tropical Rainforest Ethnic Culture Museum, some plant collections and Green Stone Forest area in XTBG. The delegation highly complimented XTBG regarding scientific research conditions, horticulture, conservation and public education.



*Nyi Nyi KYAW and Dr. CHEN Jin exchanging the MoU.*



## The Organization for Tropical Studies

Prof. CHEN Jin headed a 7-person group to the Organization for Tropical Studies (OTS) at San Jose in Costa Rica during June 16 and 22. A MoU was signed between XTBG and OTS.

According to the MoU, XTBG and OTS agree to join efforts oriented towards increasing their scientific technical cooperation. Cooperation between the two sides will be implemented through reciprocal visits by members of OTS and XTBG to support the development of collaborative efforts in education, training and research opportunities. Each party will designate a representative to the directors of each institution, who will be responsible for proposing specific activities to be implemented under the MoU, identifying resources to support



*Dr. Elizabeth LOSOS and Dr. CHEN Jin signing the MoU.*

the activities, and coordinating the administration of the agreement.

XTBG has made enormous efforts to expand its influence on biodiversity conservation in Asia by conducting the Program for Field Studies in Tropical Asia, recruiting graduate students from Southeast Asian countries and hosting international conferences. In 2012, Prof. CAO Min visited USA at the invitation of Dr. Bill CHANG, a regional coordinator of the National Science Foundation of USA, which led to the cooperation with OTS.





## Thailand

Dr. Suyanee VESSABUTR, director of Queen Sirikit Botanic Garden (QSBG) of Thailand, headed up a 4-person delegation to XTBG during August 24-26. A MoU was signed between the two sides.

*Dr. Piyakaset SUKSATHAN with a specimen he identified.*



*Dr. CHEN Jin and Dr. Suyanee VESSABUTR exchanging MoU.*

According to the MoU, XTBG and QSBG agree to join efforts oriented to increase scientific technical cooperation and to enhance capacity building. Cooperation between the two sides will be implemented through reciprocal visits, education, training, resources exchange, joint research programs, academic meetings, etc.

## Cambodia

Prof. CHEN Jin, director of XTBG, led a delegation to Cambodia during February 27 and March 5. The visit was aimed at further promoting the establishment of Cambodian National Botanical Garden (CNBG) and proposing to set up Phnom Penh Biodiversity Center (PPBC).

Mr. YIN Kim Sean, Permanent Secretary (Executive vice minister) of the Ministry of Environment of Cambodia, presided over a meeting to discuss the design, construction and running of CNBG. The discussion was based on the Feasibility Plan of CNBG jointly completed by Cambodian Ministry of Environment and XTBG.

Afterwards, Prof. CHEN Jin made a report concerning the proposal of setting up PPBC. The vice minister said that the Cambodian Ministry of Environment will actively assist the Chinese Academy of Sciences in promoting the project. Minutes of the meeting were recorded.

The XTBG delegation made a field investigation at Phnom Kulen National Park (the site for CNBG). They also inspected the candidate sites for PPBC at Kiriron National Park and Bokor National Park. On invitation, CHEN Jin and his companions identified and labeled the plants within the Chinese Embassy in Cambodia during their visit.



*ABOVE: Vice minister YIN Kim Sean (center) presiding over a meeting;  
BOTTOM: Investigating candidate sites for Phnom Penh Biodiversity Center.*



A low-angle photograph of a tree with vibrant red flowers and green leaves against a clear sky. The tree's branches are thick and dark, with many smaller branches extending outwards. The red flowers are numerous and appear to be in full bloom, creating a dense canopy of color. The green leaves are interspersed among the flowers, adding to the lush appearance of the tree. The sky is a pale, clear blue, providing a soft background for the tree's foliage.

# Talent Training and Team Building

*Photo by LIU Guang-Yu*



# Postgraduate Education

## 6 XTBG students receive national scholarships

According to an announcement by the University of Chinese Academy of Sciences (UCAS), 6 graduate students were granted national scholarships. The 3 award-winning doctoral students (LI Su, TIAN Xiao-Fei, and YANG Shi-Jian) will each receive 30,000 yuan per year, while the 3 outstanding postgraduates (CHEN Huan-Huan, XUE Bao-Jin, and YANG Tian-Quan) will each receive 20,000 yuan per year, in recognition of their outstanding performance.

The national scholarships were established by the Ministry of Education and the Ministry of Finance and went into effect in September 2012. The scholarships are awarded on the basis of moral quality, academic merit and research capacity. Every year, 45,000 outstanding graduate students will be offered with national scholarships, according to a statement by the Ministry of Finance.



