XTBG

Annual Report 2010

Xishuangbanna Tropical Botanical Garden
Chinese Academy of Sciences

Cover photos, anti-clockwise:

1. The finished Tropical Energy Plants Collection;
2. Red-whiskered bulbul (*Pycnonotus jocosus*);
3. A huge *Koompassia excelsa* tree in a forest in SE Borneo;
4. Nigel MARVEN in the garden;
5. Accompanied by Prof. CAO Min, Cambodian delegation visiting XTBG Herbarium;
6. AFEC-X 2010 opening ceremony at XTBG;
7. Low Carbon Ambassador from the local school.

Photo by YE Chenxi

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March 31, 2011

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:

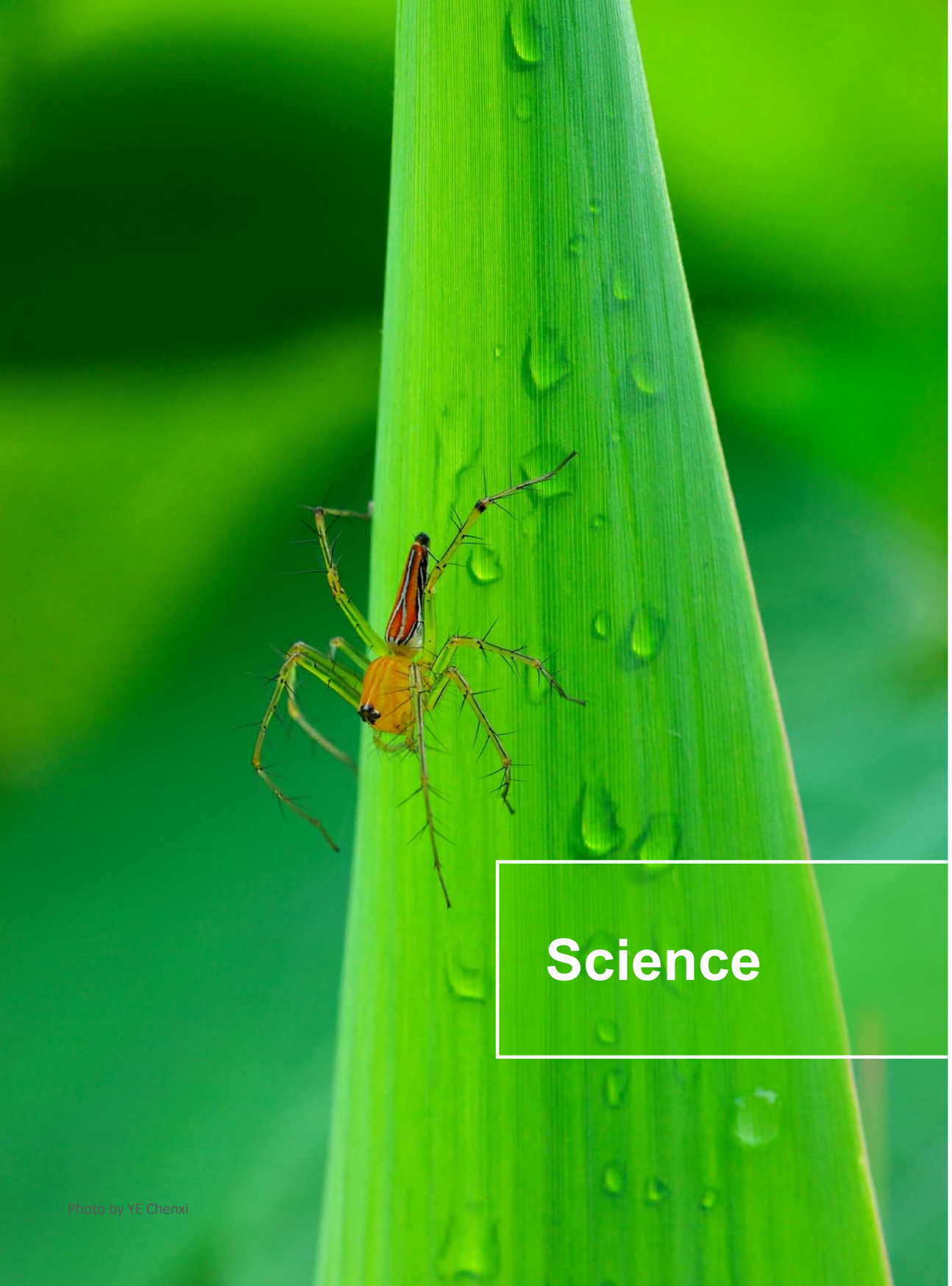
Desirable base for plant diversity conservation and ecological studies.

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



Science

Photo by YE Chenxi

In 2010, XTBG received 31.2 million Yuan in research funds from 61 new projects:

12 projects funded by the National Natural Science Foundation of China;
4 projects supported by the Ministry of Science and Technology;
8 projects supported by other Ministries in China;
2 projects funded by Yunnan Provincial Fund for Natural Sciences;
11 projects supported by the Chinese Academy of Sciences;
5 projects funded by the CAS “Light in Western China” program;
13 projects funded by local government, enterprises and international agencies;
2 international projects.

Also this year, XTBG researchers have achieved the following:

91 research articles published on internationally peer-reviewed scientific journals (Source Journals of ISI Web of Science);
77 research articles published on CSCD (Chinese Science Citation Database) refereed journals;
1 monograph published;
7 patented inventions;
1 registered new plant variety.

Project Development

On-site final evaluation meeting at XTBG.

National S&T project "Integration and demonstration of key-techniques on the rehabilitation of eco-environment in Karst mountain areas" pass the final evaluation with promising output

On November 4, 2010, scientists and government officials gathered at XTBG to evaluate the final-report of a project granted by the National Science and Technology Support Program of China "The Integration and demonstration of key-techniques in the rehabilitation of eco-environment in Karst mountain areas".

With a total funding of 45.95 million Yuan, XTBG launched this project in January 2006 with the aim to provide scientific basis for the restoration of degraded Karst environment.

Armed with his extensive experience in ecological restoration of Karst mountain landscape, the principal investigator, Prof. LIU Wenyao, carried out research in Bijie area of Guizhou Province, SW China. Due to the complex nature of the project, research teams from diverse expertise were brought together to accomplished the task. Experts documented and assessed land use change, examined the potential for rehabilitation of different plant communities, investigated the selection of native plants, and optimized the ecological cycle of breeding modes. Based on the data collected, the project team developed multiple solutions and techniques integrating soil and water conservation. By planting grass, raising livestock embryo transfer, raising varieties of livestock and poultry adaptable to local environment, and standardized the planting practice of Chinese herbs, the research team improved the rehabilitation of the Karst mountain areas. Good ecological, social and economic benefits have been achieved through promotion and implementation of these patterns and technologies. After years of intensive work, over 40 articles have been published and 3 patent applications have been filed. 2 PhD students and 45 Master students obtained their degrees. The project was also awarded the 2nd prize of Agricultural Harvest in Guizhou Province, and the 1st prize of Science & Technology Progress of Bijie Prefecture, Guizhou Province.

The evaluation committee led by Science and Technology Department of Guizhou Province recognized the effectiveness of this project.

CAS Key Project of Knowledge Innovation Engineering "Responses and acclimation of the typical subalpine forest ecosystems in SW China to global climate change" initiated

Global change is one of the hottest issues in Ecology. Xishuangbanna Tropical Botanical Garden,in cooperation with Kunming Institute of Botany, Chengdu Institute of Biology, and Wuhan Botanical Garden, was funded to explore the ecological effects, the responses of vulnerable ecosystems and their acclimation mechanisms to global climate change. Leaded by Prof. FENG Yulong of XTBG, this research aimed to investigate the responses of alien plant species and important native plant species to climate change in Sothern-west China. This work was supported by the Chinese Academy of Sciences through the Key Project of Knowledge Innovation Engineering of CAS (KSCX2-YW-Z-1019). The total fund of this 2-year project is 2 million Yuan.

DNA barcode is similar to barcodes used to tag retail products in supermarkets.

"DNA barcoding of trees in the 20-ha Xishuangbanna tropical seasonal rainforest dynamics plot"

DNA barcoding is a diagnostic technique for species identification using short standardized DNA regions. Five research groups from XTBG collaborated in a cooperative project, "DNA barcoding the trees of 20-ha Xishuangbanna tropical seasonal rainforest dynamics plot". They sampled approximate 2,000 plants and selected 743 samples representing 70 families, 213 genus, and 468 species. Following guidelines from the Plant DNA Barcoding Working Group, 3 plastid fragments-*mat*K、*rbc*L、*trn*H-*psb*A and one nuclear fragment nrITS were amplified and sequenced. DNA barcoding will help to inventory biodiversity in species-rich geographic areas, and provide basic information for other biological disciplines such as community ecology, phylogenetics.

TOP *Ficus cyrtophylla* (Wall. ex Miq.) Miq.

ABOVE Red-whiskered bulbul (*Pycnonotus jocosus*).

Research Progress and Outreach Highlights

"Who" Shapes the Spatial Genetic Structure of Plant Populations?

The spatial genetic structure (SGS) of a plant population is mainly determined by gene flow via seed and pollen, various natural selection pressures and spatial patterns of existing plants. The study about the roles of those factors in shaping SGS has been the focus in ecology for many years. However, for the complexity, to disentangle the roles of those factors still requires further investigation.

Fig plants are best known for their species-specific interactions with pollinating wasps, and they are also cognized as the key food resources for tropical frugivores. For such a special group, understanding the contributions of seed dispersers and wasp pollinators to gene flow and genetic structure is always a central question. XTBG PhD candidate ZHOU Huiping and her supervisor Prof. CHEN Jin selected an understorey dioecious fig species (*Ficus cyrtophylla*) occurring in the understorey or mid-canopy layer of seasonal rain forest in Xishuangbanna area as the study object. By field investigation on the spatial pattern of plant individuals and seed rain, observation on seed dispersers, parentage analyses on gene flow and comparative study on SGS of different age cohorts, they found that seed dispersal by three mid-sized bulbuls and pollen dispersal by *Kradibia* wasps initially determined the cluster spatial pattern and significant SGS of *F. cyrtophylla*, whereas demographic selection effects during recruitment (density-dependent predation and competition) could lead to the decrease in individual number and the loss of SGS.

This study clarified clearly the relative importance of different factors in different recruitment stages of plant populations. Their findings have been published in *Journal of Ecology*.

Disturbance result in community assemblages of closely related species

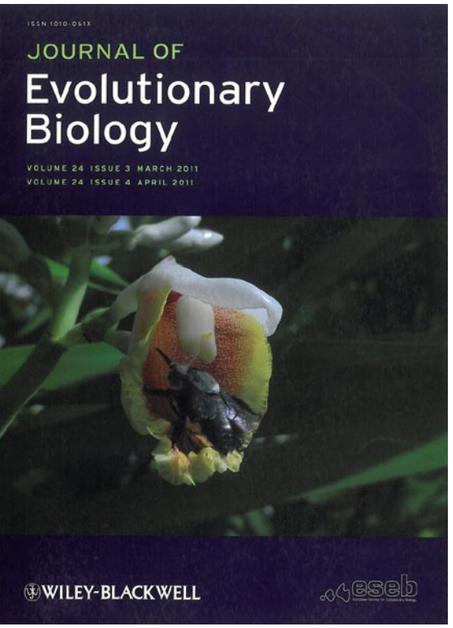
Dr. Matthew HELMUS, a postdoc from the Ecological Evolution Group, made a hypothesis that disturbance should result in community assemblages of closely related species. The research observation entitled "Communities contain closely related species during ecosystem disturbance" has been published in the prestigious journal *Ecology Letters*.

Dr. Matthew HELMUS (right 1), celebrating X'mas with team members in XTBG.

The authors tested the hypothesis with 18 disturbed and 16 reference whole-lake, long-term zooplankton data sets. When disturbed, communities generally contained more closely related species, regardless of disturbance type. They also discovered that the effect was independent of species richness, evenness, and abundance. Species sensitivities to specific disturbances were phylogenetically conserved, were independent of body size, and could be predicted by the sensitivities of close relatives within same community. Thus, the authors propose phylogentetic relatedness to act as an effective proxy for missing trait information when predicting community and species responses to disturbance.

Assembly free comparative genomics of short-read sequence data discovers the needles in the haystack

In Feb 2010, Prof. Chuck CANNON, Asst Prof. Chai-Shian KUA and members of the Ecological Evolution group published a method to analyze short-read sequence in the journal *Molecular Ecology*. Most comparative genomic analyses of short-read sequence (SRS) data rely upon the prior assembly of a reference sequence. They presented an assembly free analysis pipeline of SRS data that discovers sequence variants among focal genomes by tabulating the presence and frequency of 'complex' fragments in the data. Using data from nine tree species, the team compared genomic diversity at different taxonomic levels. As a control, SRS data for three known plant genomes were simulated. The results provide insight into the quality and distributional bias of the sequencing reaction. Three main types of informative "complexmers" were identified, each possessing unique statistical properties. Type I complexmers are unique to a genome but suffer from a high false positive rate, being highly dependent on read coverage and distribution. Type II complexmers are shared between two genomes and can highlight potential copy-number differences. Type III complexmers are exclusive to a subset of genomes and can be useful for associating genetic differences with phenotypic or geographic variation. At the population level in an endangered timber species, numerous markers were identified that could potentially determine geographic origin of individuals and regulate international trade. The authors observed that the genomic data for the four fig species analyzed were more divergent than for stone oak species, possibly due to their complex pollination syndrome and high rates of gene flow. This new approach greatly enhances the application of SRS technology to the study of non-model organisms and directly identifies the most informative genetic elements for more detailed study and assembly.



Cover of *Journal of Evolutionary Biology*.

Why do stigmas move in a flexistylous plant?

LI *et al*. (2001) defined a new mechanism of stylar polymorphism – Flexistyly, involving both spatial and temporal segregation of sex roles within hermaphroditic flowers. They made a new progress in this year. Using the experimental manipulation of stigma movement in self-compatible *Alpinia mutica*, XTBG postdoctoral researcher SUN Shan and his supervisor Prof. LI Qingjun tested the hypothesis that selection for reducing interference between male and female function drives the evolution and / or maintenance of stigma movement. In experimental arrays, anaflexistylous (protogynous) flowers served as pollen donors competing for mating opportunities on cataflexistylous (protandrous) flowers. The pollen donors were either manipulated so their stigmas could not move or were left intact, and their success was determined by using allozymes to assess the paternity of recipient seeds. They found that the manipulated flowers sired a significantly smaller proportion of seeds, showing that stigma movement in unmanipulated plants increased male fitness. This result was strongest under conditions in which pollen competition was expected to be highest, especially when pollinators visited multiple donor plants before visiting recipient flowers. This result has been published as the cover story at *Journal of Evolutionary Biology*.

