Program and Abstracts

THE THIRD XISHUANGBANNA INTERNATIONAL SYMPOSIUM BOTANICAL GARDENS AND CLIMATE CHANGE

January 13-16, 2014 Xishuangbanna, China

Xishuangbanna Tropical Botanical Garden (XTBG)

Xishuangbanna Tropical Botanical Garden (XTBG) of the Chinese Academy of Sciences (CAS) was founded under the leadership of the eminent botanist Cai Xitao in 1959. Geographically, it lies at 101°25′E, 21°41′N, with an elevation of 570 m above sea level. Its average annual temperature is 21.4℃. Following its separation from the Kunming Institute of Botany and its combination with the Kunming Institute of Ecology, the new Xishuangbanna Tropical Botanical Garden (XTBG) came into being in 1997. It is a comprehensive research institution engaged in scientific research, species preservation, public education, and science and technology development, and a well-known scenic spot as well.

With Yunnan Province as its focal working area, XTBG probes into the impact of human activities and climate change on ecosystem structures and services, as well as the endangerment mechanism of species. Effective conservation, sustainable development and the utilization of biological resources are the primary goals of XTBG. Its scientific research focuses on forest ecosystem ecology, conservation biology and resource plant development, with 27 research groups working in these three research fields.

XTBG's 11.25 km^2 area includes 225 ha of undisturbed limestone seasonal forest (the Green Stone Forest), as well as a smaller patch of tropical seasonal rainforest. Over 13,000 species of plants are found in its 35 living collections, enhancing XTBG's reputation as a botanical garden with one of the richest outdoor plant collections in the world.

Since 2001, 600 important scientific research projects have been conducted by XTBG, among which 20 were awarded either ministerial or provincial prizes. More than 2500 academic papers and 30 monographs have been published, and 60 national patents were granted for scientific innovations.

Facilities available for scientific research include two key laboratories at the CAS level (Key Laboratory of Tropical Forest Ecology and Key laboratory of Tropical Plant Resources and Sustainable Use), the Center for Integrative Conservation, two national field research stations (Xishuangbanna Tropical Rainforest Ecosystem Station, and Ailaoshan Station for Forest Ecosystem Studies), the Yuanjiang Hot and Dry Valley Observation Station, the Public Technology Service Center, the Germplasm Bank for Rare & Endangered Plants, the Herbarium of Tropical Plants, the Department of Gardening & Horticulture, the Department of Public Education & Tourism, etc. An new extension garden, the Jingdong Subtropical Botanical Garden, is currently under construction.

In November 2013, XTBG has 343 staff members, including 30 professors and 56 associate professors or equivalent.

XTBG offers Master's and PhD Programs in Ecology and Plant Sciences, with 145 graduate students and 89 Ph.D. candidates studying here. It has also been authorized to confer Master degrees in Biological Engineering. The postdoctoral program in Biology was initiated in 2004. There are currently 11 postdocs conducting scientific research in the Garden.

XTBG has established substantial cooperation with botanical gardens, universities, and other academic research institutions in more than 50 countries and regions, as well as with international organizations. Each year, more than 200 foreign scientists come to XTBG to attend international conferences, workshops and trainings courses, and for doing research and academic degrees.

As a National 5A Tourist Attraction (i.e., one of the top scenic spots in China), XTBG receives 650,000 visitors each year. It is also the National Popular Science Education Base, a National Base of Environmental Protection & Popular Science, and a Patriotic Education Base.

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WELCOME LETTER

On behalf of Xishuangbanna Tropical Botanical Garden of the Chinese Academy of Sciences, I would like to extend my warmest welcome you all to the 3rd Xishuangbanna International Symposium – Botanical Gardens and Climate Change, in Xishuangbanna, China, from 13th to 16th January, 2014.

The Xishuangbanna International Symposium, held every five years, aims to bring together leading scientists to present cutting-edge research, address current debates and assess future directions for research on biodiversity conservation and botanical gardens. The 1st Xishuangbanna International Symposium, attended by 180 delegates from 20 countries, was held in January 1999 and focused on "Biodiversity Conservation and Sustainable Development". The 2nd Xishuangbanna International Symposium was held in January 2009, with the major theme of "Biodiversity Conservation: Research Imperative for Scientific Institutions". The Xishuangbanna International Symposium is becoming am important platform bringing scholars from all over the world.