# Talent Training

## Advanced field course in ecology and conservation – XTBG 2013

Between October 19 to November 30 2013, the Program for Field Studies in Tropical Asia (PFS) conducted the 6th field course in XTBG (AFEC-X 2013). In total, XTBG received 115 applications from 81 organizations in 32 countries, from which 24 were selected from 17 institutions in 8 countries to attend the course. The six-week field course included four components: lectures and practical, field trips, independent project and course symposium. 53 staff members from XTBG contributed to the course. Profs. Richard T. CORLETT and Ferry SLIK and Drs. Alice HUGHES, Eben GOODALE, Kyle TOMLINSON and Uromi M. GOODALE were the core instructors for the course. Course components were taught by 26 other staff members based on their expertise with the help of another 19 teaching assistants.

The topics during the course included tropical environments, ecophysiology, systematics, evolutionary ecology, plant-animal interactions, biodiversity, conservation biology, invasive species, climate change, molecular ecology, soil ecology, and experimental design and statistics. Pierre HONORÉ, a visiting professional photographer, was invited to teach ecological photography. All lectures were followed by a practical or demonstration. In addition, the students paid a one-day trip to Mengla to visit the Dipterocarpaceae forest, and 5-day trip to Ailaoshan Mountain to experience the altitudinal vegetation and agricultural changes. Six groups, formed according to the students' interests, carried out six small projects in XTBG: 1). Comparative communities of non-volant small mammals in adjacent areas of limestone forest, seasonal rainforest and rubber plantation in Xishuangbanna, Yunnan, China;

2). Bats in Menglun: a preliminary study in different habitats; 3). Leaf variation in *Ficus*: an evolutionary perspective; 4). How do different species of bulbuls co-exist in different habitats?; 5). Light determines the function, diversity and abundance of

ground ferns; and 6). Likely possible change in forest communities from climate change in the Mt. Ailao region. At the end, a symposium was held to present the findings from the independent research projects. A panel of judges composed of CHEN Jin, Richard CORLETT, Ferry SLIK, Eben GOODALE, Kyle TOMLINSON, Alice HUGHES and Edward STASHKO were impressed by the quality of the projects. The first prize was given to "Leaf variation in *Ficus*: an evolutionary perspective" completed by Gaurav KANDILKAR, NGUYEN Hai Huyen, WU Wei-Huan, YAO Xin, and ZENG Si-Jin. Afterwards, the participants received certificates from the judges. AFEC-X is primarily supported by XTBG. In addition, XTBG got funding from the Bureau of Personnel of Chinese Academy of Sciences, the Chinese Academy of Sciences Graduate Education Foundation and the International Center for Research in Agroforestry Beijing Office.



Advanced Field course in Ecology and Conservation – XTBG 2013.





## Summer school for graduate students

From August 3 to 9, XTBG organized the summer school Climate Change and Plant Response at the headquarters of XTBG. The summer school was funded by the National Natural Science Foundation of China (NSFC).

More than 50 graduate students and Ph.D. candidates from more than 20 universities and institutes of China, as well as Suranaree University of Technology, Thailand came to XTBG to follow high-quality lectures on the most recent theories and results on climate change. Professors and researchers gave 15 lectures on: climate change, ecology, plant evolution, botany, and plant biogeography.

This summer school gave the opportunity



*Group photo of professors and students.*

to improve the scientific exchange between students in these fields, and improve their skills for scientific innovation. A field trip to the 50 ha plot in Xishuangbanna National Nature Reserve enabled the students to see field applications of what they learned in the lectures.



## CUBG horticulture training course

36 staff from 21 botanical gardens of China gathered together in Kunming and Xishuangbanna during November 13-26 to attend a horticulture training course in Kunming Botanical Garden and XTBG. The course was sponsored by the Chinese Union of Botanical Gardens (CUBG), with the aim of raising horticulture capacity through botanical gardens nationwide.

The training course was composed of seven parts: propagation technology – seed propagation and cutting propagation of plants; common diseases and pest insects in plants in botanical gardens; brush cutting and care of woody plants; technique

of plant transplantation; effective ex situ conservation of important plant groups (mainly wild plant species with extremely small populations and extremely endangered plant species); ornamental plant configuration and display aimed at knowledge dissemination; use, maintenance and management of gardening machines.