Robber-like pollination in a distylous plant

"Nectar robbing" occurs commonly in flowering plants, especially those with tubular flowers of flowers with nectar spurs. Nectar robbers usually obtain reward without providing a pollination service, so they have frequently been described as cheaters in the plant-pollinator mutualism system. Under the guidance of Prof. LI Qingjun, XTBG Master candidate ZHU Xingfu found flowers of distylous *Primula secundiflora* were frequently robbed by *Bombus richardsi* and robbing holes were always situated between high and low sexual organs for both floral morphs. Using manipulative experiment, they proved nectar robbers touch low sexual organs and thus transfer pollen grains from pin flowers to thrum flowers. Such asymmetrical pollen flow caused by nectar robbers may act as an important selective agent in floral fitness and evolution of distyly. This research has been published at *Biology Letters*.

LI Qingjun (left) and ZHU Xinfu (right), in the "nectar robber" research site.

Mass fruiting in Borneo: a missed opportunity

In the October 29, 2010 issue of *Science* magazine, a group of twenty-five tropical biologists published a brief letter to the editor about the recent occurrence of a general fruiting event in the rainforests on the island of Borneo. The letter states the importance of these events to the future of forest restoration efforts in Indonesia. The seeds of most tropical species cannot be stored and must germinate and survive as small seedlings. The fruiting events in Borneo are unpredictable and only occur infrequently which means that the availability of future seed crops is unknown. These seed crops will be a major source of biodiversity and genetic wealth, so international and national organizations should prepare infrastructure and expertise to take advantage of the next fruiting event, because the seeds are highly perishable. Two faculty members from XTBG, Prof. Chuck CANNON and Assoc. Prof. Rhett D. HARRISON, contributed to the letter. They have extensive experience working in the rainforest of Borneo.

Water uptake patterns of two canopy tree species in the tropical rainforest

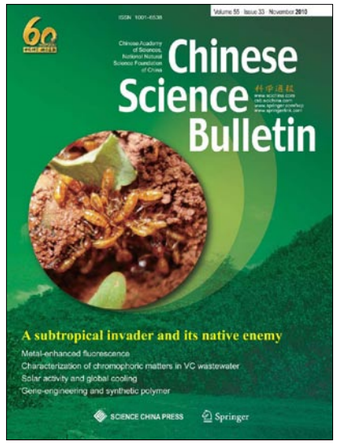
Radiation fog has been suggested as an important source of moisture in tropical seasonal rainforest of Xishuangbanna during the dry season, yet its importance for the plants which inhabit this ecosystem is virtually unknown. Prof. LIU Wenjie assessed patterns of water uptake by two major seasonal rainforest canopy tree species in this area. Results indicated that evergreen *Gironniera subaequalis* tree appeared to be acquiring water preferentially from the upper 50 cm of the soil profile, with around 53–72% of its water from shallow soil. In contrast, brevi-deciduous *Pometia tomentosa* tree seemed to be tapping water mostly from depths greater than 60 cm or from groundwater, with about 28–46% of its water from shallow soil, suggesting that it relies predominantly on its deep taproot for water uptake. During the dry season, when fog was most frequent, 23–59% of the water used by *P. tomentosa* seedling came from fog water after it had dropped from tree foliage into the soil, indicating that fog water was an important source for seedling growth, especially at the peak of the dry season. Since both seedlings and shallow-rooted understory species require moisture and cool conditions to regenerate, it might be expected that some other tree seedlings and understory species also partially rely on fog moisture during the pronounced dry season, but further research is needed. This research has been published at *Agricultural and Forest Meteorology*.

Fog-inundated tropical rainforest in Xishuangbanna during the dry season.

Noxious invasive *Eupatorium adenophorum* may be a moving target

Eupatorium adenophorum is one of the most noxious perennial invasive weeds in six provinces of SW China. The mechanisms underlying its invasion success are still poorly understood. Prof. FENG Yulong and his team observed that *Dorylus orientalis*, a polyphagous ant feeding on *E. adenophorum*, which create damage to the epidermis, cortex, phloem, cambium, and xylem tissues of roots and stems around the root collar of the weed. This resulted in the death of the plants by interrupting the nutrient exchange between shoots and roots. This ant showed selectivity for the invader to some extent. Their observation showed that this ant may have potential for use as a biocontrol agent against *E. adenophorum*. The finding of *D. orientalis* and other native enemies indicate that *E. adenophorum* may gradually naturalize in introduced landscapes.

Their observation was published as cover story on *Chinese Science Bulletin*.

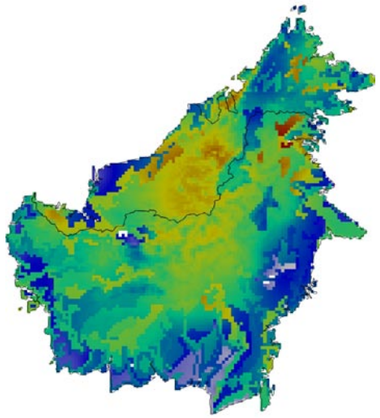


Ants are nibbling root collar of *Ageratina adenophora*.

New evidence for explain honey bee's Colony Collapse Disorder (CCD)

The common hive bee *Apis mellifera* has recently experienced a puzzling phenomenon, termed as Colony Collapse Disorder (CCD), in which foraging bees mysteriously disappeared from the hives. Most researchers suggest that the potential factors causing CCD including malnutrition, bee diseases, and other environmental stresses. However, no cause relationship has been established between these factors and CCD. The group of Prof. LIU Fanglin examined the effect of nectar phenolics on social organization of a bee colony. The result showed that worker bees fed sugar solution with high concentration of nectar phenolics were more likely to initiate ovarian development and built many queen cells in their colony throughout the feeding trial. Also, these workers frequently attacked their queen. So the phenolic-concentrated nectar could disturb the phenomenal communication in honeybee colonies. This study provides insights into a possible, unsuspected cause of CCD. This work has been published in *Journal of Chemical Ecology.*

Aboveground biomass of tropical forests in Borneo is 60% higher than those of Amazonia



Forest above ground biomass model for Borneo developed in Prof. SLIK's Lab.

A recent study led by Prof. Ferry SLIK revealed a surprising finding about the biomass of tropical forests. This study used tree inventory data to calculate forest aboveground biomass values for more than 80 locations across Borneo with the aim to find correlations between biomass and environmental variables such as elevation, climate and soils. It found that forest biomass in Borneo was mainly driven by annual rainfall amounts and soil fertility. The resulting modeling equations were then used to predict the biomass of forests for which no tree inventory data was available, resulting in a potential biomass map for the whole island of Borneo.

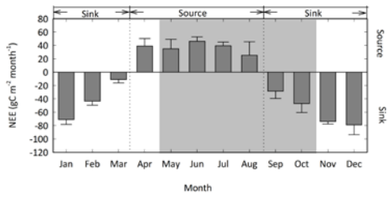
When these outcomes were compared with other tropical regions where such analysis have also been performed, it was immediately clear that Borneo's forest biomass was, on average, as much as 60% higher than that of comparable areas in the Amazon. This difference could not be linked to differences in climate or soils, and eventually the high density of large Dipterocarp trees in Asia turned out to be the only factor that could explain the observed biomass difference between the two continents. As a follow up, Prof. SLIK is now exploring a pan-tropical biomass data set to try to explain the differences in large tree density and biomass across the tropics.

In close relation to the Borneo findings, Prof. SLIK was also involved in another publication that showed that efforts to protect tropical forests via the 'Reduced Emissions from Deforestation and Degradation' (REDD) might not automatically lead to better protection of biodiversity. In Borneo, the forests with the highest combined above- and below-ground biomass are the peat-swamp forests. Although these forests are quite diverse in plants and animals, they contain far fewer plant and animal species than the lowland Dipterocarp forests on mineral soils that cover a large part of Borneo. Focusing REDD projects only on forests containing the highest carbon content might in this case lead to the decision to protect the relatively low diversity peat-swamp forests instead of the highly diverse surrounding forests on mineral soils. This makes it necessary to adapt REDD programs so that they include some measure of biodiversity protection as well. Those results have been published in *Global Ecology and Biogeography* and *Carbon Balance and Management*.

A huge *Koompassia excelsa* tree in a forest in SE Borneo.

Respiration controls the unexpected seasonal pattern of carbon flux in an Asian tropical rain forest

Tropical rain forests play important roles in the global carbon cycle. Prof. ZHANG Yiping and his research team discovered a six-year eddy covariance carbon flux campaign in a primary tropical seasonal rain forest in Southwest China. An unexpected seasonal pattern of net ecosystem carbon exchange was detected, with carbon lost during the rainy season and stored in the dry season. Strong seasonality of ecosystem respiration was suggested to primarily account for this seasonal pattern. The annual net uptake of CO_2 by the forest varied from 0.98 to 2.35 metric tons of carbon per hectare between 2003 and 2008. Six-year averaged sink strength was 1.68 metric tons of carbon per hectare. Their foundings have been published in *Atmospheric Environment*.



Six-year averaged seasonal variation of net ecosystem CO_2 exchange (NEE). Shaded area represents the rainy season. The error bar was standard error of six years.

MicroRNA395 mediates regulation of sulfate accumulation and allocation in *Arabidopsis thaliana*

Sulfur is one of the macronutrients necessary for plant growth and development. Sulfate, a major source of sulfur nutrient, is up-taken by plant roots and then transported into different tissues for assimilation. miR395 is a conserved plant microRNA, which is induced dramatically by sulfate starvation. However, it is unclear how miR395 regulates sulfate metabolism in plants.

To investigate the functions of miR395, transgenic plants over-expressing miR395 were constructed and found to over-accumulate sulfate in the leaves. In contrast, the mutants of ATP genes (three targets of miR395) also contained higher sulfate content than wild type leaves. Correspondingly, these three APS genes were down-regulated significantly in transgenic plants. These results establish a link between the decrease of APS genes and the increase of sulfate in *Arabidopsis* leaves.

Another phenotype of transgenic plants is the disruption of sulfate transport from mature to young leaves. The overexpression of miR395 led to the suppression of SULTR2;1 gene (another target of miR395). By analysis of T-DNA insertion mutants, the normal sulfate transport of sultr2;1 mutants was despaired, which phenocopied the transgenic plants.

XTBG PhD LIANG Gang and his supervisor Prof. YU Diqiu revealed that miR395 mediates sulfate accumulation and allocation by regulating three ATP sulfurylases (APS) and one sulfate transporter (SULTR2;1) in *Arabidopsis*. The paper, entitled "MicroRNA395 mediates regulation of sulfate accumulation and allocation in *Arabidopsis thaliana*", was published in *The Plant Journal*.

Research team led by Prof. YU Diqiu.

Wounding-Induced WRKY8 Is Involved in Basal Defense in Arabidopsis

The WRKY family of plant transcription factors controls several types of plant stress responses. *Arabidopsis* WRKY8 is induced by both biotic and abiotic stress factors, such as ABA, H_2O_2, wounding, *Pseudomonas syringae* and *Botrytis cinerea* infection, and aphid and maggot feeding. The *wrky8* mutant Plants showed increased resistance to *P. syringae* but slightly decreased resistance to *B. cinerea*. In contrast, transgenic plants over-expressing *WRKY8* were more susceptible to *P. syringae* infection, but more resistant to *B. cinerea* infection. The contrasting responses to the two pathogens were correlated with opposite effects on pathogen-induced expression of two genes; salicylic acid-regulated *PATHOGENESIS-RELATED1(PR1)* and jasmonic acid-regulated *PDF1.2*. Therefore, Prof. YU Diqiu and his research team found that *WRKY8* is a negative regulator of basal resistance to *P. syringae* and positive regulator to *B. cinerea*. Their results support the existing of trade-off between SA-dependent and JA-dependent defense against biotrophic and necrotrophic pathogens. These results have been published in *Molecular Plant-Microbe Interactions*.

LEFT *Dracaena cambodiana*

RIGHT *Kmeria septentrionalis*

Research advances in conservation genetics of two endangered plants

Kmeria septentrionalis, a dioecious treefound in isolatedrelicpopulations in Southern China, is subject to extensive protection due to its rarity and high economic values. To improve conservation outcomes, information on spatial genetic structure of the species was studied by used of fluorescent AFLP (Amplified Fragment Length Polymorphism). This study reveals a coarse and fine scale genetic structure of the relic populations. The results suggest that a) outbreeding depression should be avoided when introducing, b) *ex situ* collection, seed bank and DNA bank should be carried out.

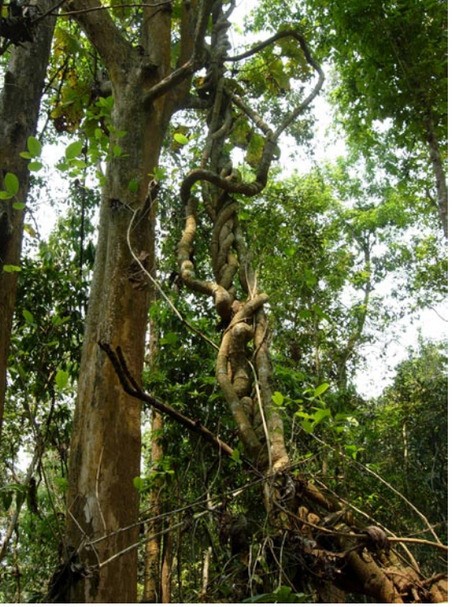
Dracaena cambodiana is an endangered species, narrowly distributed in China and the Indochina Peninsula. Considering its medicinal, ornamental and ecological values, an appropriate conservation program is urgently needed to prevent further loss of *D. cambodiana*. 16 polymorphism microsatellite (SSR) markers have been developed using the Fast Isolation by AFLP of Sequences Containing Repeats (FIASCO) protocol, which is a very important step to gain managed and protected information for *D. cambodiana*.

ZHAO Jianli and ZHANG Lu under the guidance of Assoc. Prof. LI Qiaoming, from the Plant Phylogenetics and Conservation Group (PPCG) at XTBG, have finished these works. Preliminary results have been published in *Genetica* and *American Journal of Botany* respectively.

