



XTBG



Annual Report 2008



Xishuangbanna Tropical Botanical Garden
Chinese Academy of Sciences



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.



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CONTENTS

GENERAL	1
Project development	2
Research Progress and Outreach Highlights	3
Improvement of research facility	2
Conferences and symposia	3
CIRCULAR	3
Collections & Nursery	8
Ecological observation	8
Data management and digital garden system	9
Landscape design	9
PUBLIC EDUCATION	4
Entrance to the garden	2
World botanic gardens exhibition in Beijing	3
Exhibition in Shenzhen	4
Winter camp for youth	5
XTBG public education & tourism wins praise	6
PERSONNEL	7
TALENT TRAINING AND RESEARCH	51
Graduate Education	5
Talent Training	5
Team Building	5
Commemoration of the 10 th Anniversary	6
BOOKS	57
ANNUAL REVIEW	6
PUBLICATIONS	6
Book	6
Articles	6



SCIENCE



Project development

Xishuangbanna Biodiversity Conservation Corridors a pilot project sponsored by the Asian Development Bank

In the year 2008, there are altogether 60 newly established research projects with total contract fund 38 million Yuan, of which:

8 projects funded by the National Natural Science Foundation of China, including a Key project (1.7 million Yuan) "The evolution of invasive species *Eupatorium odoratum*" lead by Prof. FENG Yulong;

8 projects supported by the Ministry of Science and Technology, including a counterpart funding project (1.12 million Yuan) to support international collaboration with German counterpart lead by Prof. CHEN Jin.

4 projects funded by Yunnan Provincial Fund for Natural Sciences.

18 projects supported by the Chinese Academy of Sciences, including three projects (2.6 million Yuan) to enhance the capability for national strategic plant resource conservation, which are performed by the Department of Horticulture, Herbarium, and the Plant Germplasm Bank; and eight projects funded by the CAS "Light in Western China" program, the grantees are: Asso. Prof. CAI Zhiquan, Asso. Prof. LIU Wenjie, Asso. Prof. PENG Yanqiong, Asso. Prof. QUAN Ruichang, Dr. LUO Yanjiang, Dr. CHEN Jiyue, Dr. LEI Yanbao, Dr. LIN Luxiang. To date, 22 XTBG researchers have been funded by the program since 1997.

17 projects funded by local government, enterprises and international agencies, including Forest Bureau of Xishuangbanna Dai Autonomous Prefecture, Yunnan Mengxiang Bamboo Industry Co. Ltd., etc.

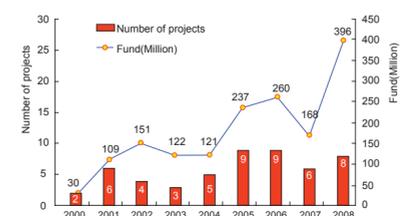


Figure 1. NSFC Approved Research Projects and Funds (2000-2008)

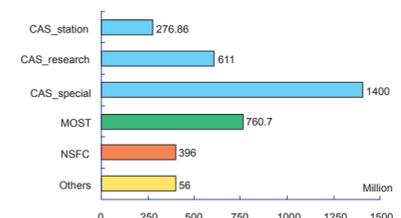


Figure 2. Research funds from major sources engaged in 2008

Research Progress and Outreach Highlights

Conservation of cultural landscapes through diversification of resource-use strategies and technologies for agro-ecosystems in mountainous Southwest China

The Ministry of Science and Technology granted XTBG 1.12 Million Yuan as counterpart fund to support this Sino-German cooperation project.

After the inception workshop, the project has set up an office in Jinghong for coordination of on-site works. Scientists from both sides actively started working together in the field, particularly in the Nabahe Watershed Natural Reserve. Hohenheim University has sent several batches of professors and PhD students to visit XTBG and work in the field.

Dr. CHEN Jin organized an on-the-spot workshop in Guomenshan station of Nabanhe Watershed Nature Reserve with participation of 30 experts and students from both sides. Sub-contracts were signed with relevant participating institutions after series discussion during the workshop. Field visits were conducted to villages nearby.



German Professors and students visit XTBG



Field visit after the workshop



ADB-GMS Xishuangbanna Biodiversity Conservation Corridors

This ADB-GMS flagship project has been undertaken in accordance with the plans outlined in the Inception Report. Through organized debriefing about the progress of project implementation to the government officials, and various activities for awareness building, the public began to aware of the importance and necessity to establish "one nature reserve and two corridors". At the end of 2008, 13 out of the 15 sub-projects have been initiated or completed.