The trainers included Prof. SUN Wei-Bang of Kunming Botanical Garden, Dr. Leigh MORRIS and Dr. Martyn DICKSON of Royal Botanical Gardens Edinburgh (RBGE), Prof. CHEN Xiu-Hong of Southwest Forestry University, and Mr. LI You-Yun of XTBG. At the closing meeting of the training course on November 25, Dr. CHEN Jin, director of XTBG and Chairman of CUBG, conferred certificates to the participants. He also encouraged the participants to change vocational interests into personal interests, to extend communication and share information and experiences. He expressed hope that the training would improve the horticulture capacity of the participants.

Three participants at this training course will be chosen and

recommended for further study in RBGE. RBGE has had a historic relationship with China, which has developed from simply collecting plants to helping to conserve plants within China. RBGE will now work as a partner to develop and deliver horticultural training with CUBG and we are looking at the model of the RBGE Certificate in Practical Horticulture coupled with our Train the Trainer programme, so that our training input is maximised. The course at Kunming was a trial for how this could work. Alongside the teaching, Leigh Morris also had the opportunity to meet with Prof. CHEN Jin, and Prof SUN Wei-Bang, director of Kunming Botanic Garden to discuss the longer-term plans for this partnership.

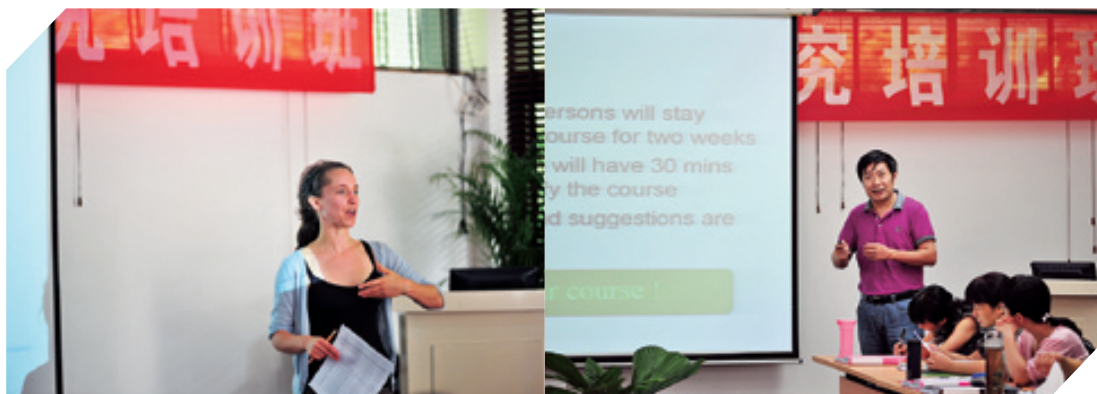


ABOVE LEFT: Explaining the pros and cons of landscapes of Kunming Botanical garden;  
ABOVE RIGHT: Practice of plant transplantation;  
BOTTOM: Learning seed propagation.





## CUBG environmental education training course 2013



*Dr. Sophie WILLIAMS(L) and Dr. CHEN Jin (R) teaching concept of environmental education, evaluation, and statistics.*

The Training Course 2013 on Environmental Education Research in Botanical Gardens of the Chinese Union of Botanic Gardens (CUBG) was held during August 26 and September 8 at XTBG. 28 botanic garden staff from 18 botanical gardens around China participated in the training.

The training course focused on techniques for delivering innovative environmental education and also how to evaluate the success of environmental education programs. Prof. CHEN Jin, Dr. Sophie WILLIAMS, and Mr. WANG Xi-Min were invited as training specialists.

In the first week, the training specialists delivered a series of lectures on environmental education, research and evaluation. A few students from XTBG shared their case studies. The teachers also guided the trainees to read literature on environmental education. During the two-week workshop, all participants were asked to read more than 20 research papers about

environmental education in English, discussing the methods and results and sharing their thoughts with others.

In the second week, the trainees were divided into 9 small groups to raise scientific questions, test their hypotheses, and design experiments (including questionnaire). After a 3-day data collection period, the trainees analyzed their data and presented their results.

The successful presentations by the trainees won praise from the training specialists. Afterwards, certificates of completion were conferred upon the trainees by Dr. CHEN Jin, director of XTBG and chairman of CUBG.



*Trainees share their design.*

## Summer camp for outstanding college students



*Summer camp for outstanding college students.*

On a summer morning in August 2013, the opening ceremony of the first XTBG summer camp for outstanding college students was held at XTBG. 30 students from 20 universities attended the camp.