Research advances in Lauraceae

The genus *Neocinnamomum* H. Liu is one of the most enigmatic groups in Lauraceae, with six species endemic to tropical to subtropical Asia. In the past *Neocinnamomum* was considered to be close to *Cinnamomum*. In contrast, recent molecular phylogenetic studies in Lauraceae have revealed novel but conflicting phylogenetic relationships for *Neocinnamomum*, and the previously suggested affinity with *Cinnamomum* was rejected.

Using *psb*A–*trn*H, *trn*K cpDNA regions, and the ITS nrDNA segment, XTBG Master candidate WANG Zhihua and his supervisor Prof. LI Jie from the Plant Phylogenetics and Conservation Group (PPCG)), conducted a phylogenetic analysis of *Neocinnamomum* by using the materials of five *Neocinnamomum* species and 15 species from the related genera in Lauraceae. They found that *Neocinnamomum* was monophyletic. The compound thyrse (a dense flower cluster in which the main axis is racemose and the branches are cymose) seen in *N. caudatum* is reduced to the few- to many-flowered condensed inflorescences with a poorly defined branching system seen in most species, and ultimately to the 1-flowered inflorescence seen in *N. atjehense*. *Neocinnamomum* is more closely related to the genus *Caryodaphnopsis* than to the genus *Cassytha*. *Caryodaphnopsis* and *Neocinnamomum* may be the descendants of Laurasian Cretaceous Lauraceae. These analyses further suggest that *Neocinnamomum* may be one of the basal groups in Lauraceae. Their results, entitled “Phylogeny of the Southeast Asian endemic genus *Neocinnamomum* H. Liu (Lauraceae)”, reported in *Plant Systematics and Evolution*.



TOP Liana species in tropical rain forest in Xishuangbanna, SW China.

ABOVE *Ficus concinna* of epiphytic (left) and terrestrial (right) stages strangling their host palm trees in Xishuangbanna Tropical Botanical Garden.

Contrasting cost–benefit strategy between lianas and trees in a tropical seasonal rain forest in SW China

Under the guidance of Prof. CAO Kunfang, PhD candidate ZHU Shidan compared leaf construction cost, leaf nutrients and photosynthetic rates between leaves from 18 liana species and 19 tree species in a tropical seasonal rain forest in SW China. Their results revealed that lianas were located at the quick-return end of the leaf economics spectrum, with higher photosynthetic rates, higher photosynthetic nitrogen and phosphorus use efficiencies, a lower leaf construction cost per unit leaf area and cost-benefit ratio, and a shorter leaf life span. Trees showed the opposite trends. These traits give lianas a competitive advantage over trees in open tropical forest habitats. These could also benefit lianas more than trees in terms of an increased productivity from the increasing atmospheric CO_2 concentration. Their results have been published in *Oecologia*.

Differentiation of leaf water flux and drought tolerance traits in Ficus tree species

Under the guidance of Prof. CAO Kunfang, PhD candidate HAO Guanyou compared the differentiation of leaf water flux and drought tolerance traits in leaves of five hemiepiphytic and five non-hemiepiphytic *Ficus* tree species grown in a common garden. Their results revealed that hemiepiphytic *Ficus* tree species had lower xylem water transport capacity, but tighter stomatal control and greater ability of leaves to persist under drought, and vice versa. Species adaptation to habitats with contrasting demands on leaf function may lead to divergence along a leaf water-flux-drought tolerance spectrum. Their results reported in *Functional Ecology*.

FANG Zexin, in the Gaoligong Mountains.

Tree ring recorded May–August temperature variations since A.D. 1585

XTBG PhD candidate FANG Zexin and his supervisor, Prof. CAO Kunfang, developed 595-year tree ring-width chronology from *Larix speciosa* W. C. Cheng near the timberlines of the Gaoligong Mountains, Southeastern Tibetan Plateau. They investigated the May–August temperature variability since A.D. 1585, and the findings indicate that cold conditions prevailed during the periods 1600s, 1730–40s, 1760s, 1810–20s, 1850s, 1910s and 1960–70s in the 420-year temperature reconstruction. The 1810–20s stand out as the coldest period. It may be linked to the occurrence of strong volcanic eruptions during this period. Since 1970s, the Gaoligong Mountains has shown continuous warming trend. Spatial correlations with gridded land surface temperatures revealed that this historical reconstruction is representative of the regional climate change in Gaoligong Mountains. Comparison with other tree ring-based temperature reconstructions from the Southeastern Tibetan Plateau implies a high degree of confidence. Their work has been published in *Palaeogeography, Palaeoclimatology, Palaeoecology*.

Study on photoinhibition and subsequent recovery in tropical tree species

Tropical plants are sensitive to chilling temperatures above zero but the mechanism is still unclear. PhD candidate HUANG Wei and his supervisor, Prof. CAO Kunfang, studied the effect of the chilling temperature associated with various light densities on PSII and PSI in the potted seedlings of four tropical evergreen tree species grown in an open field. Their results indicate that PSII is more sensitive to chilling temperature under the moderate light than PSI in tropical trees. This contradicts the previous findings. The most sensitive species, *Erythrophleum guineense*, failed to recover from the severe photoinhibition of PSII induced by the chilling-and- light stress. It also failed in the recovery of the quantity of efficient PSI complex. This would be fatal because the treated leaves died. Their results have important implications for the understanding of the chilling sensitivity of chilling-sensitive species under natural conditions. This work has been published in *Photosynthesis Research*.

The regeneration characteristics and potential of degraded forest edge vegetation in subtropical montane evergreen broad-leaved forest

As a result of long-term human activity, subtropical montane evergreen broad-leaved forest in many areas worldwide has been degraded and fragmented. The degradation is especially severe at the edges. Few studies have been carried out to investigate the regeneration of primary forest species, especially of dominant species, along an interior-edge-exterior gradient.

Aiming at quantifying the spatial distribution of primary forest species along the forest-field gradients, Prof. LIU Wenyao and his team conducted field observations on forest regeneration pattern of forest edge in subtropical montane evergreen broad-leaved forest in Ailao Mountain, SW China. Their results revealed that there was a higher abundance and richness of primary species, late secondary species and thorny lianas at the distances 0–50 m than at the distances more than 50 m from the edge into the forest exterior. At the distances >50 m, no individuals of dominant canopy trees *Lithocarpus xylocarpus*, *Castanopsis wattii*, and *L. jingdongensis* were found, whereas the abundance of early pioneer shrub species and herbaceous cover was significantly greater. The richness of primary species showed a decrease with increasing distances from the forest edge to the exterior, particularly of medium-seeded primary species showing a drastic decrease. Moreover, no large-seeded primary species occurred at the distances > 60 m. This study indicates that the forest edge as a buffer zone may be favorable for primary species regeneration. Dense shrub and herbaceous layer, and the ability for the seed to disperse may be the major limiting factors for the forest regeneration farther from the forest edge. The evidence suggests that management should give priority to the protection of buffer zones of this forest edge to facilitate forest recovery processes.

This research result has been published in *Journal Plant Research*. The *Science Times* carried the story on its front page on January 6, 2011.

TOP Five-year sandalwood tree has reached nearly 5 m high.

ABOVE Agroforestry plantation of sandalwood with other economic plants like teak and mango.

Introduction and plantation of sandalwood on tropical degraded uplands a success

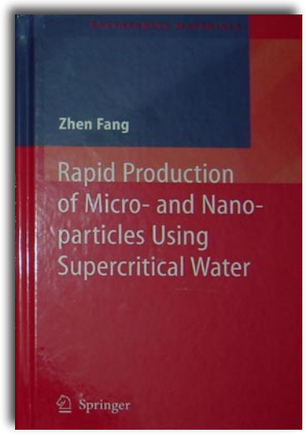
Prof. LIU Wenyao and his research team of XTBG have paid considerable attention to the research into the biology and ecology of Indian sandalwood (*Santalum album*). They introduced seeds of *Santalum album* from Australia and conducted studies of flowering, fruiting, germination and early seedling growth of *Santalum album*. Afterwards, they carried out experiment on agroforestry plantation of *Santalum album* with other economic plants like mango and teak. With a number of trees flowering and producing fruits, the experiment has been proved to be successful.

In response to vegetation restoration of degraded ecosystems, Prof. LIU Wenyao and his team cooperated with an enterprise of Pu'er city, Yunnan to conduct experiement of introduction and plantation of sandalwood on tropical degraded uplands. They found that Indian sandalwood has considerable potential to be used as an agroforestry tree species in degraded mountanious ecosystems. Commercialization of planting of sandalwood and nut yields would be possible.

Litterfall production, decomposition and nutrient use efficiency varies with tropical forest types in Xishuangbanna, SW China: a 10-year study

Litterfall production, decomposition and nutrient use efficiency in three different tropical forest ecosystems in SW China were studied by Assoc. Prof. TANG Jianwei for 10 years. The results showed that annual mean litterfall production in tropical seasonal forest (TSF) (9.47 ± 1.65Mg•ha^{-1}) was similar to that in man-made tropical forest (MTF) (9.23 ± 1.29 Mg•ha^{-1}) ($P > 0.05$) but both were significantly lower than that in secondary tropical forest (STF) (12.96 ± 1.71 Mg•ha^{-1}) ($P < 0.05$). The annual variation of litterfall was greater in TSF (17.4%, $P < 0.05$) than that in MTF (14.0%) and STF (13.2%). The annual mean decomposition rate of litterfall increased followed the order of MTF (2.72) < TSF (3.15) < STF (3.50) ($P < 0.05$), which was not correlated with the annual precipitation and annual mean temperature, but related to litter quality. The nutrient use efficiency was found to be element-dependent and to vary significantly among the three forest types ($P < 0.05$). These results indicate that litterfall production and decomposition rates in different tropical forest systems are related to plant species composition and are strongly influenced by the coexisting species and their life stage (age) but less so by the species richness. Constructing multi-species and multistory man-made tropical forest is an effective way to enhance biological productivity and maintain soil nutrients on degraded tropical land. These results have been published in *Plant and Soil*.

Multi-species and multistory man-made tropical forest.



TOP The two-step process coupled with ultrasonic radiation for biodiesel production from crude oil with high FFA value.

ABOVE Cover page of the new book.

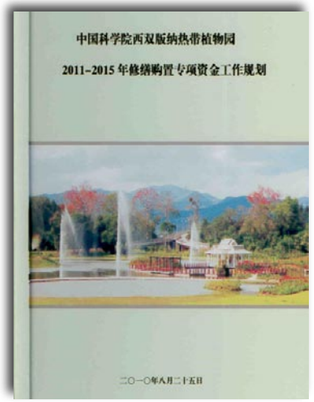
Two-step process to produce *Jatropha* biodiesel

Owing to high free acid content, transesterification of *Jatropha* oil to biodiesel directly catalyzed by solid catalyst had a low conversion rate. Even using longer reaction times, only 80.4% biodiesel yield was achieved. In order to increase biodiesel yield, free acids of *Jatrapha* oil need to remove. A two-step process of *Jatropha* oil to biodiesel was used to solve the problem. It was found that at 210 W ultrasonic power, when methanol reacted with the oil (4/1 molar ratio) mixed with 1.0 % catalyst (w/w of oil) at 318 K for 1.5 h, biodiesel yield of 95.2% was obtained(which was higher than previous reported). The biodiesel properties were close to those of the German standard (DIN V 51606). The relevant papers were published in *Energy conversion and management*, *Energy*, *Transactions of the Chinese society of agricultural engineering* (in Chinese), *Petrochemical technology* (in Chinese) and Materials review (in Chinese) and applied two Chinese patents.

New Book published in Springer

Prof. FANG Zhen authored a new book entitled “Rapid production of micro- and nano-particles using supercritical water,” (Springer-Verlag, Berlin, ISBN: 978-3-642-12986-5, hardcover, 130 pages). Published in August 2010, this is the first book in its genre discussing the use of supercritical water in the rapid production of nanoparticles for biorefinery.

This book describes the use of supercritical water (SCW) to rapidly produce micro- and nano-particles of metal oxides, inorganic salts, metals and organics. It covers basic principles, experimental methodologies and reactors, particle production, characterizations and applications as well as the recent advancement in this field.



TOP On-site evaluation meeting at XTBG.

ABOVE XTBG's Action Plan for the Special Infrastructure Fund (2011-2015).

Improvement of Research Facility

XTBG Public Technical Service Center put into operation

In 2010, XTBG set up the XTBG Public Technical Service Center which is consisted of Central Laboratory (Xishuangbanna), Biogeochemistry Laboratory (Kunming), and the libraries. XTBG managed to build up the XTBG Public Technical Service Center as a public platform of large scientific instruments for research in tropical forest ecology, sustainable use and development of tropical plant resources, and biodiversity conservation. Meanwhile, while the center has been approved by CAS, CAS will provide basic budget for running the center.

Since 2010, the XTBG Public Technical Service Center has been awarded a grant of ￥300,000 each year by CAS for further development. This has allowed XTBG to improve the infrastructure of the supporting system and maintain the performance, quality, and service of the research facilities.

XTBG Public Technical Service Center receives 8.08 million Yuan of Special Infrastructure Fund

In 2010, Chinese government earmarked special funds in the period of 2011-2015 for improving CAS facilities. The XTBG Public Technical Service Center receives 8.08 million Yuan for repairing and purchasing large-sized equipment.

XTBG Central Laboratory

After more than 2 years of construction and preparation, the facilities in XTBG Central Laboratory were finally put into use at the end of 2010.

With an area of about 5,325 m^2 in laboratory space, this fully functional lab will meet the needs of researchers from XTBG, CAS as well as visiting researchers.

TOP Tissue culture laboratory.

ABOVE The water purification system in XTBG Central Laboratory.

Conferences and Symposia

Advanced Fieldcourse in Ecology and Conservation – XTBG 2010

AFEC-X 2010 opening ceremony at XTBG.