At the invitation of ADB's Southeast Asia Department, Prof. CHEN Jin and Dr. HU Huabin attended the second GMS Environment Ministers' Meeting (EMM) which was held in Vientiane, Lao P.D.R. during January 28-30. The meeting brought together ministers, vice ministers or ambassadors of the six GMS countries and officials of ADB, UNEP, UNDP, WWF, and IUCN, etc. During course of the meeting, Prof. CHEN Jin communicated with officials of the ADB's Environment Operations Center (EOC) and representatives of international NGOs implementing BCI project in Laos and Cambodia.

On April 3, a special meeting organized by the Peoples' Government of Xishuangbanna Dai Autonomous Prefecture, brought together officials, experts and personnel of implementing agencies of the BCI project. Prof. MA Youxin and Prof. ZHU Hua reported on the plan of corridors construction and feasibility of establishing Mengsong Nature Reserve. After discussion, the participants reached the consensus on the new nature reserve and 2 pilot corridors. The Program Management Office was requested to submit meeting minutes to the prefecture government to get approval for the boundaries of biodiversity conservation corridors, and further field work for the new nature reserve was delegated to the Bureau of forestry.



The 2nd GMS Environment Ministers' Meeting (EMM), Vientiane, Lao P.D.R.



Prof. MA Youxin presents their findings to the Officials of Xishuangbanna



On May 6, XTBG director CHEN Jin and vice governor of Xishuangbanna Mr. YANG Sha headed up a 30-person group to investigate tropical forest protection in Mingsong-Bulang Mountain areas. That was a unique tropical region reflects a complete forest ecosystem of Xishuangbanna with rich biological diversity. The project planned to propose the area as a new nature reserve. After field investigation, Mr. YANG Sha, who is also the leader for the steering committee of ADB-GMS Xishuangbanna project, concluded and urged relevant agencies to speed up the processes of setting up a new nature reserve.



Vice Governor of Xishuangbanna, YANG Sha inspects project site

On May 15 2009, the proposed boundaries of the two pilot Biodiversity Conservation Corridors in Xishuangbanna were approved in principle by the vice governor of the prefecture.

In the middle of May, the Project was inspected by two ADB Evaluation Missions. On May 18, Mr. Hasan MOINUDDIN, the BCI task leader, visited two villages along the target biodiversity conservation corridors, interviewed villagers about the operation of village revolving funds and field practices of forest restoration; On May 20, Dr. Mala HETTIGE, principal evaluation specialist of ADB Operations Evaluation Department, came to XTBG to assess the operation of ADB-GMS-Xishuangbanna Biodiversity Conservation Corridors project. Dr. HU Huabin, project manager, reported to her on the implementation progress of the project in detail on May 21. Dr. Mala HETTIGE met and held talks with Prof. CHEN Jin. Both ADB officials and specialists were satisfied with the achievements made in the ADB-GMS Xishuangbanna Biodiversity Conservation Corridors project.



Mr. Hasan MOINUDDIN, the BCI task leader, visits project site



Dr. Mala HETTIGE on her evaluation mission to XTBG

During the BCI Subregional Exchange Meeting (BCI-SEM) for Implementing Agencies, held in Bangkok, September 15-16, Dr. HU Huabin and Mr. HU Shaoyun presented the progress of BCI-Xishuangbanna to over 70 participants from GMS countries. In the session of Valuation of and Payment for Ecosystem Services, Dr. HU Huabin also made a presentation on the "Impact of land use and land cover changes on ecosystem services in Southwest China". Immediately after the meeting, Dr. HU Huabin was invited to attend the workshop on "Biodiversity conservation and tourism development in the GMS" held also in Bangkok.

On the occasion of World Environment Day 2008, ADB released the documentary film "Forests for Our Future" in Beijing. The documentary is aimed to urge the world to pool its efforts for forests protection and fight against climate change. Dr. HU Huabin attended the releasing ceremony on invitation. Regarding ADB-GMS-BCI Xishuangbanna, Dr. HU Huabin introduced implementation progress and achievements on the biodiversity corridors, and answered questions proposed by journalists / reporters.