Deputy director ZHOU Zhe-Kun warmly welcomed all campers. He wished campers a happy and successful experience through the visit from studying, communicating and other activities at XTBG. The first XTBG summer camp for outstanding college students lasted in Xishuangbanna until August 6. A series of activities were involved, including introduction of current development of XTBG, special themed lectures, academic salon, laboratory tours, field trips to the Xishuangbanna National Nature Reserve, etc.

## Training course on measurement of tree architecture

A training course on the measurement of tree architecture was held at XTBG during May 8-12. Students and young staff members of XTBG participated in the course. The course was co-organized by the Biodiversity Committee of CAS and the Key Laboratory of Tropical Forest Ecology, XTBG, CAS. Dr. Yoshiko IIDA, a postdoctoral researcher of Michigan State University, was invited as the keynote speaker.

The training course was composed of introduction of fundamental theory, field measurement, and data analysis. The instruments used in the training course included height poles, ultrasonic height gauges, and digital calipers, etc. The field measurement was conducted at the XTBG Arboretum and the Green Stone Forest.

The participants chose some important

tree species, *Dalbergia odorifera*, *Tectona grandis*, *Parashorea chinensis*, *Celtis wightii*, and *Cleistanthus sumatranus*. They measured DBH (diameter at breast height), breast height, crown diameter, clear bole height, and height of lowest leaves, etc. Architectural variables of over 100 tree individuals were measured and analyzed in the training course.

*At the 20-ha plot.*



*Trainees after having field measurement.*





# Team Building

## CAO Min honored with the title National Advanced Individual of Nature Reserves

In recognition of outstanding performance in the construction and management of national nature reserves, a batch of administrations and individuals has been awarded advanced collective or individual titles in January. Prof. CAO Min, deputy director of XTBG, is honored with the title of National Advanced Individual.

The honor was jointly conferred by the Ministry of Environmental Protection, State Forestry Administration, Ministry of Agriculture, Ministry of Land and Resources, Ministry of Water Resources, State Oceanic Administration,



Dr. CAO Min (right 2) working in a nature reserve.

and Chinese Academy of Sciences. The honor is aimed at comprehensively promoting the sustainable development of nature reserves all over China.

## Two professors receive special allowance from the State Council

Two XTBG professors (LIU Wen-Yao and CAO Kun-Fang) are qualified to receive the 2012 State Council Special Allowance. Each of them received 20,000 Yuan tax-free allowance from the central government.

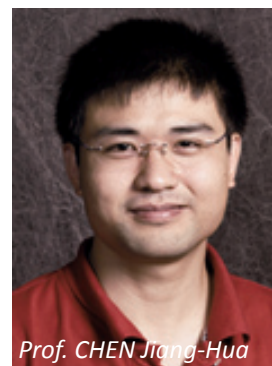
Dr. LIU Wen-Yao is engaged in studies on plant ecology, restoration ecology, and global change biology. He has made outstanding achievements in both scientific research and talents training.

Dr. CAO Kun-Fang is a well-known plant physiological ecologist. He has supervised a batch of young researchers. He has published his studies in *Ecology Letters*, *Journal of Ecology*, etc.

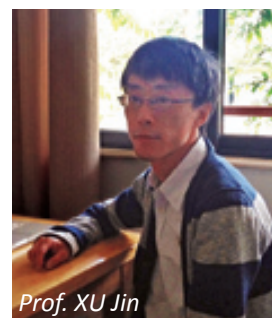
The State Council Special Allowance was set up in 1990 by the Central Committee of CPC and the State Council to award experts, scholars and technicians in recognition of their outstanding achievements. The selection of the recipients is biennial. Since 2008, the high-skilled talent personnel have been included into the selection. Up to now, 25 professors in XTBG have received this honor.

## New PI recruitment

Prof. CHEN Jiang-Hua, Principle Investigator and doctoral supervisor of Plant Functional Genomics Group in XTBG. He earned PhD degree from Shanghai Institute of Plant Physiology, CAS in 2006. After the post-doctoral training at Samuel Roberts Noble Foundation Inc. from 2006 to 2013, he joined XTBG in June 2013. He was elected as a scholar of the Hundred Talents Program of CAS. In the last decade, he focused on gene functional study of the legume plants. Several key genes had been isolated and studied in the model legume *Medicago truncatula*. He had published more than ten research articles in the peer-review journals, including *PNAS*, *Plant Cell*, *Cell Research* and *Plant Physiology*. These papers had been cited more than 300 times. He was also awarded a USA patent in 2011, and he is the member of American Society of Plant Biologist since 2007. Now he is leading a group in XTBG to work on the plant functional genomics using *M. truncatula*, soybean and other tropical crops as materials.