The 3rd Xishuangbanna International Symposium will feature the major theme: “Botanical Gardens and Climate Change”. The ultimate aim of this symposium is to develop a roadmap for scientific research and education in climate change biology at Botanical Gardens in China and worldwide. In order to achieve this, we will first review what is known, and what isn’t, and what is being done currently, before moving on to assess ways in which existing resources can be better used and new resources targeted at the critical gaps.

As the host institution for Xishuangbanna International Symposium, XTBG will continue to provide such platform bringing scholars from all over the world for intellectual exchange.

I wish this symposium a full success and all guests have a pleasant stay in the Garden.

Prof. Dr. Jin CHEN

Director-General

Xishuangbanna Tropical Botanical Garden, Chinese Academic of Sciences

COMMITTEES

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Members:

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Li-Ming LI	Xishuangbanna Tropical Botanical Garden, CAS
Lei-Lei SHI	Xishuangbanna Tropical Botanical Garden, CAS
Wei ZHANG	Xishuangbanna Tropical Botanical Garden, CAS
Qi GAO	Xishuangbanna Tropical Botanical Garden, CAS

PROGRAM

SUNDAY 12 January 2014		
14:00-16:00	XTBG Limestone Forest Tour	
15:00-21:00	Registration	XTBG Hotel Lobby
18:00	Dinner	

MONDAY 13 January 2014		
8:00	Transportation	Buses leave from hotels
8:00-8:50	Breakfast	
8:00-9:00	Registration	XTBG Research Center
9:00-9:30	Opening Ceremony	Chair: **Ze-Xin Fan** Place: **Conference Hall**
Plenary Lecture	**A1**	Chair: **Zhe-Kun ZHOU** Place: **Conference Hall**
9:30-10:10	Tong JIANG	Climate Change in China: Observation and Projection
10:10-10:40	Coffee Break	
Oral Session	**O1-O4**	Chair: **Richard CORLETT** Place: **Conference Hall**
10:40-11:00	Zhe-Kun ZHOU	The Asian Monsoon is an Important Dynamic Factor for Biodiversity Change in Eastern Asia
11:00-11:20	Frédéric JACQUES	Winter Drought and Plant Response to Past Climate Changes
11:20-11:40	Julie ANBERREE	The First Fossil Fruit of *Burretiodendron* (Malvaceae s.l.) From the Late Miocene of Yunnan, China: Implication for its Conservation
11:40-12:00	Yong-Chuan YANG	Survival of Tertiary Relict Species in South-central China, with Special Reference to Anthropogenic Activities
12:00-13:00	Lunch	
13:00-14:40	Garden Tour	
Plenary Lecture	**A2**	Chair: **Ze-Xin FAN** Place: **Conference Hall**
14:40-15:20	Guo-Yi ZHOU	Global Climate Changes on Land Surface Hydrological Processes and Their Consequent Effects on Reorganization for China's Biomes of Tropical and Subtropical Forests
15:20-15:40	Coffee Break	
Oral Session	**O5-O11**	Chair: **Ze-Xin FAN** Place: **Conference Hall**
15:40-16:00	Olesya BONDARENKO	The Late Early Pleistocene Climate Dynamic in Southern Primory'e (Far East of Russia)
16:00-16:20	Axel THOMAS	Evapotranspiration Decreases While Temperature Increases - a Yunnan Province Case Study
16:20-16:40	Zhen-Dong FANG	A Progress Reporting 2005-2013 of the Gloria Climate &

		Vegetation Change Monitoring in NW Yunnan, China
16:40-17:00	Zheng-Hong TAN	Has Water-Use Efficiency of China's Old-Growth Forests Increased with Carbon Dioxide Concentrations in the Past Decade?
17:00-17:20	Qing-Hai SONG	Do the Rubber Plantations in Tropical China Act as Large Carbon Sinks?
17:20-17:40	Nizami MOAZZAM	Managing Carbon Sinks in Rubber (*Hevea brasilensis*) Plantation by Changing Rotation length in SW China
17:40-18:00	Aki NAKAMURA	Elevation, Latitude and Fragmentation: Monitoring Forest Biodiversity in the Era of Global Anthropocene
18:00-19:00	Welcome Dinner	
19:00	Transportation	Buses leave to hotels from Staff Cafeteria