Documentary film "Forests for Our Future" released in Beijing

An aerial photograph showing a vast, dense forest of tall, slender trees covering a steep hillside. The forest is lush green, with many trees having light-colored trunks. At the bottom of the frame, a small village is visible, featuring several traditional houses with dark, tiled roofs. Some houses have laundry hanging on lines, and there are some utility poles. The overall scene is a mix of natural forest and human habitation.

Through the effort of the project, the Peoples' Government of Xishuangbanna Dai Autonomous Prefecture officially approved to set up "Bulong Nature Reserve", which was named after the two respective townships Bulangshan (of Menghai county) and Damenglong (of Jinghong municipality) on December 22. It becomes the first prefecture level nature reserve ever established.



Cambodian national botanical garden

During October 23-25, Dr. CHEN Jin, director of XTBG, headed a 4-person delegation to visit the Ministry of Environment (MOE), Cambodia. The aim of their visit was to further discuss proper measures on the establishment of the Cambodian National Botanical Garden (CNBG). His Excellency Dr. Mok MARETH, the Minister of MOE, met with XTBG delegation, and told them that the economy of Cambodia maintains a good momentum of growth in recent years, and the King pays much attention to environmental protection. The two years plus preparation for the construction of national botanical garden received support from the Chinese Academy of Sciences. MOE is to start part of the construction work in advance. Afterwards, XTBG delegation held discussion with key personnel in charge of the preparation work of CNBG. On behalf of the preparation group, Dr. Yin Kim SEAN, Secretary of State for the Environment, discussed further details with XTBG delegation. Dr. CHEN promised to invite three staff from Cambodia to XTBG for one month training on botanical garden management, and will send scientists from XTBG to help surveying plant resources in the identified CNBG location.

Later on, Dr. CHEN Jin and members on the delegation were taken to visit the CNBG site near Angkor Wat.



Meeting with His Excellency Dr. Mok MARETH, the Minister of MOE.



Visit to the CNBG location

Studies reveal invasive mechanism of exotic plants

Comparisons between invasive and native species may not necessarily characterize the traits of invasive species, as native species might be invasive elsewhere if they are introduced into a new habitat.

By comparing two invasive species, *Oxalis corymbosa* and *Peperomia pellucida*, with their noninvasive alien congeners; Prof. FENG Yulong's team found that invasive species have higher specific leaf area than their respective noninvasive alien congeners. The higher specific leaf area of the invasive plants leads to lower leaf construction cost but higher nitrogen allocation to photosynthesis, which contributes to higher photosynthetic capacity and nitrogen-use efficiency. The observation was published in *PLANTA*, under the title "Specific leaf area relates to the differences in leaf construction

cost, photosynthesis, nitrogen allocation, and use efficiencies between invasive and noninvasive alien congeners."

Related research results by FENG's team were also published in other international peer-reviewed journals. The study "Nitrogen allocation, partitioning and use efficiency in three invasive plant species in comparison with their native congeners" was published in *BIOLOGICAL INVASIONS* in 2008. The researches entitled "Photosynthesis, nitrogen allocation and specific leaf area in invasive *Eupatorium adenophorum* and native *Eupatorium japonicum* grown at different irradiances" and "Nitrogen allocation and partitioning in invasive and native *Eupatorium* species" were published in *PHYSIOLOGIA PLANTARUM* in 2008.



Invasive *Oxalis corymbosa* is still used as an ornamental plant in China



Frugivory and seed dispersal by mammalian carnivores and their role in forest recruitment and regeneration

That many mammalian carnivores ingest large quantities and varieties of fruits is well established. With larger foraging ranges, longer seed passage times in their gut, and selection for particular defecation microsites, their role as seed-disperser is significant and important for maintaining and establishing the floristic diversity and species composition of forested habitats. However, quantitative studies of the role frugivores play in forest ecosystems are limited.

Under joint supervision of Prof. CHEN Jin and Prof. ZHANG Shuyi, XTBG PhD candidate ZHOU Youbing has done four-year systematic studies on the functions of three carnivores as seed dispersers, by means of radio tracking and faecal analyses, and made new research advances. Although the masked palm civet is considered to be a generalist carnivore, the animals prefer fruits to rodents when the former are available, presumably because of the higher profitability of consuming fruit.