Prof. XU Jin, Principle Investigator of Horticultural Plant Breeding Group in XTBG. He received doctorate degree from Chinese Academy of Sciences in 2007. Since August 2013, XU Jin has been working as a professor and PI in XTBG. His research work focuses on molecular biology and breeding of horticultural plants; plant physiology and molecular biology of plant responses to abiotic stresses, such as heavy metal toxicity, micronutrition deficiency, and salt stress; phytoremediation. XU published a number of research papers in *New Phytologist*, *Plant Physiology*, *Planta*, *Plant and Soil*, etc.



## CHEN Li-Gang and 6 other doctors were approved by CAS “Light in Western China” project

After the approval of CAS Personnel Bureau, CHEN Li-Gang and 6 other doctors got funded by “Light in Western China” project.

Among the seven doctors, CHEN Li-Gang achieved a key project fund; HU Yan-Ru achieved one general project fund, while LI Su, ZHAO Jin, ZHAN Jian-Li, FU Pei-Li and CAO Lin achieved five Western Doctoral project funds. XTBG

was funded 1.3 million Yuan in total from “Light in Western China” project in the year of 2013.

CAS “Light in Western China” project started in 1996, with the purpose of supporting the development of research institutes and meeting the need of high-level talents in the western part of China. By the end of 2013, 62 scientists in XTBG had received funding by “Light in Western China” project, totaling 8.87 million Yuan. Due to this support, the level of scientific research has improved significantly in XTBG.





## Two young scholars obtain membership of Youth Innovation Promotion Association

Dr. CHEN Li-Gang and Dr. SONG Liang have obtained the membership of Youth Innovation Promotion Association of Chinese Academy of Sciences.

After graduating from Yunnan University in 2004, CHEN Li-gang came to XTBG to pursue his further study with Prof. YU Di-Qiu as his supervisor and obtained his Ph.D. degree in Botany in 2009. His research focuses on rice and *Arabidopsis* functional factors. His study has been published in *Proceedings of the National Academy of Sciences of USA*, etc.

Dr. SONG Liang conducted his postgraduate study with Prof. LIU Wen-Yao as his supervisor and obtained his Ph.D. from XTBG in 2012. His research interests include forest canopy ecology and global change ecology.

In 2012, CAS strengthened support for the development of young scholars by establishing the Association for the Promotion of Youth Innovation. The organization, which has about one thousand members, is aimed at nurturing a strong group of scientists and technical experts under 35 years old. The association aims to expand the vision of its members, promote



Dr. CHEN Li-Gang



Dr. SONG Liang

cooperation and increase opportunities for scholarly work.

To date, five young scholars of XTBG have obtained membership of the CAS Association for the Promotion of Youth Innovation.

## XTBG receives CAS Visiting Professorship and Young Scientists Fellowships

Five foreign scientists received grants from the Chinese Academy of Sciences for participating in research work of XTBG.

Prof. Charles CANNON of Texas Tech University, USA has been granted the CAS Visiting Professorship for Senior International Scientists (Visiting Professorship).

The four young scientists who have been granted the CAS Fellowship for Young International Scientists (Young Scientists Fellowship) are Dr. Olesya V. BONDARENKO of Far Eastern Branch of Russian Academy of Sciences, Dr. Alice Catherine HUGHES of Commonwealth Scientific and Industrial Research Organization of Australia, Dr. Masatoshi KATABUCHI of Tohoku University, Japan, and Dr. Yann SURGET-GROBA from University of California, Santa Cruz. The Visiting Professorships Program is for international scientists either currently or previously working in well-known universities, research institutes or multinational corporations, who wish to develop an effective long-term collaborative relationship with

CAS institutes. It provides for visits of 2-12 months duration. The fund is about RMB 400,000 -500,000 per year.

The aim of the Young Scientists Fellowship is to promote academic exchange and cooperation between CAS institutes and international research institutions and universities, and the development of talented scientists, by attracting young international scientists to conduct a period of cooperative research at CAS institutes. The fellowship provides for visits of 12 months duration, and funding covers the personal expenses of the international visitors. The fund is about RMB 150,000-250,000 per year.





# Visits

Photo by YANG Yun





## YIN He-Jun

YIN He-Jun, vice president of CAS, inspected XTBG on November 23-24.