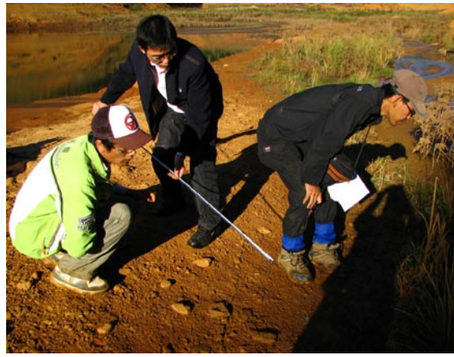
Building on the success of Advanced Fieldcourse in Ecology and Conservation, Xishuangbanna 2009 (AFEC-X 2009), AFEC-X 2010 was held between November 20 and December 18, 2010, under the newly established Program for Field Studies in Tropical Asia (PFS-TropAsia), which is based in Xishuangbanna Tropical Botanical Garden (XTBG). AFEC-X 2010 was attended by 20 graduate students and young researchers from ten countries (Argentina, Benin, Cambodia, Cameroon, China, India, Indonesia, North Korea, Sri Lanka and Thailand). A total of 15 instructors from various countries committed their time and expertise to give lectures and lead field activities during the course. The course was coordinated by Prof. Ferry SLIK from XTBG and Dr. QIE Lan, scientific coordinator of PFS-TropAsia.

Prof. DING Wenjun, Acting Dean of the College of Life Sciences, Graduate University of Chinese Academy of Sciences, presented at the AFEC-X 2010 opening, and in his speech, praised and gave great support to the training activities of PFS-TropAsia. The aim of this program is to provide affordable, high-level training for young conservation ecologists from the tropical Asian region, who are at the start of their thesis research and professional careers. Prof. DING also took the pleasure to give the first lecture after the course opening.

XTBG Director, Prof. CHEN Jin, who has lent his strong support to the establishment of PFS-TropAsia, is also a regular resource staff of the field courses. This year, Prof. CHEN gave a lecture on his favorite topic – Seed Dispersal.

The first half of AFEC-X 2010 engaged participants with a series of lectures and hands-on activities on a broad range of topics in Ecology and Conservation Biology. The most valuable experience of the participants during the course was the independent research project, conducted in and around Bulong Nature Reserve of Xishunagbanna Dai Autonomous Prefecture, Yunnan. The field course has a strong emphasis on the development of independent research skills among young researchers. Participants worked in groups to carry out research projects, starting from research proposal, field data collection, to data analysis and report writing. These projects covered various topics, including soil respiration, plant traits, invasive plants and insect and bird diversity. AFEC-X 2010 was closed with a course symposium, where participants presented their independent research projects. The Best Research Project Award went to “The distribution patterns of birds in tropical riparian forest of Mengsong”. Works of the AFEC-X 2010 participants are compiled into the AFEC-X Proceedings 2010.

Four weeks’ of intensive training not only equipped participants with stronger research skills, but also provided them with a taste of the intriguing cultures of the Dai and Hani ethnic groups in Yunnan. Such courses also place XTBG as an international leader in the important mission of creating and promoting an Asian network of young, well-trained international scientists.



TOP Participants conducting invasive plant sampling for their independent research project.

ABOVE Tea & Forest - the mountains around Bulong Nature Reserve.

Sino-German Research Co-operation “Living Landscapes China” LILAC Symposium

Participants of the Sino-German Symposium.

Organized by Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences and University of Horhenheim, Germany, the Sino-German Research Co-operation “Living Landscapes China” LILAC Symposium took place at XTBG from October 11-14, 2010.

With the theme “Land use in the Greater Mekong Subregion – A Challenge for Society, Economy and Biodiversity”, the symposium includes 5 keynote presentations and 27 oral presentations covering many diverse fields, including biodiversity and land use, socio-economy, land-use change modeling. Over 80 participants from 8 countries attended this symposium.

Prof. LI Yongmei, from Yunnan Agricultural University, presided over the opening ceremony. Prof. LI Qingjun, deputy director of XTBG, delivered a welcome speech. Prof. Joachim SAUERBORN, from University of Hohenheim, introduced the background of the LILAC project. Mr. LI Gang, Assistant Governor of Xishuangbanna Dai Autonomous Prefecture, expressed his warm congratulations to the symposium.

On October 14, participants took part in post-conference excursion to the Naban River Watershed National Nature Reserve.

The 3-year Sino-German research cooperation project “LILAC” is financially supported by the Ministry of Science and Technology, China and the Federal Ministry of Education and Research, Germany.

The sustainability of development and land-use change processes requires the understanding of the underlying driving forces as well as the consequences of specific decisions. It has been, therefore, the objective of this research co-operation to analyze social, economic, and ecological framework conditions in Naban River Watershed National Nature Reserve and the possible consequences of land-use change. Based on this analysis the researchers developed a GIS-based scenario tool for modeling development trajectories on regional scale. Such a modeling tool supports the assessment of land-use change with regard to their social, economic, hydrological and ecological implications. The overall framework can be used in decision making processes affecting land-use patterns.

IUFRO 2010

Prof. Chuck CANNON presented his work on the comparative genomics of tropical trees using next-gen sequencing technology at the joint conference of the International Union of Forest Research Organizations Working Parties 2.04.01 (Population, Ecological and Conservation Genetics) and 2.04.10 (Genomics), with the theme of “Sustainable Utilization and Conservation of Forests in the Genomics Era”.

He presented the plenary talk for the Phylogeny and Phylogeography Session on March 8, 2010 in Kuala Lumpur, Malaysia.

The 2nd Symposium on Tropical Forest Ecology

The 2nd Symposium on Tropical Forest Ecology, organized by the CAS Key Laboratory of Tropical Forest Ecology of XTBG, was held during September 13-18 in Nanning, capital city of Guangxi Zhuang Autonomous Region. The symposium brought together more than 200 scientific participants engaged in tropical forest ecology studies. Prof. CHEN Jin and Prof. CAO Min of XTBG, and Prof. OU Xiaokun of Yunnan University were invited as keynote speakers.

The theme of the symposium was "Species patterns and ecosystem processes of tropical forests". Twenty-six lectures, ranging from landscape ecology to molecular ecology were delivered. The participants discussed the status quo and conflict between social development and ecological environmental protection in tropical areas of China.

XTBG leaders also discussed with representatives of Guangxi University and Hainan University on the cooperation in academic exchanges and talents training.

After the Symposium, the participants toured to the Nonggang National Nature Reserve, Damingshan National Nature Reserve, and Weizhou Island of Guangxi.

The colloquium among participants of the 2nd Symposium on Tropical Forest Ecology.

The 3rd Mekong Sub-regional Seminar on Traditional Medicine

The Third Mekong Sub-regional Seminar on Traditional Medicine took place from March 12-17 in Jinghong, the capital city of Xushuangbanna Dai Autonomous Prefecture. The seminar brought together over 100 folk medicine experts and scholars from Thailand, Laos, Myanmar, Cambodia, and China. Prof. XU Zaifu, Emeritus Professor and former director of XTBG, delivered a keynote speech on invitation with the title "Discussion on Dai traditional medicine and rainforest eco-culture in Xishuangbanna".

The participants conducted in-depth exchange on their experience and practices of traditional medicine in their respective countries. The seminar serves as a platform to promote information sharing and networking for traditional medicine practitioners and researchers.

The 5th National Symposium on Ethnobotany

The joint 5th National Symposium on Ethnobotany and 4th Asia-Pacific Forum on Ethnobotany, initiated by the Ethnobotanical Society of China and organized by Minzu University of China, was held in Beijing during September 10-13. Four students from the Lab of Ethnobotany of XTBG participated in the symposium.

Talking about development of ethnobotany and application of traditional knowledge, Ms. SHI Yinxian, a MSc candidate from XTBG Lab of Ethnobotany, delivering a lecture entitled "Study on the antioxidant activity of young edible leaves in seven fig trees in Xishuangbanna".

The 4th Global Botanic Gardens Congress

The 4th Global Botanic Gardens Congress was held in Dublin, Ireland, during June 13-18, which brought together over 300 delegates around the world. Prof. LI Qingjun, deputy director of XTBG, attended the meeting.

The theme of the meeting was "Addressing global change – a new agenda for botanic gardens". The meeting reviewed progress in conservation policies and practice. New initiatives for conservation of cycads, European bryophytes and imperiled oceanic islands were all developed during the conference.

During the discussion of theme 4: "Frontiers of science and conservation biology research in botanic gardens", Prof. LI Qingjun delivered a lecture entitles title "Can tropical botanic gardens play a role in regional biodiversity conservation and ecological restoration?" Prof. LI talked about the efforts and achievements by XTBG in biodiversity conservation corridors in Xishuangbanna, restoration of degraded ecological environment in Karst mountain areas, and in situ conservation and reintroduction of orchids. He stressed the important role of botanic gardens in regional biodiversity conservation.

Student Conference on Conservation Science, Cambridge, UK

Two students from the Ecological Evolution Group, XTBG, were invited to present their work at the Student Conference on Conservation Science (SCCS) held in Cambridge, UK during March 23-25, 2010, the biggest student- oriented conservation conference in the world. The international meeting brought together 220 students from 63 countries and included 4 plenary talks, 33 students' talks, 2 poster sessions, 6 workshops and many social events.

YI Zhuangfang, the first PhD student from the Dai minority, presented a talk in the session for economics and ecosystem services. YI's talk about whether eco-compensation in Xishuangbanna is a reasonable option to convert rubber plantations back into nature forest.

FAN Huan, a MSc student, presented a poster on using digital technology for rapid biodiversity assessment. These two students also stayed in the UK for a few more weeks on invited internship with Cambridge University (Ms. YI) and Botanical Gardens Conservation International (Ms. FAN), also supported by SCCS. They carried out projects with their hosts and brought back knowledge and new ideas for their own study. It is a really beneficial experience for graduate students to be involved in such invaluable program.

TOP YI Zhuangfang giving the presentation in the Economics and Ecosystem Services section.

ABOVE Group photo of SCCS-2010 in front of the Zoology Department building, University of Cambridge.


Photo by JIANG Hong

Training Workshop on data collection publishing and information sharing systems for field stations of CNERN and CERN

The “Training Workshop on data collection publishing and information sharing systems for field stations of CNERN and CERN” was held during May 25-27 at XTBG headquarters in Menglun. The workshop brought together 120 participants from 53 field stations, CERN, CAS, MOST and Agriculture Publishing House nationwide.

The workshop was sponsored by the National Ecosystem Research Network of China (CNERN) and Chinese Ecosystem Research Network (CERN), and organized by Xishuangbanna Tropical Rainforest Ecosystem Station of XTBG.

The goals of the workshop were publishing the long-term monitoring data collection of the filed stations, constructing a platform for science data sharing, and managing databases.

International Seminar on Conservation of Tropical Rainforest in Xishuangbanna and Development of Xishuangbanna Tropical Rainforest National Park

In order to exchange ideas on the topics of tropical rainforest conservation, national park management and sustainable development, International Seminar on Conservation of Tropical Rainforest in Xishuangbanna and Development of Xishuangbanna Tropical Rainforest National Park, was held in Xishuangbann on Octorber 18. The seminar brought together 80 participants from the People’s Government of Xishuangbanna Dai Autonomous Prefecture, Forestry Department of Yunnan Province, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Xishuangbanna National Nature Reserve, Southwest Forestry University, Yunnan Institute of Forest Inventory and Planning, Nam Ha Protected Area, Laos, The Nature Conservancy, Conservation International, and Tropical Rainforest Conservation Foundation of Xishuangbanna Dai Autonomous Prefecture.

The seminar was co-organized by XTBG and Xishuangbanna National Nature Reserve.

Prof. GAO Jiangyun and Assoc. Prof. Rhett D. HARRISON gave plenary presentations, which was entitled “Conservation of Orchid plants in national parks: challenges and opportunities” and “Threats to biodiversity in tropical nature reserve” respectively.

Prof. GAO Jiangyun delivering a lecture.

Horticulture

Photo by YE Chenxi

Landscape reconstruction in three living plant collections

In 2010, the XTBG horticultural team reconstructed parts of the landscape in the Tropical Flower Garden, Exotic Plants Garden and Shaded Plants Garden. Some plants were replanted within these three collections. As indicated by the increase numbers of visitors to these gardens, the improvements has greatly enhanced the experience of the visitors. More artists were also attracted to paint in these pleasant collections.

The Exotic Plants Garden after landscape reconstruction.

Phenological observation

Phenological information on the growth and flowering of 1,902 species were monitored and documented weekly. Annual growth of 911 plants were observed and documented.

Staff undertaking phenological observation.

XTBG researchers conducting field trip.

Plant collecting

This year 1,293 species of tropical plants were collected, of which 1,074 species were from China, 219 species from abroad, and 262 species are new to XTBG. The collections will be displayed in the Garden, and added to the collection of the Herbarium and the Seed Bank.

Seed collect in the Tropical Plant Germplasm Bank

In 2010, XTBG's Tropical Plant Germplasm Bank organized and successfully completed6seeds collecting fieldtrips in Xishuangbanna prefecture. A total of 140 collections consisting of 130 species were made. The collecting sites were Bubeng, Yiwu in Mengla county, Nannuo mountain, Xiding in Menghai county, Jinuo mountain, Guanpin, Puwen, Dadugang in Jinghong city. Material collected was predominantly in the form of seed, and herbarium specimen vouchers were prepared when possible. Over 600 seed voucher herbarium specimens were made and more than 4,000 photos were taken. Most of the collected seeds had been identified. During the whole 2010, 286 new seed collection of 157 species were added to the Tropical Plant Germplasm Bank of XTBG.

New plant collections

As parts of "National Strategic Plant Resources Conservation and Sustainable Utilization Plan", a Key Project of Knowledge Innovation Engineering of CAS (KSCX2-YW-Z-0705), two new plant collections, the Tropical Energy Plants Collection, and the Edible Wild Plants Collection, have been under construction since 2008.

The new Tropical Energy Plants Collection receives financial support from the Chinese Academy of Sciences through two Key Projects of Knowledge Innovation Engineering of CAS (KSCX2-YW-Z-0955 and KSCX2-YW-Z-0705). Until the end of 2010, XTBG horticultural team cleared 53,336 m^2 of land, created 14 man-made mounds for planting, completed the construction of 200 m asphalt driveway, and finished the 1,000 m^2 square in this new garden. The garden is planted with over 5,500 plant individuals of 350+ species in 50 families.

When the new Edible Wild Plants Collection opens to the public next year, it will add a unique living plant collection to XTBG, offering visitors the opportunity to view and taste a diverse collection of wild edible plants in a Dai style pavilion.

TOP Part of the finished Tropical Energy Plants Collection.

ABOVE Part of the new Edible Wild Plants Collection.

The preparatory work for the expansion of the Medicinal Plants Collection is underway. Several XTBG horticultural staff undertook study tours at various institutions in South China, to investigate and introduce plants. XTBG horticultural team also cleaned the site and shortlisted ethnic medicinal plants for replanting.