Ferret-badgers are very important for forest conservation, due to their multi-faceted role in forest recruitment. Martens were legitimate (they defecated viable seeds) and efficient dispersers (they transport seeds over long distances).

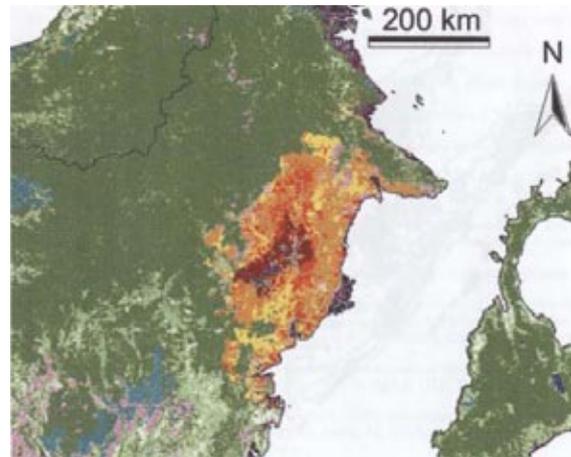
Related research results were published in three international peer-reviewed journals. The study “Frugivory and seed dispersal by a small carnivore, the Chinese ferret-badger, *Melogale moschata*, in a fragmented subtropical forest of central China” was published in FOREST ECOLOGY AND MANAGEMENT. Another research observation entitled “Dietary shifts in relation to fruit availability among masked palm civets (*Paguma Larvata*) in Central china” was published in JOURNAL OF MAMMALOGY. The study was also published in JOURNAL OF TROPICAL ECOLOGY, entitled “Frugivory and seed dispersal by the yellow-throated marten, *Martes flavigula*, in a subtropical forest of China”.



Focus three mammalian carnivores: left, *Paguma Larvata*; middle, *Melogale moschata*; right, *Martes flavigula*

Recovery mechanism of tropical rainforest after fire damage

More than 2 million hectares of forest and scrubland was burned during the 1997-1998 *El Nino* events. Satellite analysis of the 1997-1998 fires revealed that 80 percent of the fires could be linked to plantations or logging concession holders. Forest fires remain a devastating phenomenon in the tropics. How the tropical rainforest may be recovered after fire damage has been a common concern. Through studies on the forest structure, tree species diversity, tree species composition, and aboveground biomass during the first 7 years since fire in unburned, once burned and twice burned forest of eastern Borneo, Dr. Ferry SLIK and his cooperators determined the rate of recovery of these forests. The observation entitled "Tree diversity, composition, forest structure and aboveground biomass dynamics after single and repeated fire in a Bornean rain forest" was published in *OECOLOGIA* in 2008.



In red and orange the extent of the 1997-98 fires in eastern Borneo



Picture taken in a lowland rain forest directly after the 1998 fires in eastern Borneo

OECOLOGIA published an original research paper by XTBG student



HAO Guangyou at the savanna study site in central Brazil

Mr. HAO Guangyou, a PhD candidate under joint supervision of Prof. Guillermo GOLDSTEIN of University of Miami and Prof. CAO Kunfang of XTBG, published an original research paper in *OECOLOGIA*. By studying six congeneric species pairs growing in savanna habitats, HAO and his supervisors studied leaf and stem functions related to plant water relations. The research results were published entitled "Stem and leaf hydraulics of congeneric tree species from adjacent tropical savanna and forest ecosystems".



Grain for green program contributes to greenhouse gas management

Since the implementation of Grain for Green Program (GGP) in Yunnan in 1999, a lot of studies themed around its consequences have been conducted. Mr. CHEN Xiangang, PhD candidate with XTBG studied the carbon sequestration potential in the forests converted from farmlands. Related result was published in *FOREST ECOLOGY AND MANAGEMENT*.

Potential carbon sequestration has become an important issue for greenhouse gas management, with an increasing concern for

global climate changes resulting from more and more anthropogenic greenhouse gas. A variety of carbon sequestration policies have been evaluated. The initiation of GGP is one of effective policies. Protecting carbon stocks in the existing forests and getting the new carbon stocks through afforestation and reforestation have become the important measures to enhance the carbon sequestration capacity in the terrestrial ecosystems and mitigate the increasing carbon dioxide concentration in the atmosphere.