TUESDAY 14 January 2014		
8:00	Transportation	Buses leave from hotels
8:00-8:50	Breakfast	
Plenary Lectures	**A3-A4**	Chair: **Jin CHEN** Place: **Conference Hall**
9:00-9:40	Jian-Chu XU	Plant Phenology and Climate Change: The Role of Botanic Gardens
9:40-10:20	Sara OLDFIELD	Conserving and Restoring Plant Diversity – a Response to Climate Change
10:20-10:40	Coffee Break	
Oral Session	**O12-O15**	Chair: **Jin CHEN** Place: **Conference Hall**
10:40-11:00	Alice HUGHES	Using Data from Botanic Gardens to Calibrate Predictive Models of the Effect of Climate Change on Species Distributions into the Future
11:00-11:20	Zafar SIDDIQ	Using the Common Garden Trees for Estimation of Water Use, Their Response to Climatic Factors and Implications for Climate Change
11:20-11:40	Jiao-Lin ZHANG	Water-Use Advantage of Lianas over Trees in Seasonal Tropical Forests
11:40-12:00	Sheng XU	Physiological Responses and Adaptations of Urban Garden Plants to Global Climate Change
12:00-13:00	Lunch	
13:00-13:40	Poster Session	
Plenary Lectures	**A5-A6**	Chair: **Richard CORLETT** Place: **Conference Hall**
13:40-14:20	Stephen BLACKMORE	Climate Change – Where do Botanic Gardens Fit in?
14:20-15:00	Richard PRIMACK	Opportunities for Botanical Gardens in Climate Change Research
15:00-15:20	Coffee Break	
Oral Session	**O16-O23**	Chair: **Richard CORLETT** Place: **Conference Hall**

15:20-15:40	Rakan ZAHAWI	Climate Change and the Role of Botanical Gardens; Going Beyond the Safe House Concept
15:40-16:00	Dharmalingam MOHANDASS	Climatic Factors Influence Flowering Periodicity in the Seasonal Rainforest Trees of South-west China: A Comparative Phenology Study of Botanical Garden *vs*. Nature Reserve Forest
16:00-16:20	Xiao-Dong YANG	The Effect of Soil Fauna on Litter Decomposition among Elevation Gradient in Subtropical Evergreen Broadleaf Forest, Southwestern China
16:20-16:40	Long-Fei FU	Conservation of Shade Plants Biodiversity under the Background of Climate Change - Studies on the Diversity of *Elatostema* (Urticaceae) from Karst Caves of Guangxi, China
16:40-17:00	Fang WEN	Global Warming and the Conservation of Gesneriaceae in China
17:00-17:20	Hui-Ying WU	Climate Change Adaptation Plan for Bangliang Gibbon Nature Reserve and Adjacent Communities
17:20-17:40	Zhou-Li LIU	Influence of Elevated CO_2 in an Urban Area on the Leaf Secondary Metabolism of *Pinus tabulaeformis*
17:40-18:00	Na QIAO	Labile Carbon Retention Compensates for CO_2 Released by Priming in Forest Soils
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Oral Session	**O24-O29**	Chair: **Xiao-Dong YANG** Place: **Conference Hall**
19:00-19:20	Richard CORLETT	The Observed Impacts of Recent Climate Change in Asia
19:20-19:40	Gupta HIMANGANA	Policy Conflict between Forest Land Use and Climate Change
19:40-20:00	Hua-Zheng LU	Vital role of Clonal Integration in Canopy Rather Than Understory -A Case of Ferns
20:00-20:20	Yu-Long ZHENG	Integrating the Importance of Novel Chemical Weapons and Adaption in the New Ranges of a Tropical Invader
20:20-20:40	Gbadamassi DOSSA	Phylogenic patterns in Wood Decomposition: A Common Garden Experiment in a Botanical Garden
20:40-21:00	Teng LI	"Age" and "Climate Shift" Effects on Long-Term Changes of Tree-Growth–Climate Relationships：A Case of Chinese Pine in Southern Northeast China
21:00	Transportation	Buses leave to hotels from Conference Hall