Staff undertake work cleaning the site.

Data management and digital garden system

A website for “Plant Introduction and Conservation Database” (www.plantip.csdb.cn) had been launched and 8 sub-databases had been published in 2010. XTBG staff had tested the outdoor-information collect system. Positions of plants and location points of roads and buildings in XTBG have been mapped continuously.

A website for Plant Introduction and Conservation Database.

Useful techniques developed for garden management

XTBG staff have independently designed and developed wagons for transporting potted plants.

In XTBG, gardening litter and green organic matters were processed into mulch that can be reused on garden beds to improve growing conditions. Mulching helps to reduce fertilizer consumption and to control weeds.

By artificial pollination and vegetative mass conservation, XTBG staff developed the long term storage technique of *Victoria amazonica*, a world famous ornamental tropical hydrophyte. Seeds of *Victoria amazonica* were harvested in 2010.

TOP XTBG staff use local materials to create charcoal for cultivating orchids.

ABOVE Garden waste is turned into mulch to be reused on garden beds.

Flower show in the Tropical Brilliant Flower Garden.

Flower show to greet the 61st anniversary of China

The 61st anniversary of China was celebrated with a magnificient flower show in October. 30,000 pots of flowers were set out for the flower show during the “Golden Week” from October 1-7in the Tropical Brilliant Flower Garden. The 30,000 pots of flowers had been designed and arranged into an image of “gold peacock”, with blooming yellow flowers playing a major role. The “gold peacock” will be ornamented with other colorful flowers as well.

Public Education

Photo by Duan Qiwu

Facts:
Total annual visits to the Garden: 485,548
Total annual visits to the museums: 215,732
Special educational programs: 30
Total annual hits to the Garden websites: 2,918,229

TOP Education program for tourists in Spring Festival.

ABOVE Tour guide for the public.

Tourists Enjoy XTBG Tours and Education Programs

Every year, more than half a million people visit XTBG and experience a variety of educational programs which are prepared by the public education and tourism department. They are impressed by the amazing plants, flowers and landscapes as well as the interactive environmental education activities. The professional tour guides at XTBG show them around in the garden and tell the stories of trees, flowers, and cultures. In the Tropical Rainforest Ethnic Culture Museum, visitors can see many animals, butterflies, birds and experience the biodiversity of Xishuangbanna and the local people's lives and cultures. In National Day Golden Week, Spring Festival Golden Week, National Science Communication Day, CAS Open Day, and other holidays, specific programs can be designed. Volunteers, including graduate students and their tutors, some of them are well-known scientists, take tours for the public. Visitors can also create art works with dry leaves and flowers themselves, feel the weight of different woods, or solve puzzles of plants and insects. They also can learn more about low carbon lifestyle, insects in the garden or community-based conservation through exhibitions and activities.

Rainforest Story published four issues in 2010

In 2010, the e-magazine *Rainforest Story* successfully published four issues after its first debut in September 2009. Every issue has a specific theme, including minorities and plants, elephant-king of Asian tropical rainforest (2 issues) and stories of fig and fig wasps. Forty-four articles with more than 93,000 words have been published in the magazine. The well-known artist, Mr. GUO Yizong inscribed the title for the magazine. The editor also interviewed some experts, including Ms. Jocelyn BEHM about amphibians at XTBG and Prof. Richard CORLETT about rainforest conservation. The e-magazine received high praise from readers nationwide for its interesting content and wonderful nature photography. The number of reader is increasing.

Cover of *Rainforest Story.*

LEFT New Garden Map.

RIGHT New Interpretive Signboard.

New Interpretation System Established

XTBG designed and installed a new interpretation system in 2010 including interpretive signboards, maps, information signs, and interpretive guide. Twenty interpretive signboards in three languages, (Chinese, English, and Dai) were installed in seventeen specific collections. A new detailed garden map with important landmarks were redesigned and installed in fourteen sites for the visitors. Five highway signs were also installed outside the garden for self-driving tourists. The new interpretation system received high recommendation from the tourists. With the help of these new sings and maps, visitors will be able to explore the garden without worry about being lost.

Students Explored the Secrets of Rainforest in Adventure in Wonderland Program

In 2010, under the guidance and instruction from XTBG's Educational Department staff, hundreds of students visited the garden to explore the rainforest. The Educational Department developed a special program named "Adventure in Wonderland" for students from Xishuangbanna and other cities, such as Beijing, Shanghai, and Macau. During the program, students learned about basic ecology or biodiversity about tropical forests. They identified plants, flowers, birds, butterflies, insects, as well as gazed at the stars in the clear sky at XTBG. They learned about the relationship of all creatures as ecosystem. Hiking and camping in the forest made everyone excited. Scientists, including foreign experts in the garden also gave students lectures about their ongoing research. The students also experienced local ethnic culture, such as those of the Dai and Hani tribes by visiting local villages.

Foreign expert is instructing students.

Students are learning the structure of fig fruit.

Photo by ZHU Ying

TOP Crimson Sunbird in the garden.

ABOVE Nigel MARVEN in the garden.

Birds in the Garden Attracting Bird Watchers from all over the Country

As the biggest botanical garden in China, XTBG not only has the most plants in the garden, but also attracted many wild birds to live in the garden. In September, Nigel MARVEN, the well-known wildlife film maker, was in the garden taking film of sunbirds. From October, birders from all over the country visited the garden for bird watching and photography. Some rare bird species, such as Brown-throated Sunbird, Barn Owl, and Pompadour Green Pigeon were found in the garden. Some of bird watchers were so generous that they gave their pictures to XTBG for education purpose. After returning, these bird watchers and photographers posted their pictures in the websites and recommended the garden to others. XTBG is becoming a birding hotspot in China.

In order to involve local communists into bird conservation and education, XTBG's staff from Education Department presented a lecture about local birds to the Menglun Junior School and organized a bird drawing competition in December. Many students showed their interests in birds. Educating younger generations will play an important role in future conservation. XTBG also will hold the first bird fair in the garden in February, 2011.

Low Carbon Education

Low Carbon is becoming a new lifestyle. An increasing number of people realize the importance of saving energy and resources. XTBG organized a series of programs to improve the public's awareness in 2010.

In September, to celebrate the National Science Popularization Day, XTBG held activities like "increasing low-carbon awareness among local primary school students", "collecting cartoon images of low-carbon life", "thematic exhibition" and "show cartoon videos of low-carbon life" as well. During the National Day Golden Week Holiday, working with some NGOs in Kunming, they had a special exhibit focusing on reusing second-hand materials, such as wrist bracelets, bags, purse, tissues box made from old clothing. Some students from a local primary school also advocated low carbon knowledge as Low Carbon Ambassadors in the garden.

During October 17-18, Dr. Rebecca NADIN, Director of Climate Change &Science Programme, Cultural and Education Section of the British Consulate-General, China, visited XTBG to discuss cooperation on environmental education in the future. They have a progamme focusing on climate change named as Climate Cool, which includes awareness improving, capacity building, media journalists training, social science researching, and a global climate change programs online community. As a part of Climate Cool, they have a specific programme for students known as Young Climate Change Ambassadors. They choose more than 200 outstanding students from all over the country to attend a two-week summer camp receiving training on climate change and biodiversity conservation. Dr. NADIN was so impressed by XTBG's environmental education programmes that she looked forward to potential cooperation with XTBG in the future.

TOP Low carbon Exhibit.

ABOVE Low Carbon Ambassador from the local school.

Partnership

Photo by YE Chenxi

Domestic

Prof. CHEN Jin was honored as one of the Top 10 Excellent Science & Technology Workers in China

In December 6, 2010, Prof. CHEN Jin has been voted as “Top 10 Excellent Science & Technology Workers in China” by public and experts.

CHEN Jin is serving as the director-general of XTBG, team leader of Ecology and Evolution of Plant Animal Interaction Group, and PhD supervisor. He attaches great importance to research and practice on environmental education. He launched the first environmental education major in Yunnan Province in a creative way and supervised master degree students. Under his leadership, XTBG has set up a platform for environmental education and tourist interpretation system, carried out environmental education activities and exhibitions, established special website for environmental education and released e-magazine. The unique XTBG environmental education system has been evolving and favorably impressing on counterparts at home and abroad.

As a scientist and manager, CHEN Jin has been making his comments actively on local economic and social development and raising the local government’s awareness of tropical forest conservation. It was reported that Prof. CHEN Jin is the youngest winner of 2010 “Top 10 Excellent Science & Technology Workers in China” and the only winner within the three southwest China provinces.

National Popular Science Education Base granted to XTBG

XTBG has been awarded the National Popular Science Education Base from 2010-2014 by China Association for Science and Technology (CAST).

By utilizing the high-quality research and tourism resources, XTBG forms a science popularization system characterized by science experience, sightseeing and leisure.

XTBG is among the first batch of national popular science education base granted by the CAST. After a new round of comprehensive evaluation, XTBG attains the honor again.

XTBG honored “Advanced Collective” for poverty alleviation a third time

XTBG has been granted the title of “Advanced Collective” for work in poverty alleviation by Yunnan Provincial Government in 2010. It is the third consecutive year for XTBG to get the honorary title.

XTBG has been attaching importance to help the local government to reduce poverty for many years. By taking its own advantages into play, XTBG has contributed a lot to improve the living of local people, such as science & technology aid, labor training, technology application, and tourism industry, *etc*.

XTBG conferred National Field Practice Base for College Students

Prof. SUN Jiaguang, academician of Chinese Academy of Engineering (CAE) and vice president of National Natural Science Foundation of China (NSFC), paid an inspection tour to XTBG on the New Year Day.

The purpose of the tour was to confer on four institutions in Xishuangbanna with National Field Practice Base for College Students. XTBG was recognized.

Xishuangbanna is located at the southernmost prefecture of Yunnan Province. It is a hot area for biodiversity research with its abundant species of plants and animals in the rainforest.

Just as what Dr. MENG Xianping, director general of NSFC Bureau of Planning, said that it is strategic to have college students have field practice in Xishuangbanna. NSFC will have closer cooperation with XTBG and other institutions based in Xishuangbanna.


Photo by JIANG Hong

Mr. ZHOU Fengyue (left front) and Prof. CHEN Jin (right front) shaking hands to celebrate the signing of the MOU and their cooperation.

Chenggong, Yunnan

XTBG and Chenggong New Development Area of Kunming have signed a cooperation agreement on the establishment of nursery stock in early August. To promote the implementation of the agreement, Prof. CHEN Jin, director of XTBG, led a delegation to seek suitable partnership enterprises for the quality nursery stock on August 18.

XTBG delegation had a field visit to the seedling breeding nurseries of the Chennong Group. Afterwards, the two parties showed intention for cooperating in setting up large quality nursery stock, distributing plants, trees, shrubs, flowers, etc. to a world hungry for greenery. They may also further cooperate in the production, processing, and sale of wild vegetables.

As an integrated research institution, XTBG is willing to contribute to the establishment of a low-carbon, environment-friendly new Chenggong.

Around 1,000 trees representing friendship and cooperation between XTBG and Chenggong were planted on the same day.

Simao, Yunnan

In recognition of the achievements by the "Personnel Training Base for Tropical Horticulture", XTBG and Simao Normal College were jointly awarded the second prize of Teaching Achievement by Yunnan Provincial Government.

The award was granted to Ms. DU Wei, president of Simao Normal College, and Mr. LI Hongwei, deputy director of XTBG, and several teachers.

XTBG and Simao Normal College have been keeping good cooperation relationship for many years. In 2001, a "Personnel Training Base for Tropical Horticulture" was established by the two partners. Each year, about 60 college students are trained in XTBG.

Hong Kong

XTBG sent two young staff members engaged in popular science education to Kadoorie Farm & Botanic Garden (KFBG) for communication in early 2010 on invitation.

During their stay in Hongkong, the 2 young ladies, ZHAO Jinli and JIANG Hong, were invited to talk about such issues as cultures in Xishuangbanna, tropical rainforest conservation, ethno-forest culture, e-magazine *Rainforest Stories*, and popular science activities at XTBG, etc. They exchanged ideas on science popularization with related personnel at KFBG.

They also took active participation in the activities like "Nature's Pulse" Installation Art Exhibition. They assisted KFBG Artists-in-Residence in completing artworks created in a natural environment.

Xishuangbanna, Yunnan

Officials in Xishuangbanna have been promoting farming of the hemp, with hemp variety Yunma No.1 as the major seed, since 2004, to help raise the living standard of farmers. XTBG has palyed an important role in the screening and rapid propagation of new hemp varieties. Up to now, a series of hemp varieties tested to be without a narcotic component for industrial use has been screened by XTBG researchers. Over the past five years, XTBG set up a hemp research base in Mengsong Township, Menghai County in Xishuangbanna, a mountainous region in Yunnan. The screening and high-yield cultivation practice has got success and helped resolve the bottleneck problem of single variety of Yunma No.1.

Mr. JIANG Pusheng, the CPC secretary of Xishuangbanna, spoke highly of XTBG's contribution to the sustainable development of hemp industry. XTBG-locality cooperation witnessed great progress.

"The hemp contains less than 0.1 percent of tetrahydrocannabinol, or THC, the key ingredient in marijuana, while the Cannabis grown for marijuana can contain up to five percent of THC or even more", said researchers.

Photo by YE Chenxi

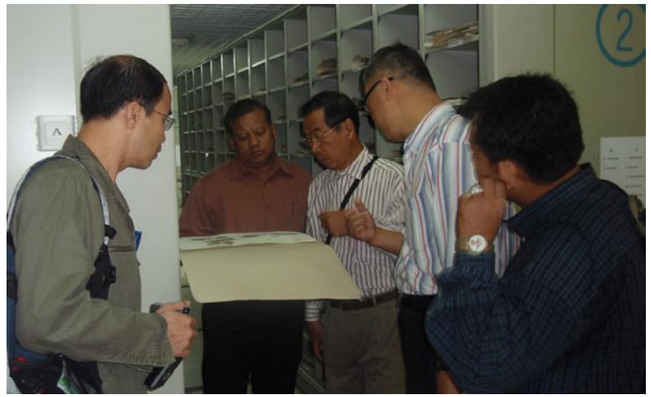
Local villages, Yunnan

Headed up by Mr. YAN Zong, first deputy county chief of Menghai county, Xishuangbanna prefecture, a 30-person delegation including indigenous Dai villagers and local officials from Manhong village, Menghai county paid a field trip to XTBG on November 16, 2010. The purpose of the trip is learning about planting techniques for tropical economic trees and fruit trees.