XTBG proposes wood density as a conservation tool

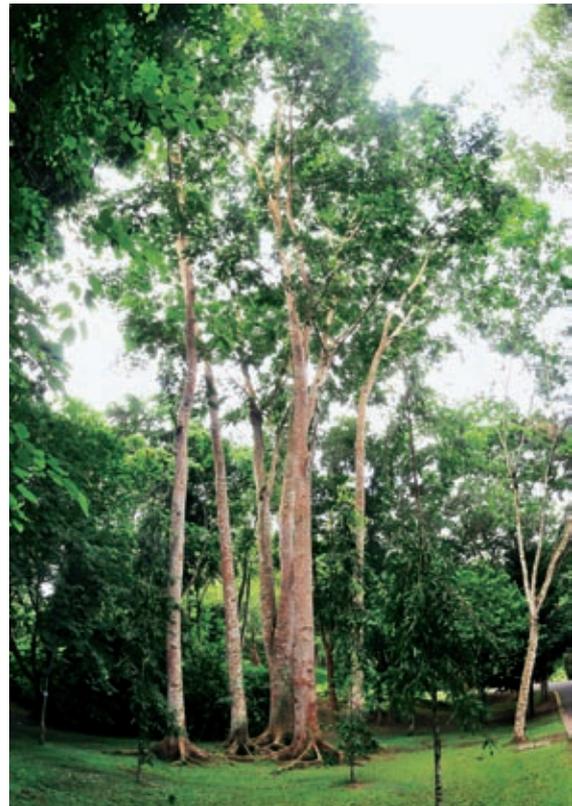
The continued decline and fragmentation of tropical rainforests have aroused global concerns. The conservation of tropical rainforest is a major task for conservationists and ecologists. However, it remains difficult to scientifically and properly assess the primitive tropical forests. By using tree inventory data from Borneo, Dr Ferry SLIK hypothesized that wood density can be used to quantify forest disturbance and conservation importance. They concluded that wood density at the plot level could be a powerful tool for identifying areas of conservation priority in the tropical rainforest. The observation, entitled “Wood Density as a Conservation Tool: Quantification of Disturbance and Identification of Conservation-Priority Areas in Tropical Forests”, was published in *CONSERVATION BIOLOGY*.



A typical low wood density pioneer species, indicating disturbed vegetation

Vegetation cover of forest, shrub and pasture strongly influences soil bacterial community structure

Bacterial community structure is influenced by vegetation, climate and soil chemical properties. To evaluate these influences, Dr. CHAN OC used terminal restriction fragment length polymorphism (T-RFLP) and cloning of the 16S rRNA gene, to analyze the soil bacterial communities in different ecosystems in Yunnan Province, SW China. They compared broad-leaved forest, shrub and pastures in a high-plateau region, three broad-leaved forests representing a climate gradient from high plateau temperate to subtropical and tropical regions and the humus and mineral soil layers of forests, shrub lands and pastures with open and restricted grazing activities, having varied soil carbon and nutrient contents. Principal component analysis of the T-RFLP patterns revealed that soil bacterial communities of the three vegetation types were distinct. The broad-leaved forests in different climates clustered together, and relatively minor differences were observed between the soil layers or the grazing regimes. *Acidobacteria* dominated the broad-leaved forests (comprising 62% of the total clone sequences), but exhibited lower relative abundances in the soils of shrub (31%) and pasture (23%). *Betaproteobacteria* was another dominant taxa of shrub land (31%), whereas *Alpha-* (19%) and *Gammaproteobacteria* (13%) and *Bacteriodetes* (16%) were major components of pasture. Vegetation exerted more pronounced influences than climate and soil chemical properties. The observation was published in FEMS MICROBIOLOGY ECOLOGY.





New evidence: why flowers self-fertilize

Studies on some Himalayan ginger flowers have contributed novel empirical evidence to Darwin's self-pollination theory, according to the results of the Plant Evolutionary Ecology Research Group (PEER).

Offspring resulting from self-fertilization usually exhibit reduced viability and fertility compared with those arising from cross-fertilization. Thus, it is not unexpected that many floral adaptations have evolved to reduce inbreeding depression and other costs incur by self-pollination. However, about one fifth of the Earth's flowering plants still choose to be fertilized with their own pollen. To explain this phenomenon, Darwin proposed a "reproductive assurance hypothesis" in the 1870s, which says the plants self-pollinate for the sake of seed production when pollinators or mating chances are scarce. The theory later became a widely-accepted explanation for the evolution of self-fertilization in plants.