YIN He-Jun visited living collections, environmental friendly rubber plantation, Green Stone Forest, cultivation bases of *Jatropha curcas* L. and Inca peanut, as well as XTBG laboratories. He then listened to the work report of XTBG, and had a discussion with directorate members, professors, and administrative staff.

YIN He-Jun urged XTBG to uplift the position of the botanical

garden, to enhance scientific research and science popularization, and to play a demonstrative role for botanical gardens nationwide, by making full use of the platform of Chinese Union of Botanical Gardens. He also emphasized the importance of security and secrecy.





## LU Zhan-Gong

Mr. LU Zhan-Gong, vice chairman of the Chinese People's Political Consultative Conference (C.P.P.C.C.) paid an inspection tour to XTBG on October 29. Mr. LI Hong-Wei, secretary of XTBG Communist Party Committee and deputy director accompanied the group that visited the living collections and the museum. During the inspection, LI Hong-Wei briefed the officials on XTBG's scientific research, plant diversity conservation, public education, and talent training. In the central laboratory, the inspection group paid attention to the phytotron and large precision instruments and communicated with the scientists who briefed the visitors on the operating status of these instruments.



Mr. LU Zhan-Gong spoke highly about XTBG's research experimental platform and horticultural capacity. He affirmed XTBG's role of promoting local scientific tourism development and community environmental education.

## QIN Guang-Rong

Mr. QIN Guang-Rong, the Party chief of Yunnan Province, paid an investigation visit to Xishuangbanna on ecological protection and economic development on August 8-9. XTBG was an important stepping point in the CPC secretary's check on development of the biological industry. At the tropical agroforestry system exhibition, QIN Guang-



Rong looked around the artificial community models, including rubber, tea, coffee, cocoa, and other economic crops. The environmental friendly rubber plantation was of his interest. At the experiment demonstration plot of environmentally friendly rubber plantation, Mr. QIN listened to CHEN Jin's introduction about seeking key technologies for promoting and developing environmentally friendly rubber plantations in Xishuangbanna. Mr. QIN said that it's important to speed up the development of environmentally-friendly rubber plantations and develop plants that can be grown in the rubber understory and contribute economic value.





## QIU He

On July 24, Mr. QIU He, deputy secretary of Yunnan Provincial Communist Party Committee (YPCPC) and Mr. LUO Hong, governor of Xishuangbanna Prefecture, headed a delegation and paid an inspection visit to XTBG on its biological industry development.

Accompanied by Prof. CHEN Jin, the director of XTBG, QIU He inspected the growth of some precious timber species, such as *Dipterocarpus turbinatus*, *Parashorea chinensis* and *Ostryoderris stuhlmannii*. Then they visited the Central Laboratory and CAS Key Laboratory of Tropical Plant Resource and Sustainable Use at the XTBG research center. Finally, the delegation visited biological diesel *Jatropha curcas* field and *Plukenetia volubilis* experimental field to learn about research progress.

CHEN Jin briefed recent achievements on scientific research, plant diversity conservation, and public education during the implementing of innovative projects in XTBG. QIU He evaluated XTBG highly on the scientific research, as well as XTBG research experimental platform construction. He encouraged XTBG to



make full use of resource superiority, to develop biological industry, by which to help with the construction of the Xishuangbanna Valuable Tree Species Demonstration Base.

## LIU Hui-Yan

During October 11 to 12, Mr. LIU Hui-Yan, vice governor of Yunnan Province, headed up a delegation to Xishuangbanna to investigate the situation of the rubber industry. During the inspection, LIU Hui-Yan visited XTBG to inspect construction of environmental-friendly rubber garden. At the agroforestry area, CHEN Jin, director of XTBG, made a work report regarding major tasks of building environmentally friendly rubber garden, as well as XTBG's overall status, scientific research, talent building and internationalization. LIU Hui-Yan inspected the growth status of cocoa plants, economic plants that grow below



rubber forests in the field, and asked in detail about species selection, cropping patterns and ecological benefits regarding the construction of the environmentally friendly rubber garden. LIU stressed that provincial government pays high attention to the development of the rubber industry. He pointed out that while developing the rubber industry, it is important to consider sustainable development, ecological environmental protection and integrated use of natural resources. Therefore he emphasized that environmentally friendly rubber gardens should be widely promoted.