Photo by LIU Meng

The delegation visited the agroforestry systems which consisted of *Citrus maxima* intercropping *Plukenetia volubilis*, and *Jatropha curcas* intercropping *Curcuma longa* L., high-yield cultivation models of *Artocarpus heterophylla* L., and *Amorphophalms* konjac in wild edible plants plantation. XTBG technologists provided the delegation with technical skills and knowledge in planting and management, economic value, ethnic traditional knowledge, recent developments and market prospects of the tropical economic trees and fruit trees. XTBG technologists emphasized that agroforestry systems can be developed that farmers could have high yield harvest without any forest destroying. These will help for tropical forest conservation and sustainable development.

After finishing their visit to XTBG, YAN Zong and villagers expressed appreciation for XTBG. They hope for further cooperation with XTBG in modern agricultural industry.



LEFT Accompanied by Prof. CAO Min, Cambodian delegation visiting XTBG Herbarium.

RIGHT The bilateral colloquium between XTBG and Cambodian delegation.

Abroad

Cambodia

A 6-person delegation of Cambodian officials of environment and finance paid a visit to XTBG during March 21-24. The delegation was headed up by Dr. YIN Kim Sean, Cambodian Vice Minister of Environment.

Senior translator QIU Huasheng, deputy director general of CAS Bureau of International Cooperation, took a special tour to XTBG to give warm reception to the delegation.

Prof. Dr. CAO Min, deputy director of XTBG, accompanied the delegation to visit the ex situ conservation area for rare and endangered plants, new research center, green stone forest, and research facilities of the Garden.

The delegation said that they have got a better understanding on the scientific content and management of a botanical garden.

A bilateral colloquium was held on March 23, with Prof. CAO Min as chair. Giving a welcoming speech to the delegation, Prof. Dr. CHEN Jin, director of XTBG, gave a detailed introduction to scientific research, species preservation, gardening, and international cooperation. Senior translator QIU Huasheng fully recognized the efforts made by Cambodian Ministry of Environment to promote the establishment of Cambodian National Botanical Garden and hoped them to submit its proposal of being a priority assistance project to Chinese Ministry of Commerce soon.

Officials from Cambodian Ministry of Finance showed support for listing the establishment of national botanical garden as a priority assistance project and would start preparatory work soon.

According to Dr. YIN Kim Sean, Cambodian Prime Minister Hun Sen has approved of supporting the national botanical garden as a key project.

The Cambodian delegation continued to visit Beijing and Shanghai. Prof. DING Zhongli, Vice President of CAS, gave them a reception in Beijing.

Germany

Prof. Jens Gunter ROHWER from University of Hamburg, Germany, an expert in plant taxonomy and phylogeny of Lauraceae, paid a 20 day visit for the Plant Phylogenetics and Conservation Group (PPCG) in XTBG. He visited Ailaoshan Subtropical forest Ecosystem Station and Xishuangbanna forest Ecosystem Station, and checked and revised the specimens of Lauraceae in HITBC. Furthermore, he gave two seminars entitled “Landscapes and Vegetation of Central Europe” and “The Lauraceae - an overview of the current state of knowledge” in Kunming and Xishuangbanna respectively during his visiting. His visit enhanced the cooperation research in the phylogeny of the family Lauraceae.

Prof. Jens Gunter ROHWER delivering a lecture.

Talent Training and Team Building

Photo by YE Chenxi

Graduate Education

XTBG has enrolled more than 500 graduates from 1986 and more than 350 graduates got their degrees here. There are 176 graduates in the garden now, among whom 57 are doctoral students, including 3 foreign students and 119 are master students, including 2 foreign students. And there are 16 graduates co-supervised by XTBG and colleges. XTBG offers programs in two major academic fields: plants and ecology. Until now, 42 scientific researchers are qualified to supervise graduates in botany (16) and ecology (26), including 4 foreign supervisors. In 2010, 53 students, including 34 master students and 19 doctoral students, accomplished their study and graduated.

Graduation ceremomy 2010.

Dr. HAO Guangyou received "Excellent Student Prize of President Fellowships, CAS"

Dr. HAO Guangyou is co-supervised by Prof. CAO Kunfang in XTBG and the University of Miami. He published several high qualified papers in leading journals, such as *Oecologia*, *Tree Physiology* and *Functional Ecology*. With his outstanding performance, he was awarded "Excellent Student Prize of President Fellowships, CAS" in 2010. In the same year, he gained the postdoctoral scholarship in Harvard University.

Dr. ZHANG Fengping won "the Nomination of Excellent Doctoral Dissertations, CAS"

Dr. ZHANG Fengping was supervised by Prof. YANG Darong. She published several excellent papers in *Naturwissenschaften*, *Bulletin of Entomological Research*, *Evolutionary Ecology Research* and *Symbiosis* during her study in XTBG and received "the Nomination of Excellent Doctoral Dissertations, CAS" in 2010.

Scholarships from CAS

Prof. CHEN Jin won the 2010 Zhuliyuehua Scholarship for Excellent Supervisor, CAS. LI Zhiheng, LI Zongbo, ZHENG Yulong and ZHU Shidan had the honor of 2010 Zhuliyuehua Scholarship for Excellent Doctoral Students, CAS and LIU Yulan was awarded the second prize of Di Ao Scholarship, CAS.

Talent Training

Training tropical horticulture for Simao Normal College students

In cooperation with Simao Normal College, a personnel training base for tropical horticulture has been established at XTBG since 2001. A total of 37 college students began their one-year training courses at XTBG to improve their knowledge on tropical horticulture technique in the year 2010.

Training course on gardening and horticulture

The 16th annual Training Course on Gardening and Horticulture was held by the No. 68 Institute of Yunnan Provincial Professional and Technical Ability Appraisal on Horticulture at XTBG. The 31-day (August 1st -31st) curriculum consisted of lectures, field practice, demonstration, study tours, discussion and final test. A certificate was awarded to each participant upon his or her successful completion of the curriculum. 73 participants from Xishuangbanna prefecture and Simao prefecture accomplished the training. The No. 68 Institute of Yunnan Provincial Professional and Technical Ability Appraisal on Horticulture at XTBG was designated by the Department of Labor and Social Security of Yunnan Province in 1997. Since then, XTBG has hosted training course on gardening and horticulture each year, making full use of its advantages in landscape planning and designing, horticultural cultivation, seed storage, plant protection, forest science. From then on, more than 1,000 gardeners have been trained at XTBG.

Team Building

New Recruitment

All departments of administrative section were reconstructed, and several laboratories and research groups were newly set up or reconstructed this year, which included laboratory of resource plant research, Global Change Group, Floristic Biogeography Group, Aromatic Plant Research, Specimen and Plasma Conservation Center, Public Technical Service Center, Yuanjiang Ecological Station.

More than 20 interview meetings were held for recruiting new staffs for departments of administrative section, laboratories, and research groups in 2010. Thirteen head of departments were appointed for administrative sections. Three principal investigators have been recruited for scientific research groups, and five persons responsible for supporting systems. Of scientific staffs, two were promoted as associate professor from assistant professor, one as professor from associate professor. Moreover, 24 newly-graduated students were recruited from universities or research institutes, including 7 PhD, 14 MSc, and 3 undergraduate students.

Honors

Prof. CHEN Jin won the title of the 'excellent individuals for personnel work' by Chinese Academy of Sciences.

Prof. LIU Wenjie has been honored "CAS WANG Kuancheng Award for Outstanding Achievements to Western Scholars", approved by "WANG Kuancheng Education Fund".

Prof. GAO Jiangyun has been elected as backup young and middle-aged academic leaders of Yunnan Province, getting financial support of 30,000 RMB.

Two professors, Prof. LIU Aizhong and Prof. FANG Zhen, have been supported by Special grant for Selected Outstanding Young Scientist from Chinese Academy of Sciences.

On July 26, 2010, the performances of 2006 West Light Foundation were appraised. Associate Prof. SHEN Youxin was assessed as excellent in this final appraisal. Moreover, five staffs were sponsored by new projections of West Light Foundation, including one key project, two projects for newly graduated PhDs, and other two projects for PhD candidates who are the scientific staffs of XTBG.

On April 12, 2010, the performances of 13 scientific research groups have been reviewed by national and international scientific consultant panels. A total of 11 groups passed the evaluation of their performance, of which 2 groups were honored as super excellent, other 2 groups as excellent.

Postdoctoral Researchers and Visiting Scholars

Five postdoctoral researchers have been recruited, three of which are from overseas, Dr. Mohandass DHARMALINGAM from India, Dr. Joeri Sergej STRIJK from Netherlands, and Dr. Modabber Ahmed KHAN from Bangladesh.

Four senior visiting scholars, Dr. Timothy BRODRIBB from University of Tasmania, Australia, Prof. Dr. Roy TURKINGTON from University of British Columbia, Canada, Prof. Dr. Jens G. ROHWER from University Hamburg, Germany, and Prof. Dr. Stephen G. A. COMPTON from University of Leeds, England, were sponsored for doing cooperative studies with research groups of XTBG.

Visits

Photo by JIANG Hong

LI Changchun

Mr. LI Changchun, member of the Standing Committee of the Political Bureau of the CPC Central Committee, paid an inspection tour to XTBG on November 12. Mr. BAI Enpei, Secretary of Yunnan Provincial Committee of the CPC, accompanied the tour.

Prof. CHEN Jin, director of XTBG, reported the Master Plan of XTBG, general philosophy of building new living collections, and development in biodiversity conservation, scientific research, and public education which XTBG had made since its accession to the CAS Knowledge Innovation Project.

LI Changchun showed great concern about biodiversity conservation and development of botanical gardens in China. He was satisfied that XTBG pay great attention to public education. XTBG had established a Tropical Rainforest and Ethno Culture Museum in the campus and presents the knowledge of tropical rainforest and ethnic culture in Xishuangbanna to the public with a unique conception and in diversified displaying techniques.

LI Changchun planted an *Erythrophleum fordii* as a ceremonial tree in the garden.

TOP LI Changchun (middle), inspecting XTBG.

ABOVE LI Changchun watering an *Erythrophleum fordii* as a ceremonial tree in XTBG.

LU Hao (front right 2), paying an on-site inspection to XTBG.

LU Hao

Mr. LU Hao, first secretary of the Secretariat of the 16th Communist Youth League of China (CYLC) Central Committee, paid a visit to XTBG on April 21. The tour was accompanied by Mr. LI Jiheng, Vice Secretary of Yunnan CPC Committee, and other local officials.

While showing the officials around the Garden, Prof. Dr. CHEN Jin, director of XTBG, gave a brief introduction to the garden. The officials were very interested in issues concerning scientific research, campus construction, biodiversity conservation, and the work of the mass youth organization -CYLC showing appreciation to its development efforts.

DING Zhongli

Academician DING Zhongli, Vice President of Chinese Academy of Sciences, paid an inspection tour to XTBG on February 13. The tour was accompanied by Prof. CHEN Jin, director of XTBG and Prof. LI Qingjun, deputy director of XTBG.

DING Zhongli expects more development for both science and public education made by XTBG in the future.

DING Zhongli, in XTBG.

WANG Shengjun

Mr. WANG Shengjun, President of Supreme People's Court, paid a visit to XTBG on July 21. Mr. JING Hanchao, vice president of Supreme People's Court was among the visiting group.

Mr. LI Hongwei, deputy director of XTBG, showed the officials around the living collections and tropical rainforest within XTBG. The tropical rainforest and its spectacular ecological phenomena were most eye-catching to the guests.

WANG Shengjun (in dark shirt), inspecting XTBG.

LI Shenglin (front left 3), listening to a brief introduction about XTBG.

LI Shenglin

Mr. LI Shenglin, Minister of Chinese Ministry of Transport, paid a visit to XTBG on May 23. He visited the living collections and listened to a brief introduction about the Garden. Mr. LI Hongwei, deputy director of XTBG, showed the officials around the Garden.

Local officials like CPC secretary JIANG Pusheng of Xishuangbanna and others accompanied the tour.

Minister LI Shenglin's tour was on the sidelines of investigating construction of great international passage, highway management and rural road maintenance in Yunnan Province.