Prof. LI Qingjun and his PhD student ZHANG Zhiqiang have been actively involved in the studies of *Roscoea*, a high-latitude genus of the predominantly tropical ginger family. The orchid-resembling *Roscoea* flowers have differentiated from its tropical and subtropical sister genera of the ginger family and adapted itself to alpine habitats since the uplift of the Qinghai-Tibet Plateau.

ZHANG and LI's recent focus is on *Roscoea schneideriana*, a small Himalayan perennial herb typically found in the mixed forests, stony pastures and rocky mountain cliffs across Yunnan, Sichuan and Tibet at around 3,000m above the sea level. With falcate leaf blade, purple/white flowers, yellow anther and hooked stigma, this plant is special in two aspects. First, despite the bright color of their petals, few insects are attracted to pollinate them. Second, given the fact that they are not fertilized with the help of pollinators, their fruit set is exceptionally high compared to other natural populations of flowering plants. To decode the pollination mechanism of *R. schneideriana*, ZHANG and LI first carried out pollinator exclusion experiments to estimate its capacity of autonomous selfing. They discovered that



Despite it has conspicuous floral display, the alpine ginger *Roscoea schneideriana* evolved some self-pollinated traits including nectarless and stigma curving towards its own anthers. These autogamous characters are supposed to adapt the pollinator lack environment.

the selfing is achieved by hooked stigmas curling towards the anther and contacting pollen grains, and those flowers with potential pollinators excluded set as many seeds per fruit as hand-selfed and opened flowers. Then the anther was removed at different times during flowering to reveal the timing of selfing. It turned out that the selfing mostly occurs at an early stage of anthesis, that is, within two days of blossom.

ZHANG and LI also emasculated some flowers to compare their reproduction ability with that of the self-pollinated ones. Results showed during the flowering seasons of 2005-2007, autonomous selfing increased seed production by an average of 84 percent in four populations of *R. schneideriana*. Last but not least, the botanists made a comparison between progeny of self- and cross-pollinated *R. schneideriana*, quantifying the cumulative inbreeding depression of the plant as 0.226.

The study suggests that under poor pollination conditions, autonomous selfing has been selected by the alpine ginger because it can provide substantial reproductive assurance with very low costs. It is convincing evidence to Darwin's theory based upon a long-term investigation across several flowering seasons within a natural population. According to ZHANG and LI, violet and yellow are both bright colors to attract bees for pollination. The lack of pollinators in the area might be due to climate factors: the flowering seasons of *R. schneideriana* just fall across the major raining seasons of the region. The collapse of plant-pollinator mutualism may also cause *R. schneideriana* to become dependent on autonomous selfing to achieve successful pollination.

The study was published in ANNALS OF BOTANY in October 2008.



Survey reveals the situation of Chinese caterpillar fungus resources

Following an investigation of the aweto (or Chinese caterpillar fungus) resources from May to July 2007 on the Tibetan Plateau, the central producing area of this precious ingredient for the traditional Chinese medicine (TCM), Prof. YANG Darong and his team conducted a further survey on the aweto's marginal habitats from May to July 2008.

Funded by CAS, this survey covered the populations on the south and the north verges of its geographical range, including those on the southeastern skirts of the Tibetan Plateau in Yunnan Province and those scattering in the mountainous areas on the north edge of the Plateau in Gansu and Qinghai provinces, in a bid to reveal the impact of human herborizing on the local ecological environment.

The aweto is actually the combination of two species from two different biological kingdoms, consisting of the fruiting body of a fungus called *Cordyceps sinensis* and the corpse of a caterpillar named *Hepialus* spp.. This is just the peculiar outcome of a common phenomenon created by magical Nature, parasitism.

Strong demands for this precious medicinal material, however, have pulled lots of pickers to its habitats. Their herborization ruins the surface soil and vegetation on the frigid Plateau, posing great pressure on the local wildlife ecologies and pushing this fungus to the verge of extinction. In this context, the survey was launched to evaluate the conditions of the aweto resources and identify the impact of the human intervention on the fragile ecological balance in its producing areas. Combining the data from last year's investigation, so far the analysis of this survey has initially revealed some fundamental facts about the distribution of aweto resources, and meanwhile alerted some dangerous trends.