## Other Visitors

### January

- 8 Dr. Steve COMPTON from University of Leeds, UK, visited XTBG and gave a talk at the XTBG Seminar.
- 12 Mr. CHEN Yu-Hou, member of Standing Committee and secretary of Xishuangbanna Prefectural Party Committee headed up a delegation investigating eco-environmental protection and biological industry development.
- 13 Prof. Melvin Thomas TYREE from University of Alberta, Canada, visited XTBG and gave a talk at the XTBG Seminar.
- 14 Dr. WANG Shu-Sen from Centre for Remote Sensing, Natural Resources Canada visited XTBG and gave a talk at the XTBG Seminar.

### March

- 1 Mr. Maurice van VEEN, manager of Tissue Culture Laboratory, Anthura Horticulture Co., Ltd., the Netherlands and Mr. KE Lihua, manager Kunming Anthura Horticulture Co., Ltd., China visited XTBG.
- 3 Mr. Nakul CHETTRI and 2 others from The International Centre for Integrated Mountain Development (ICIMOD) visited XTBG.
- 3 Dr. Alice HUGHES from University of Bristol, UK, visited XTBG and gave a talk at the XTBG Seminar.
- 5 Dr. Kyle TOMLINSON, Wageningen University, the Netherlands, visited XTBG and gave a talk at the XTBG Seminar.
- 6 Dr. René HAAK, Science and Technology counselor at the Embassy of the Federal Republic of Germany in China, Ruth SCHIMANOWSKI, deputy director of German Academic Exchange Service Beijing office, ZHAO Miaogen, deputy director of Sino-German Center for Research Promotion, HAN Xiaoding from Fraunhofer-Gesellschaft zur Förderung der angewandten Forschung. V., and HE Hong from Helmholtz Association Beijing office visited XTBG.
- 19 19 foreign scholars participated in the Late Cenozoic Environmental Change in Eastern Eurasia and Its Impact on Past and Present Biodiversity, a Sino-German meeting, in XTBG.

### April

- 4 18 foreign professors and students attended XTBG Field Botany Course.
- 9 Prof. Takashi KOHYAMA from Hokkaido University, Japan visited XTBG and gave a talk at the XTBG Seminar.
- 10 Prof. Arata Momohara, Chiba University, Japan, visited XTBG.
- 24 Dr. Magali PROFFIT from the National Scientific Research Center (CNRS), France visited XTBG and gave a talk at the XTBG Seminar.

### May

- 12 Laos Oudomxay Province government delegation (10-person) visited XTBG.
- 14 Dr. Arisoa RAJAONA from Hohenheim University, Germany visited XTBG and gave a talk at the XTBG Seminar.
- 20 Dr. Daniel LEFEBVRE from Queen's University, Canada visited XTBG and gave a talk at the XTBG Seminar.
- 21 Prof. Stephen BLACKMORE, the director of Royal Botanical Gardens Edinburgh and Prof. Pete HOLLINGSWORTH, Dr. Antje AHREADS from RBGE visited XTBG.
- 23 Thailand's Congressional Delegation (72-person) visited XTBG.
- 27 *Shen Zhou* Nine astronauts, including JING Hai-Peng, LIU Wang and LIU Yang, visited XTBG.
- 28 Dr. ZHONG Xiao-Ping, tenured professor at Duke University, USA visited XTBG and gave a talk at the XTBG Seminar.
- 28 Prof. Jan MULDER from Norwegian University visited XTBG and gave a talk at the XTBG Seminar.

### June

- 18 Dr. Guido F. PAULI and Dr. Birgit U. JAKI from the University of Illinois at Chicago, USA visited XTBG and gave talks at the XTBG Seminar.
- 18 Dr. Benoit GUENARD from Okinawa Institute of Science and Technology, Japan, visited XTBG and gave a talk at the XTBG Seminar.
- 26 Dr. Yakov KUZYAKOV from University of Gottingen, Germany, Dr. XU Xingliang and Anna GUNINA





from Institute of Geographic Sciences and Natural Resources Research, CAS visited XTBG and gave a talk at the XTBG Seminar.

### July

- 2 Dr. Marc JOHNSON from Toronto – Mississauga University, Canada, visited XTBG and gave a talk at the XTBG Seminar.
- 9 Dr. Robert EFIRD from Seattle University, USA, visited XTBG and gave a talk at the XTBG Seminar.
- 13 Dr. Peter DÖRSCH, from the Department of Plant and Environmental Sciences, Norwegian University of Life Sciences, Norway, visited XTBG.
- 23 Dr. Charles CANNON from Texas Tech University, USA, visited XTBG and gave a talk at the XTBG Seminar.
- 26 20 foreign professors and students attended the Field Course on Digital Forest Monitoring Techniques at XTBG.