Other visitors

January 28 to February 24, Prof. Anthony R. IVES from University of Wisconsin
February 4, Prof. SHANG Yongfeng, academician of CAS and Professor of Peking University
February 23, Dr. Phouthong SENG AKHOM, Minister of Prime Minister's Office, Lao PDR
March 1-31, Dr. Anthony RAGNAR, University of Wisconsin-Madison, USA
March 2-3, Dr. Ronny ALEXANDERSSON and a 18-person delegation from Uppsala University, Sweden
March 2-5, Dr. JANG Yong Chol and a 15-person delegation from Ministry of Land and Environment Protection, North Korea
March 5, Dr. ZHANG Pengjun, Waganingen University, Netherlands
March 2-6, Dr. Manuel LERDAU, University of Virginia, USA
March 13-15, Prof. Charles KREBS, University of British Columbia, Canada
March 16, Dr. Yingyong TAOPRASERT, director of the School of Traditional and Alternative Medicine and an 18-person delegation from Chiangrai Rajabhat University, Thailand
March 24, Mr. LU Dongfu, vice minister of the Ministry of Railways
April 2-5, Prof. Jonathan GERSHENZON, Max Planck Institute for Chemical Ecology, Germany
April 7-12, Dr. QIAN Hong, Illinois State Museum, USA
April 9-10, Prof. Roy TURKINGTON, University of British Columbia, Canada
April 11, Mr. Ronald R. ALOEMA, president of OIS and member of the coordinating body of the Indigenous Organizations of the Amazon Basin (COICA), and a 4-person delegation of the Organization of Indigenous Peoples in Suriname (OIS)
April 16, Mr. Hero M. EDEN, SFT Shanghai Fairtrade AG, Switzerland
April 20-22, Prof. PAN Fuh-Jiunn, Chinese Culture University, Taiwan
April 20-26, Dr. TZENG Hsy-Yu, National Chung Hsing University, Taiwan
May 3, Ms. CHEN Jiwa, deputy secretary of the CPC Guangxi Zhuang Autonomous Regional Committee
May 12, Prof. Zlatko KVACEK, Charles University, Czech Republic
May 11-15, Prof. Jeffery S PETTIS, Research leader, and a 2-person delegation from Bee Research Laboratory, United States Department of Agriculture, USA
May 22, Mr. TONG Shiping, deputy director of the General Political Department of the Chinese People's Liberation Army (PLA) and a general from the navy
May 25, Dr. Jacob D. WICKHAM, Institute of Chemistry, CAS
June 21, Mr. ZHANG Quanjing, former minister of the Organization Department of the CPC Central Committee
July 6, Mr. Jesse LASKY, University of Texas at Austin, USA
July 12-14, Prof. Fong-Long FENG, National Chung Hsing University, Taiwan
July 13, Dr. Bian LIU, University of Geneva, Switzerland
July 14-19, Prof. Wah Soon CHOW, Australian National University, Australia
July 16, Prof. Spencer C.H. BARRETT, University of Toronto, Canada
July 17 –September 3, Dr. Michael MOELLER, Royal Botanic Garden, Edinburgh
July 20, Prof. Yakov KUZYAKOV, University of Bayreuth, Germany
August 1-14, Dr. Wickneswari R., Universiti Kebangsaan, Malaysia
August 10-12, Dr. Beata PASZKO, W. Szafer Institute of Botany, Poland and Prof. Lennart STENBERG, Swedish Museum of Natural History, Sweden
August 11-19, Prof. Yue-Joe HSIA, National Dong Hwa University, Taiwan, Dr. Jehn-Yih Juang, National Taiwan University, Taiwan, and a 4-person delegation
August 11- September 11, Mr. David BROEDERBAUER, University of Vienna, Austria
August 18, Mr. ZHOU Zhenhong, member of the Standing Committee of the CPC Guangdong Provincial Committee and director general of the Department of the United Front Work of the CPC Guangdong Provincial Committee
August 26 – September 3, Prof. W. Scott ARMBRUSTER, University of Portsmouth, UK and University of Alaska, USA
September 4-28, Dr. Tim J. BRODRIBB, University of Tasmania, Australia
September 13-15, Prof. Jens Gunter ROHWER, University of Hamburg, Germany
October 17, Ms. HUA Jianhui, Vice Governor of People's Government of Anhui Province
October 17-18, Dr. Rebecca NADIN, Cultural and Education Section of the British Consulate-General, China, and a 4-person delegation
October 26, Dr. YU Haiying, World Agroforestry Centre
November 14-16, Prof. David DILCHER, University of Florida, USA
December 6-8, Prof. MA Keping, Institute of Botany, CAS
December 20-31, Dr. Matjaz KUNTNER, Institute of Biology, Scientific Research Centre of the Slovenian Academy of Sciences and Arts, Slovenia
December 20-31, Dr. LI Daiqin, National University of Singapore, Singapore
December 23-29, Prof. Hong J. DI, Lincoln University, New Zealand
December 24, Dr. Blagodatskaya EVGENIA, Institute of Physico-Chemical and Biological Problems in Soil Science, Russian Academy of Sciences
December 25-29, Prof. HE Jizheng, Research Centre for Eco-environmental Sciences, CAS

Financial Review

Photo by YE Chenxi

Income and Expenditure (Million Yuan)

	Categories	FY2008	FY2009	FY2010
INCOME				
	Government Grants	40.504	37.706	30.155
	Infrastructure	0	27.800	0
	Admissions & Services	25.776	30.179	31.919
	Grants for research	26.637	31.772	31.506
	Miscellaneous	0.417	0.195	0.526
	Sum	93.334	127.652	94.106
EXPENDITURE				
	Staff costs	41.196	43.139	52.590
	Maintenance	0.673	0.807	0.220
	General and Admin. Expense	1.687	2.403	1.581
	Infrastructure	38.548	33.540	0
	Equipment	16.041	20.559	25.211
	Research & Horticulture	21.182	29.488	24.195
	Miscellaneous	0.050	0.027	0.080
	Sum	119.377	129.963	103.877

Publications

Photo by XIAO Chunfeng

1. Cannon, CH; Kua, CS; Zhang, D; Harting, JR. 2010. Assembly free comparative genomics of short-read sequence data discovers the needles in the haystack. MOLECULAR ECOLOGY 19: 147-161.
2. Chen, JW; Zhang, QA; Li, XS; Cao, KF. 2010. Gas exchange and hydraulics in seedlings of *Hevea brasiliensis* during water stress and recovery. TREE PHYSIOLOGY 30(7): 876-885.
3. Chen, JY; Lee, S; Cao, YQ; Peng, YQ; Winkler, D; Yang, DR. 2010. Ethnomycological use of medicinal Chinese Caterpillar Fungus, *Ophiocordyceps sinensis* (Berk.) G. H. Sung et al. (Ascomycetes) in Northern Yunnan Province, SW China. INTERNATIONAL JOURNAL OF MEDICINAL MUSHROOMS 12(4): 427-434.
4. Chen, L; Liu, WY; Wang, GS. 2010. Estimation of epiphytic biomass and nutrient pools in the subtropical montane cloud forest in the Ailao Mountains, south-western China. ECOLOGICAL RESEARCH 25(2): 315-325.
5. Chen, LG; Zhang, LP; Yu, DQ. 2010. Wounding-induced WRKY8 is involved in basal defense in *Arabidopsis*. MOLECULAR PLANT-MICROBE INTERACTIONS 23(5): 558-565.
6. Chen, X; Zeng, QC; Lu, XP; Yu, DQ; Li, WZ. 2010. Characterization and expression analysis of four glycine-rich RNA-binding proteins involved in osmotic response in tobacco (*Nicotiana tabacum* cv.Xanthi). AGRICULTURAL SCIENCES IN CHINA 9(11): 1577-1587.
7. Deng, X; Fang, Z; Liu, YH. 2010. Ultrasonic transesterification of *Jatropha curcas* L. oil to biodiesel by a two-step process. ENERGY CONVERSION AND MANAGEMENT 51(12): 2802-2807.
8. Deng, ZJ; Cheng, HY; Song, SQ. 2010. Effects of temperature, scarification, dry storage, stratification, phytohormone and light on dormancy-breaking and germination of *Cotinus coggygria* var. cinerea (Anacardiaceae) seeds. SEED SCIENCE AND TECHNOLOGY 38(3): 572-584.
9. DeWalt, SJ; Schnitzer, SA; Chave, J; Bongers F; Burnham RJ; Cai ZQ; Chuyong G; Clark DB; Ewango CEN; Gerwing JJ; Gortaire E; Hart T; Ibarra-Manriquez G ; Ickes K; Kenfack D; Macia MJ; Makana JR; Martinez-Ramos M; Mascaro J; Moses S; Muller-Landau HC; Parren MPE; Parthasarathy N; Perez-Salicrup DR; Putz FE; Romero-Saltos H; Thomas D. 2010. Annual rainfall and seasonality predict pan-tropical patterns of liana density and basal area. BIOTROPICA 42(3): 309-317.
10. Enright, NJ; Cao, KF. 2010. Plant ecology in China. PLANT ECOLOGY 209(2): 181-187.
11. Fan, ZX; Brauning, A; Tian, QH; Yang, B; Cao, KF. 2010. Tree ring recorded May-August temperature variations since AD 1585 in the Gaoligong Mountains, southeastern Tibetan Plateau. PALAEOGEOGRAPHY PALAEOCLIMATOLOGY PALAEOECOLOGY 296(1-2): 94-102.
12. Fang, HJ; Yu, GR; Cheng, SL; Zhu, TH; Wang, YS; Yan, JH; Wang, M; Cao, M; Zhou, M;. 2010. Effects of multiple environmental factors on CO_2 emission and CH_4 uptake from old-growth forest soils. BIOGEOSCIENCES 7(1): 395-407.
13. Fu, QT; Li, SJ; Yu, DQ. 2010. Identification of an *Arabidopsis* Nodulin-related protein in heat stress. MOLECULES AND CELLS 29(1): 77-84.
14. Fu, YN; Chen, J; Guo, H; Hu, HB; Chen, AG; Cui, JY. 2010. Agrobiodiversity loss and livelihood vulnerability as a consequence of converting from subsistence farming systems to commercial plantation-dominated systems in Xishuangbanna, Yunnan, China: a household

level analysis. LAND DEGRADATION & DEVELOPMENT 21(3): 274-284.
15. Gao, J; Zhao, GY; Yu, YS; Liu, FL. 2010. High concentration of nectar quercetin enhances worker resistance to queen's signals in bees. JOURNAL OF CHEMICAL ECOLOGY 36(11): 1241-1243.
16. Han, B; Zou, XM; Kong, JJ; Sha, LQ; Gong, HD; Yu, Z; Cao, T. 2010. Nitrogen fixation of epiphytic plants enwrapping trees in Ailao Mountain cloud forests, Yunnan, China. PROTOPLASMA 247(1-2): 103-110.
17. Han, L; Xie, LJ; Dai, KJ; Yang, Q; Cai, ZQ. 2010. Contrasting leaf characteristics of trees and lianas in secondary and mature forests in southwestern China. PHOTOSYNTHETICA 48(4): 559-566.
18. Hao, GY; Sack, L; Wang, AY; Cao, KF; Goldstein, G. 2010. Differentiation of leaf water flux and drought tolerance traits in hemiepiphytic and non-hemiepiphytic *Ficus* tree species. FUNCTIONAL ECOLOGY 24(4): 731-740.
19. Helmus, MR; Keller, W; Paterson, MJ; Yan, ND; Cannon, CH; Rusak, JA. 2010. Communities contain closely related species during ecosystem disturbance. ECOLOGY LETTERS 13(2): 162-174.
20. Huang, W; Zhang, SB; Cao, KF. 2010. Stimulation of cyclic electron flow during recovery after chilling-induced photoinhibition of PSII. PLANT AND CELL PHYSIOLOGY 51(11): 1922-1928.
21. Huang, W; Zhang, SB; Cao, KF. 2010. The different effects of chilling stress under moderate light intensity on photosystem II compared with photosystem I and subsequent recovery in tropical tree species. PHOTOSYNTHESIS RESEARCH 103(3): 175-182.
22. Ives, AR; Helmus, MR. 2010. Phylogenetic metrics of community similarity. AMERICAN NATURALIST 176(5): E128-E142.
23. Jacques, FMB; Zhou, ZK. 2010. Geometric morphometrics: a powerful tool for the study of shape evolution in *Menispermaceae endocarps*. TAXON 59(3): 881-895.
24. Kembel SW; Cowan, PD; Helmus, MR; Cornwell, WK; Morlon, H; Ackerly, DD; Blomberg, SP; Webb, CO. 2010. Picante: R tools for integrating phylogenies and ecology. BIOINFORMATICS 26(11): 1463-1464.
25. Kettle, CJ; Ghazoul, J; Ashton, PS; Cannon, CH; Chong, L; Diway, B; Faridah, E; Harrison, R; Hector, A; Hollingsworth, P; Koh, LP; Khoo, E; Kitayama, K; Kartawinata, K; Marshall, AJ; Maycock, CR; Nanami, S; Paoli, G; Potts, MD; Sheil, D; Tan, S; Tomoaki, I; Webb, C; Yamakura, T; Burslem, DFRP. 2010. Mass fruiting in Borneo: a missed opportunity. SCIENCE 330(6004): 584.
26. Kong, JJ; Xia, YM; Li, QJ. 2010. Inflorescence and flower development in the Hedychieae (Zingiberaceae): *Hedychium coccineum* Smith. PROTOPLASMA 247(1-2): 83-90.
27. Li, SJ; Zhou, X; Chen, LG; Huang, WD; Yu, DQ. 2010. Functional characterization of *Arabidopsis thaliana* WRKY39 in heat stress. MOLECULES AND CELLS 29(5): 475-483.
28. Li, XS; Liu, WY; Chen, JW; Tang, CQ; Yuan, CM. 2010. Regeneration pattern of primary forest species across forest-field gradients in the subtropical Mountains of Southwestern China. JOURNAL OF PLANT RESEARCH 123(6): 751-761.
29. Li, XS; Liu, WY; Tang CQ. 2010. The role of the soil seed and seedling bank in the regeneration of diverse plant communities in the subtropical Ailao Mountains, Southwest China. ECOLOGICAL RESEARCH 25(6): 1171-1182.
30. Li, ZH; Zhang, YP; Wang, SS; Yuan, GF; Yang, Y; Cao, M. 2010. Evapotranspiration of a tropical rain forest in Xishuangbanna, southwest China. HYDROLOGICAL PROCESSES 24(17): 2405-2416.
31. Liang, G; Yang, FX; Yu, DQ. 2010. MicroRNA395 mediates regulation of sulfate accumulation and allocation in *Arabidopsis thaliana*. PLANT JOURNAL 62(6): 1046-1057.
32. Liao, SX; Mi, XJ; Liu, AZ; Li, K; Yang, ZY; Tian, B. 2010. Isolation and characterization of polymorphic microsatellite markers in *Calocedrus macrolepis* Kurz (Cupressaceae). HORTSCIENCE 45(1): 169-171.
33. Liu, AZ; Kress, WJ; Li, DZ. 2010. Phylogenetic analyses of the banana family (Musaceae) based on nuclear ribosomal (ITS) and chloroplast (trnL-F) evidence. TAXON 59(1): 20-28.
34. Liu, WJ; Liu, WY; Li, PJ; Duan, WP; Li, HM. 2010. Dry season water uptake by two dominant canopy tree species in a tropical seasonal rainforest of Xishuangbanna, SW China. AGRICULTURAL AND FOREST METEOROLOGY 150(3): 380-388.
35. Liu, YL; Liu, FL. 2010. Post-ingestive effect of plant phenolics on the feeding behaviour of the honeybee *Apis cerana*. PHYSIOLOGICAL ENTOMOLOGY 35(2): 175-178.
36. Lu, XT; Yin, JX; Jepsen, MR; Tang, JW. 2010. Ecosystem carbon storage and partitioning in a tropical seasonal forest in Southwestern China. FOREST ECOLOGY AND MANAGEMENT 260(10): 1798-1803.
37. Lu, XT; Yin, JX; Tang, JW. 2010. Structure, tree species diversity and composition of tropical seasonal rainforests in Xishuangbanna, southwest China. JOURNAL OF TROPICAL FOREST SCIENCE 22(3): 260-270.
38. Luo, YL; Li, QJ. 2010. Effects of light and low temperature on the reciprocal style curvature of Flexistylous *Alpinia* Species (Zingiberaceae). ACTA PHYSIOLOGIAE PLANTARUM 32(6): 1229-1234.
39. Lv, XT; Tang, JW. 2010. Structure and composition of the understory treelets in a non-dipterocarp forest of tropical Asia. FOREST ECOLOGY AND MANAGEMENT 260(4): 565-572.
40. Na, Z; Hu, HB, Fan, QF. 2010. A novel caged-prenylxanthone from *Garcinia bracteata*. CHINESE CHEMICAL LETTERS 21(4):443-445.
41. Na, Z; Hu, HB; Fan, QF. 2010. Three New Caged Prenylxanthones from *Garcinia bracteata*. HELVETICA CHIMICA ACTA 93(5): 958-963.
42. Na, Z; Xu, YK. 2010. A new prenylated xanthone from *Garcinia xipshuanbannaensis* YH Li. NATURAL PRODUCT RESEARCH 24(17): 1648-1653.
43. Niu, YF; Feng, YL; Xie, JL; Luo, FC. 2010. Noxious invasive *Eupatorium adenophorum* may be a moving target: Implications of the finding of a native natural enemy, *Dorylus orientalis*. CHINESE SCIENCE BULLETIN 55(33): 3743-3745.
44. Pan, JL; Fu, QT; Xu, ZF. 2010. *Agrobacterium tumefaciens*-mediated transformation of biofuel plant *Jatropha curcas* using kanamycin selection. AFRICAN JOURNAL OF BIOTECHNOLOGY 9(39): 6477-6481.
45. Peng, YQ; Compton, SG; Yang, DR. 2010. The reproductive success of *Ficus altissima* and its pollinator in a strongly seasonal environment: Xishuangbanna, Southwestern China. PLANT ECOLOGY 209(2): 227-236.
46. Peng, YQ; Zhao, JB; Harrison, RD; Yang, DR. 2010. Ecology of parasite *Sycophilomorpha* sp. on *Ficus altissima* and its effect on the fig-fig wasp mutualism. PARASITOLOGY 137(13): 1913-1919.
47. Phillips, OL; van der Heijden, G; Lewis, SL; Lopez-Gonzalez, G; Aragao, LEOC; Lloyd, J; Malhi, Y; Monteagudo, A; Almeida, S; Davila, EA; Amaral, I; Andelman, S; Andrade, A; Arroyo, L; Aymard, G; Baker, TR; Blanc, L; Bonal, D; de