On the Tibetan Plateau, the aweto is revealed to have a distribution stretching northward from



A nomad man looking for caterpillar fungus (*Cordyceps sinensis*) on the Tibetan Plateau at 13,000 feet (4,000 meters) near YuShu, an in Qinghai province

the Mt. Cangshan in Dali (Tali) Prefecture in Yunnan Province, or more exactly at E99°34'/N25°45', to the Qilian Mountains to the south of the Gansu Corridor (Kansu Corridor), exactly at E102°90'/N38°49'. Beyond this range, no aweto is found in the survey.

The distribution of the aweto on the Plateau has a noticeable heartland, which covers the areas including parts of the Nakqu, Chamdo and Nyingchi prefectures in Tibet Autonomous Region, Yushu Prefecture in Qinghai Province, Tibetan Qiang Autonomous Prefecture of Aba (Ngawa) and Tibetan Autonomous Prefecture of Garze in Sichuan Province, Diqing Prefecture in Yunnan Province and, part of the Gannan Prefecture in Gansu Province. This central zone produces about 70% of the national aweto yield. On the other hand, aweto from the central zone has the best quality and the biggest sizes; the farther the producing area is from the central zone, the poorer the quality of the aweto resource and the smaller the size.

A shocking trend revealed by the survey is, in the central zone, the prime altitude around which the aweto grows has risen by 200 to 500 meters compared to 20 years ago. At present the prime altitude ranges between 4,400 to 4,600 meters above sea level, while it used to be between 3,900 to 4,400 meters only two decades ago. What also deserves concern is, the prime altitude range has narrowed down significantly. In the marginal areas, things are also less than encouraging. Although the prime altitude sees little change there, the yield goes down and the quality worsens: The aweto differentiates a lot in size, shape and color from that in the central zone, showing evident signs of polarization between populations.

According to YANG, the worrying trends unveiled in the investigation might be related to global warming and predatory herborization, though the detailed results from further analyses are still under way.



The Chinese caterpillar fungus (*Cordyceps sinensis*)



Land-use change and its impact on carbon stocks of vegetations in Xishuangbanna

With a history of 50 years in rubber plantation, Xishuangbanna has become a very important field base for natural rubber supply. However, no concise data have been available for the impact of rubber plantation on the area of tropical rainforest.

Prof. MA Youxin's research team, through analysis of remote sensing data, have determined the interrelationship between the natural forest and rubber forest and got evidence that the forest cover has been decreased from 70% in 1976 to 50% or so in 2003. About 400,000 ha of tropical seasonal rainforest have been degraded or converted to monoculture of rubber forest. The increasing demand for rubber has actually intensified the expansion of rubber plantations and resulted in deforestation of mountain rain forest and subtropical evergreen broadleaf forest. Entitled "Demand for rubber is causing the loss of high diversity rain forest in SW China", this result was published in BIODIVERSITY AND CONSERVATION.

Land use/land cover change is an important driver of global change and changes in carbon stocks. By combining detailed land-use change over a 27-year period based on satellite images and forest inventory data, Ma and his team estimate changes in biomass in Xishuangbanna. The study demonstrates that the uncertainty of biomass estimates can be greatly reduced if detailed land-use analyses are combined with forest inventory data, and that slight changes in future land-use practices can have large implications for carbon fluxes. The observation, entitled "Past, present and future land-use in Xishuangbanna, China and the implications for carbon dynamics", was published in FOREST ECOLOGY AND MANAGEMENT.

SYMBIOSIS special issue

SYMBIOSIS, an international journal, publishes results of original research contributing to the understanding of symbiotic interactions at the molecular, cellular and organismic levels.

In the special volume (Vol. 45, Nos.1-3, 2008) of SYMBIOSIS, six papers by XTBG scientists were included. The special volume was a collection of reports and posters presented at the 7th International Fig Wasp Symposium, which was hosted by XTBG during July 23–26, 2006 in Yunnan, China.

Achievements in research on biomass energy

Led by Prof. FANG Zhen, the biomass research group developed a new method to completely solubilize wood in water in just 1 s. The aqueous "wood solution" like oil is easier to process into many products than solid wood. This result may open a new research area for the biomass refining process like liquid oil. Wood or cellulosic ethanol, particles, biofuels, chemicals and plastics can be produced by continuous solubilization, or pretreatment/hydrolysis in a well-designed flow reactor, and subsequent refining through chemical, biological and mechanical conversions. This finding can also help to explain the formation mechanisms of natural gas, coal and petroleum from lignocellulosic biomass under hydrothermal conditions where alkaline minerals existed. The result was published in AICHE JOURNAL, entitled "Complete dissolution and hydrolysis of wood in hot water".