WEDNESDAY 15 January 2014		
8:00	Transportation	Buses leave from Hotels
8:00- 8:50	Breakfast	
9:00-9:40	Opening Ceremony of Vine Garden	Chair: **Qing-Jun Li** Place: **Vine Garden**
Plenary Lecture	**A7**	Chair: **Stephen BLACKMORE** Place: **Conference Hall**

9:40-10:20	Jennifer SCHWARZ	The Role of Botanic Gardens in Climate Change Education
10:20-10:40	Coffee Break	
Oral Session	**O30-O35**	Chair: **Stephen BLACKMORE** Place: **Conference Hall**
10:40-11:00	Guang-Yu LIU	Climate Change Education in Chinese Botanical Gardens: An Educator's Perspective
11:00 -11:20	Kenneth ER	Gardens by the Bay: Creating Awareness of Climate Change
11:20-11:40	Sophie WILLIAMS	Making Climate Change Education Effective
11:40-12:00	Ellie BARHAM	An International Plant Sentinel Network
12:00 -12:20	Suzanne SHARROCK	Networking Botanic Gardens for Conservation – the Role of BGCI's Databases in a Time of Global Change
12:20-12:40	Elango VELAUTHAM	Singapore Botanic Gardens and Climate Change: Some Preliminary Measure
12:40-13:40	Lunch	
14:00-16:00	Group Discussions	
	Group One	Place: **Meeting Room 1**
	Group Two	Place: **Meeting Room 2**
16:00-16:20	Coffee Break	
16:20-17:40	Panel Discussion	Place: **Conference Hall**
17:40-18:00	Closing Ceremony	
18:00-19:00	Dinner	
19:00-20:00	Night Hike	
20:00-21:30	The XTBG 55th Anniversary Celebration	Place: **Conference Hall**
21:30	Transportation	Buses leave to hotels from Conference Hall

THUSDAY 16 January 2014		
8:00	Transportation	Buses leave from hotels
8:00- 8:50	Breakfast	
9:00-18:00	Post Conference Excursions	BuBeng 20 ha Plot and SKYTREE Spot
18:00- 19:00	Dinner	
19:00	Transportation	Buses leave to hotels from Staff Cafeteria

FRIDAY 17 January 2014		
8:00	Transportation	Buses leave from hotels
8:00- 8:50	Breakfast	

Poster Presentations

No	Name	Title
P1	Chun-Lai ZHANG	Characteristics of Carbon Cycle and the Effect of Carbon Sink in Karst Ecosystem
P2	Fei-Fei JIA	Tree-Ring Based PDSI Reconstruction from AD 1804 for Hasi Mountain, Northwestern China
P3	Fu-Li FANG	Distinguishing Nitrous Oxide Production from Nitrification and Dinitrification from Intramolecular Site Preference in N_2O Isotopmers
P4	Huan NGUYEN	Genetic Diversity Plays an Important Role for Species Growth to Face Climate Change
P5	Xiang ZHANG	Effect of Long-Term Throughfall Exclusion on Soil Moisture and Soil Temperature in a Tropical Rainforest in Xishuangbanna, Southwest China
P6	Liang GUO	Response of Fruit Phenology in China to Climate Variation and Change
P7	LIAO Zhi-Yong	Evolutionary Increases in Defense during a Biological Invasion
P8	LIU Jing-Jing	Growth Response of *Sabina tibetica* to Climate Factors Along an Elevation Gradient and its Climatic Implications in South Tibet, Western China
P9	Qiang ZHANG	Light Use in Relation to Carbon Gain in Five Dominant Tree Species of the Different Stages of the Subtropical Forest Succession in South China
P10	Rizwan Ali SHEIRDIL	Exploring the Potential Strains for Wheat (*Triticum aestivum* L.) Inoculation Through Characterization and Identification using 16S rRNA Gene Sequencing
P11	Tong-wen ZHANG	A Tree-Ring Based Temperature Reconstruction for the Kaiduhe River Watershed, Northwestern China, since A.D. 1680: Linkages to the North Atlantic Oscillation
P12	Wei SHI	The Phenophase Response of *Calligonum* L. in Turpan Eremophytes Botanic Garden to Temperature Change in Recent 29 Years
P13	Xian-Bao ZENG	The Research Progress of Lotus Genetic Breeding in China
P14	Keooudone SOUVANNAKHOUMMANE	The Conservation of Zingiberaceae in Lao PDR.
P15	Yi-Yi HAN	Botanical Gardens and Climate Change in Myanmar
P16	Zhi-Peng YAO	Research on Plant Endophytic Fungi for Improve Gramineous Crop Drought Resistance