Oliveira, ACA; Chao, KJ; Cardozo, ND; da Costa, L; Feldpausch, TR; Fisher, JB; Fyllas, NM; Freitas, MA; Galbraith, D; Gloor, E; Higuchi, N; Honorio, E; Jimenez, E; Keeling, H; Killeen, TJ; Lovett, JC; Meir, P; Mendoza, C; Morel, A; Vargas, PN; Patino, S; Peh, KSH; Cruz, AP; Prieto, A; Quesada, CA; Ramirez, F; Ramirez, H; Rudas, A; Salamao, R; Schwarz, M; Silva, J; Silveira, M; Slik, JWF; Sonke, B; Thomas, AS; Stropp, J; Taplin, JRD; Vasquez, R; Vilanova, E. 2010. Drought-mortality relationships for tropical forests. NEW PHYTOLOGIST 187(3): 631-646.

48. Qiu, LJ; Yang, C; Tian, B; Yang, JB; Liu, AZ. 2010. Exploiting EST databases for the development and characterization of EST-SSR markers in castor bean (*Ricinus communis* L.). BMC PLANT BIOLOGY 10: 278.
49. Ren, XJ; Huang, WD; Li, WZ; Yu, DQ. 2010. Tobacco transcription factor WRKY4 is a modulator of leaf development and disease resistance. BIOLOGIA PLANTARUM 54(4): 684-690.
50. Shao, JL; Long, YS; Chen, G; Xie, J; Xu, ZF. 2010. The reversed terminator of octopine synthase gene on the Agrobacterium Ti plasmid has a weak promoter activity in prokaryotes. MOLECULAR BIOLOGY REPORTS 37(5): 2157-2162.
51. Slik, JWF; Aiba, SI; Brearley, FQ; Cannon CH; Forshed O; Kitayama K; Nagamasu H; Nilus R; Payne J; Paoli G; Poulsen AD; Raes N; Sheil D; Sidiyasa K; Suzuki E; van Valkenburg JLCH. 2010. Environmental correlates of tree biomass, basal area, wood specific gravity and stem density gradients in Borneo's tropical forests. GLOBAL ECOLOGY AND BIOGEOGRAPHY 19(1): 50-60.
52. Slik, JWF; Breman, FC; Bernard, C; van Beek, M; Cannon, CH; Eichhorn, KAO; Sidiyasa, K. 2010. Fire as a selective force in a Bornean tropical everwet forest. OECOLOGIA 164(3): 841-849.
53. Song, Y; Ai, CR; Jing, SJ; Yu, DQ. 2010. Research progress on functional analysis of rice *WRKY* genes. RICE SCIENCE 17(1): 60-72.
54. Song, Y; Chen, LG; Zhang, LP; Yu, DQ. 2010. Overexpression of OsWRKY72 gene interferes in the abscisic acid signal and auxin transport pathway of Arabidopsis. JOURNAL OF BIOSCIENCES 35(3): 459-471.
55. Sun S, Zhang DY, Ives AR, Li QJ. 2010. Why do stigmas move in a flexistylous plant? JOURNAL OF EVOLUTIONARY BIOLOGY 24: 497-504.
56. Tan, K; Li, H; Yang, MX; Hepburn, HR; Radloff, SE. 2010. Wasp hawking induces endothermic heat production in guard bees. JOURNAL OF INSECT SCIENCE 10: 142.
57. Tan, K; Wang, ZW; Li, H; Yang, MX; Pirk, CWW; Hepburn, HR; Radloff, SE. 2010. Responses of queenright and queenless workers of *Apis Cerana* to 9-keto-2(E)-decenoic acid, a pheromonal constituent of the Mandibular gland. JOURNAL OF CHEMICAL ECOLOGY 36(9): 966-968.
58. Tan, K; Wang, ZW; Yang, MX; Hepburn, R; Radloff, S. 2010. Nestmate recognition differences between honeybee colonies of *Apis cerana* and *Apis mellifera*. JOURNAL OF INSECT BEHAVIOR 23(5): 381-388.
59. Tan, ZH; Zhang, YP; Yu, GR; Sha, LQ; Tang, JW; Deng, XB; Song, QH. 2010. Carbon balance of a primary tropical seasonal rain forest. JOURNAL OF GEOPHYSICAL RESEARCH-ATMOSPHERES 115: D00H26.
60. Tang, CQ; Zhao, MH; Li, XS; Ohsawa, M; Ou, XK. Secondary succession of plant communities in a subtropical mountainous region of SW China. ECOLOGICAL RESEARCH 25(1): 149-161.
61. Tang, JW; Cao, M; Zhang, JH; Li, MH. 2010. Litter fall production, decomposition and nutrient use efficiency varies with tropical forest types in Xishuangbanna, SW China: a 10-year study. PLANT AND SOIL 335(1-2): 271-288.
62. van Welzen, PC; Kulju, KKM; Sierra, SEC; Slik, JWF. 2010. Key to the Malesian species of *Mallotus* (Euphorbiaceae). BLUMEA 55(3): 285-290.
63. Wang, ZH; Li, J; Conran, JG; Li, HW. 2010. Phylogeny of the Southeast Asian endemic genus *Neocinnamomum* H. Liu (Lauraceae). PLANT SYSTEMATICS AND EVOLUTION 290(1-4): 173-184.
64. Wang, ZJ; Peng, YQ; Compton, SG; Yang, DR. 2010. Reproductive strategies of two forms of flightless males in a non-pollinating fig wasp under partial local mate competition. ECOLOGICAL ENTOMOLOGY 35(6): 691-697.
65. Wang, ZJ; Zhang, FP; Peng, YQ; Bai, LF; Yang, DR. 2010. Comparison of reproductive strategies in two externally ovipositing non-pollinating fig wasps. SYMBIOSIS 51(2): 181-186.
66. Webb, CO; Slik, JWF; Triono, T. 2010. Biodiversity inventory and informatics in Southeast Asia. BIODIVERSITY AND CONSERVATION 19(4): 955-972.
67. Wen, B, Wang, RL; Cheng, HY; Song, SQ. 2010. Cytological and physiological changes in orthodox maize embryos during cryopreservation. PROTOPLASMA 239(1-4): 57-67.
68. Wen, B; Cai, CT; Wang, RL; Tan, YH; Lan, QY. 2010. Critical moisture content windows differ for the cryopreservation of pomelo (*Citrus grandis*). SEEDS AND EMBRYONIC AXES. CRYOLETTERS 31(1): 29-39.
69. Wen, B; Wang, RL. 2010. Pretreatment incubation for culture and cryopreservation of Sabal embryos. PLANT CELL TISSUE AND ORGAN CULTURE 102(2): 237-243.
70. Xiao, LQ; Moller, M; Zhu, H. 2010. High nrDNA ITS polymorphism in the ancient extant seed plant *Cycas*: Incomplete concerted evolution and the origin of pseudogenes. MOLECULAR PHYLOGENETICS AND EVOLUTION 55(1): 168-177.
71. Xin, X; Jing, XM; Liu, Y; Song, SQ. 2010. Viability loss pattern under rapid dehydration of *Antiaris toxicaria* Axes and its relation to oxidative damage. JOURNAL OF INTEGRATIVE PLANT BIOLOGY 52(5): 434-441.
72. Xu, FF; Chen, J. 2010. Competition hierarchy and plant defense in a guild of ants on tropical *Passiflora*. INSECTES SOCIAUX 57(3): 343-349.
73. Yang, MX; Tan, K; Radloff, SE; Phiancharoen, M; Hepburn, HR. 2010. Comb construction in mixed-species colonies of honeybees, *Apis cerana* and *Apis mellifera*. JOURNAL OF EXPERIMENTAL BIOLOGY 213(10): 1659-1664.
74. Yin, JT; Gusman, G. 2010. *Arisaema linearifolium* (Araceae), a new species from northern Yunnan, China. ANNALES BOTANICI FENNICI 47(1): 76-78.
75. Zhang, FP; Yang, DR. 2010. Study on mating ecology and sex ratio of three internally ovipositing fig wasps of *Ficus curtipes*. BULLETIN OF ENTOMOLOGICAL RESEARCH 100(2): 241-245.
76. Zhang, L; Li, QM. 2010. Isolation and characterization of microsatellite markers in an endangered species Dracaena *Cambodiana* (Liliaceae). AMERICAN JOURNAL OF BOTANY 97(10): E91-E93.
77. Zhang, LW; Nurvianto, S; Harrison, R. 2010. Factors affecting the distribution and abundance of *Asplenium nidus* L. in a tropical lowland rain forest in Peninsular Malaysia. BIOTROPICA 42(4): 464-469.
78. Zhang, M; Zou, XM; Schaefer DA. 2010. Alteration of soil labile organic carbon by

invasive earthworms (*Pontoscolex corethrurus*) in tropical rubber plantations. EUROPEAN JOURNAL OF SOIL BIOLOGY 46(2): 74-79.

79. Zhang, SB. 2010. Temperature acclimation of photosynthesis in *Meconopsis horridula* var. *racemosa* Prain. BOTANICAL STUDIES 51(4): 457-464.
80. Zhang, SB; Chang, W; Hu, H. 2010. Photosynthetic characteristics of two alpine flowers, *Meconopsis integrifolia* and *Primula sinopurpurea*. JOURNAL OF HORTICULTURAL SCIENCE & BIOTECHNOLOGY 85(4): 335-340.
81. Zhang, YP; Tan, ZH; Song, QH; Yu, GR; Sun, XM. 2010. Respiration controls the unexpected seasonal pattern of carbon flux in an Asian tropical rain forest. ATMOSPHERIC ENVIRONMENT 44(32): 3886-3893.
82. Zhao, JL; He, TH; Li, QM. 2010. Contrasting coarse and fine scale genetic structure among isolated relic populations of *Kmeria septentrionalis*. GENETICA 138(9-10): 939-944.
83. Zhao, Y; Zhang, SB; Yang, J; Zhang, L. 2010. Characterization of 13 microsatellite loci developed from *Meconopsis horridula*. GENETICS AND MOLECULAR BIOLOGY 33(3):539-541.
84. Zhong, JS; Li, J; Li, L; Conran, JG; Li, HW. 2010. Phylogeny of Isodon (Schrad. ex Benth.) Spach (Lamiaceae) and related genera inferred from Nuclear Ribosomal ITS, trnL-trnF Region, and rps16 intron sequences and morphology. SYSTEMATIC BOTANY 35(1): 207-219.
85. Zhou, HP; Chen, J. 2010. Spatial genetic structure in an understorey dioecious fig species: the roles of seed rain, seed and pollen-mediated gene flow, and local selection. JOURNAL OF ECOLOGY 98(5): 1168-1177.
86. Zhu, H; Wang, H; Zhou, SS. 2010. Species diversity, floristic composition and physiognomy changes in a rainforest remnant in Southern Yunnan, China after 48 years. JOURNAL OF TROPICAL FOREST SCIENCE 22(1): 49-66.
87. Zhu, SD; Cao, KF. 2010. Contrasting cost-benefit strategy between lianas and trees in a tropical seasonal rain forest in southwestern China. OECOLOGIA 163(3): 591-599.
88. Zhu, XF; Wan, JP; Li, QJ. 2010. Nectar robbers pollinate flowers with sexual organs hidden within corollas in distylous *Primula secundiflora* (Primulaceae). BIOLOGY LETTERS 6(6): 785-787.
89. Zou, CS; Jiang, WB; Yu, DQ. 2010. Male gametophyte-specific WRKY34 transcription factor mediates cold sensitivity of mature pollen in Arabidopsis. JOURNAL OF EXPERIMENTAL BOTANY 61(4): 3901-3914.
90. Zou, CS; Li, ZF; Yu, DQ. 2010. Bacillus megaterium Strain XTBG34 promotes plant growth by producing 2-pentylfuran. JOURNAL OF MICROBIOLOGY 48(4): 460-466.
91. Zou, CS; Yu, DQ. 2010. Analysis of the cold-responsive transcriptome in the mature pollen of *Arabidopsis*. JOURNAL OF PLANT BIOLOGY 53(6): 400-416.

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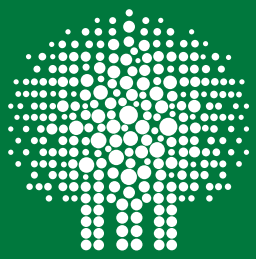

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