### August

- 4 Dr. Stefan SCHNITZER, a leading scientist on Ecology from University of Wisconsin, USA, visited XTBG and gave a talk at the XTBG Seminar.
- 6 Dr. Michael AHLHEIM from University of Hohenheim, Germany, visited XTBG and gave a talk at the XTBG Seminar.
- 6 Dr. Timothy G. GREGOIRE from Yale University visited XTBG and gave a talk on XTBG Seminar.
- 13 Dr. Jonathan ADAMS from Seoul National University, South Korea, visited XTBG and gave a talk at the XTBG Seminar.
- 13 Dr. David LOHMAN from City University of New York, USA, visited XTBG and gave a talk at the XTBG Seminar.
- 20 Dr. Georg CADISCH from University of Hohenheim, Germany, visited XTBG and gave a talk at the XTBG Seminar.
- 24 Dr. Suyanee VESSABUTR, director of Queen Sirikit Botanic Garden of Thailand, headed a 4-person delegation to XTBG. A Memorandum of Understanding (MoU) was signed.
- 25 Dr. Kevin DAVIES headed a 3-person delegation from The New Zealand Institute for Plant and Food Research Limited and visited XTBG.
- 27 Dr. Sophie WILLIAMS from Bangor University, UK, visited XTBG and gave a talk at the XTBG Seminar.

- 30 Dr. Steven MANCHESTER from Florida Museum of Natural History, USA, visited XTBG and gave a talk at the XTBG Seminar.

### September

- 20 Mr. Jonathan HUTCHINSON, the director of the Royal Horticultural Society, UK, headed a 11-person delegation to XTBG.
- 21 Dr. Aaron ELLISON, editor-in-chief of Ecological Monographs, visited XTBG and gave an academic report.

### October

- 15 Dr. Tom FAYLE from University of South Bohemia, Czech Republic, visited XTBG and gave a talk at the XTBG Seminar.
- 12 Dr. Brian TRADER from Longwood Gardens, USA headed a 9-person delegation visiting XTBG and gave a seminar talk.
- 21 Dr. Alexei OSKOLSHIF from Russian Academy of Sciences visited XTBG and gave a seminar talk.
- 22 Prof. Jussi GRIEßINGER from Erlangen-Nürnberg University, Germany, visited XTBG and gave a talk at the XTBG Seminar.
- 25 Dr. Chusie TRISONTHI from ChiangMai University, Thailand, headed a 11-person delegation and visited XTBG.

### November

- 12 Dr. Ronny ROßLER from Museum fuer Naturkunde, Germany, visited XTBG and gave a talk at the XTBG Seminar.
- 18 Dr. HAO HAO Guang-You from Harvard University, USA, visited XTBG and gave a seminar talk.

### December

- 3 Dr. Edward STASHKO from Organization for Tropical Studies, USA, visited XTBG and gave a talk at the XTBG Seminar.
- 7 Mr. LIU Ping, a member of leading party group in Yunnan Provincial Government led an investigation group and inspected the renovation project at the XTBG Green Stone Forest area.
- 10 Prof. Paul BEIER from Northern Arizona University, USA, visited XTBG and gave a talk at the XTBG Seminar.
- 17 Prof. GAO Jian-Bo from Wright State University, USA, visited XTBG and gave a talk at the XTBG Seminar.



The background of the entire page is a close-up photograph of numerous pink flowers, likely from a legume, arranged in dense, vertical clusters. The flowers are in various stages of bloom, with some showing distinct petals and stamens. The background is a soft, out-of-focus green, suggesting foliage.

# Financial Review

*Photo by LIU Guang-Yu*



## Income and Expenditure

(Million Yuan)

	Categories	FY2011	FY2012	FY2013
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### INCOME

	Government Grants	31.803	84.253	47.716
	Infrastructure	0	0	0
	Admissions & Services	36.692	46.688	56.197
	Grants for research	55.217	70.841	109.232
	Miscellaneous	1.236	0.274	0.747
	Sum	124.948	202.056	213.892

### EXPENDITURE

	Staff costs	67.303	74.629	89.739
	Maintenance	0.139	2.352	5.669
	General and Admin. Expense	1.872	16.853	7.088
	Infrastructure	4.631	0	0
	Equipment	23.326	60.384	65.920
	Research & Horticulture	32.020	35.552	34.768
	Miscellaneous	0	0	0
	Sum	129.291	189.77	203.184



# Publications

*Photo by LIU Guang-Yu*



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