A1 First plenary lecture

Mon. January 13
9:30-10:10 am
Tong JIANG

Prof. Dr. Tong JIANG has spent nearly 20 years working on climate change, water resources management and floods/drought analysis in the National Climate Centre under the China Meteorological Administration. He is an Associate editor for Hydrological Sciences Journal (2005-2010) and Atmospheric Research (2011-2014) and the leading author (LA) for IPCC AR5 WG II CH3: Freshwater Resources. Dr Jiang is specialised in developing future climate change scenarios, mainly based on the GCM model (ECHAM5 and 6) and Regional Model (CCLM) and to quantify how such scenarios may impact on water resources at regions and watershed basins. Dr Jiang has worked both on empirical analyses of observed climate change parameters on river discharge regimes and on scenarios for the future. He has published nearly 60 peer-reviewed papers.

Climate Change in China: Observation and Projection

Tong JIANG, Xiao-Yun ZHU

National Climate Centre of China Meteorological Administration

First part: Brief introduction on IPCC AR 5 WGI result is present at global scale.

Second part: Based on observed daily temperature and precipitation from 750 meteorological stations coved periods between 1960 and 2012, the trends of temperature and precipitation can be analyzed and figured out. Used in ensemble output of multiple GCMs under RCP scenarios 2.6, 4.5 and 8.6, future temperature and precipitation are investigated covering from a period from 2014 to 2050.

Third part: regarding to Yunnan province, observed and projected climate change trends can be analyzed and presented according to observed climate data and output from ensemble of multiple GCMs under RCP scenarios.

First oral session (O1-O4)

Mon. January 13
10:40-12:00 am

O1 | The Asian Monsoon is an Important Dynamic Factor for Biodiversity Change in Eastern Asia

Zhe-Kun ZHOU, Frédéric JACQUES, Tao SU

Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences

Seasonal precipitation is the main characteristic of the Eastern Asian monsoon: 50 to 80 percent of annual precipitation is concentrated during the rainy season, usually from May to October. The Asian monsoon region experiences wet summers and very dry winters and springs. The Asian monsoon system was established from the Late Miocene in association with the uplift of the Himalayas. Due to the seasonality of the monsoon climate, some plants would suffer from dryness in winter and spring, causing their distribution area to shrink or even leading to their extinction. In this work, fossil history, modern distribution, and seed biology of *Cedrus*, *Metasequoia*, and Sequoia are analyzed in relation to the paleo-monsoon evolution in order to reveal how its onset and evolution led modern plants to be endangered. Seeds of *Cedrus*, *Metasequoia*, and Sequoia germinate immediately after they are ripe, in late autumn or early winter when the rainy season is close to an end. Therefore, the seeds may not have enough water for germination or seedling growth. Even if some seeds manage to germinate, the seedlings suffer from a very dry spring. Repeated dry winters and springs caused *Cedrus*, *Metasequoia* and *Sequoia* to disappear from the Asian monsoon region. Field observations of *Quercus sichouensis*, which has 9 individuals left, and germination of seeds under lab conditions reproducing the monsoon climate, demonstrated that the monsoon climate brought this species close to extinction. Based on the study of these four taxa, it would be concluded that, as the seasonality intensity of the Asian monsoon increased, seasonality become distinguished. Some species could not adapt to the dry winter and spring, and reshaped their distribution, and some of them came close to extinction，demonstrating that the Asian monsoon is an important dynamic factor influencing biodiversity change.