FANG found that cellulose can completely dissolve and hydrolyze to glucose in hot water, and this result was further successfully used to build up a flow reactor to completely and continuously hydrolyze cellulose to glucose for hydrogen production. The observation, entitled "Catalytic hydrothermal gasification of cellulose and glucose", was published in INTERNATIONAL JOURNAL OF HYDROGEN ENERGY.

For the first time FANG's team found that when phenol was used with {lignin + water} mixtures, a homogenous phase was formed in hot water that seemed to promote the decomposition of lignin into phenolic fragments by hydrolysis and pyrolysis. Phenol, along with the homogenous reaction conditions also inhibited re-polymerization of the phenolics and promoted oil formation. These results were further used to propose reaction paths and mechanisms for lignin degradation that can be used to produce oil, chemicals and synthesis of biopolymer. The study, entitled "Reaction chemistry and phase behavior of lignin in high-temperature and supercritical water" was published in BIORESOURCE TECHNOLOGY.

Related research results by FANG's team were also published in other international peer-reviewed journals. The study "Synthesis of Erbium Hydroxide Microflowers and Nanostructures in Subcritical Water" was published in NANOTECHNOLOGY. The observation entitled "Use of Oxygen and Methanol in Promoting the Destruction of Decachlorobiphenyl in Supercritical Water" was published in FUEL.



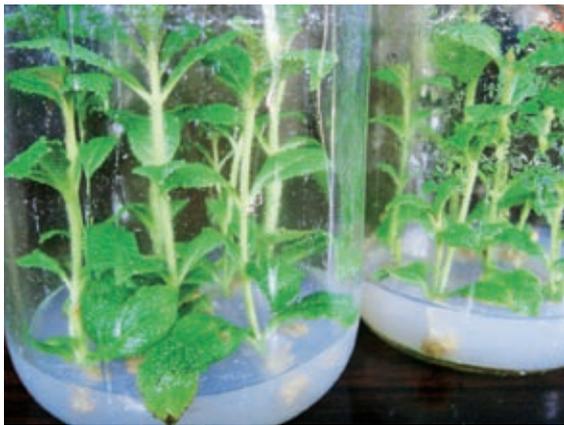
Crude *Jatropha* oil from XTBG and biodiesel produced: left, *Jatropha* oil; middle, Biodiesel with sulfuric acid; right, Biodiesel two-step process



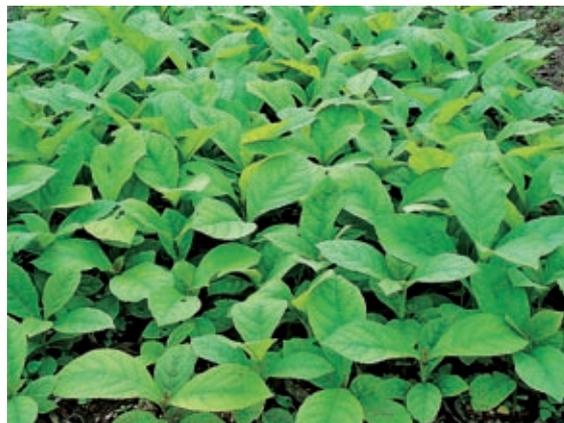
Tissue culture and rapid propagation of teak: a success at XTBG

Teak (*Tectona grandis* Linn.f.) occurs naturally in India, Thailand, Myanmar and Laos. It is commercially valued for its wood quality in the world due to the presence of fine grains, its strength, durability, and resistance to insects. It is also used in construction, plywood and furniture industries. Prof. CAI Xitao, the founder of XTBG, introduced *Tectona grandis* Linn.f. to XTBG in 1964.

Seed germination of teak has long been multifarious. Through field experiments, XTBG scientists have mastered the technique for teak propagation in vitro. About 50,000 teak seedlings have been propagated after callus induction, proliferation culture, rooting culture, and exercising seedlings in nursery.



Rooting seedlings of *Tectona grandis* Linn.f. in culture medium



Seedlings of *Tectona grandis* Linn.f.