First oral session (O1-O4)

Mon. January 13
10:40-12:00 am

O2 | Winter Drought and Plant Response to Past Climate Changes

Frédéric MB JACQUES[1], Tao SU[1], Li WANG[1], Zhe-Kun ZHOU[1,2]

1. Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Mengla, Yunnan, 666303, China
2. Kunming Institute of Botany, Chinese Academy of Sciences, Kunming, Yunnan, 650204, China

Tertiary relicts are these plants that were once widespread in the Northern Hemisphere but that are now present in only restricted areas. *Metasequoia* and *Davidia* are famous examples of Tertiary relicts. Tertiary relicts are mostly found in China where they are also known as paleo-endemic. These genera experienced past climate changes in the Cenozoic and were, in result, extirpated from most of their past distribution regions. Because, on the contrary to extinct genus, their climatic requirements are known, they are good models to study how plants respond to climate. In this study, we look at the modern Chinese distribution range of 65 Tertiary relict genera and analyze climate characteristics of this distribution pattern. The border of Hubei and Chongqing, the border of Hunan and Guizhou, as well as East Fujian and Taiwan are four hotspot regions for relict genera diversity. These regions correspond to parts of China with the most humid winter and the shortest dry season. Early Cenozoic climates were also characterized by high humidity. Along with the global cooling of the Cenozoic, the drying trend also influenced the distribution of relict genera. Future climate predictions indicate shorter dry season in China: the distribution of relict genera may expand in response to the future climate change.

First oral session (O1-O4)

Mon. January 13
10:40-12:00 am

O3 | The First Fossil Fruit of *Burretiodendron* (Malvaceae s.l.) from the Late Miocene of Yunnan, China: Implication for its Conservation

Julie Lebreton ANBERREE

Palaeoecology Research Group, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences

The first fossil fruits of *Burretiodendron* Rehd. (Malvaceae s.l.) is described based on winged mericarps found in the Late Miocene deposits of Wenshan and Maguan (Yunnan, China). This finding demonstrates that this genus was already growing in south east Yunnan during the Late Miocene. It also represents the only fossil fruit of this genus found so far in the world. The fruit consists of an obovate mericarp, with acute base and rounded and possesses two wings with craspedodromous venation originating from the endocarp area, occasionally dichotomising and anastomosing. Endocarp is prominent and triangular, with acute base and rounded apex. Today, *Burretiodendron* (s.l.) is mainly found in limestone montane forest in Thailand, North Vietnam and SW China. Three species of this genus are included in the International Union for the Conservation of Nature (IUCN) Red List because of habitat loss and over-exploitation. During the last thirty years, the population number of *Burretiodendron* has dramatically decreased and it is now crucial to stop any further loss. Indeed, efforts in trying to cultivate this genus yielded plants that could not provide fruits, impeding its expansion. Moreover, once *Burretiodendron* has disappeared from a locality, the topsoil erodes, and prevents the restoration of the habitat to its previous state. Given that *Burretiodendron* is now known to have been endemic to Yunnan since at least the Late Miocene, special attention should be paid to its conservation.

First oral session (O1-O4)

Mon. January 13
10:40-12:00 am

O4 | Survival of Tertiary Relict Species in South-Central China, with Special Reference to Anthropogenic Activities

Yong-Chuan YANG[1], Cindy Q. TANG[2], Masahiko OHSAWA[2], Si-Rong YI[3], Arata MOMOHARA[4]

1. Faculty of Urban Construction and Environmental Engineering, Chongqing University, Chongqing 400045, China;
2. Institute of Ecology and Geobotany, Yunnan University, Kunming 650091, China;
3. Institute of Medicinal Plants Cultivation of Chongqing, Nanchuan 408435, China;
4. Graduate School of Horticulture, Chiba University, 648 Matsudo, Chiba 271-8510, Japan

The mountains bordering the Yangtze River valley of south-central China support an unusual ecosystem rich in paleoendemic species, the results of historical processes and environmental heterogeneity. Many Tertiary relict taxa grow in limited areas of south-central China in areas that are identified as glacial refugia. They are characterized by a number of phylogenetically primitive taxa exemplified by the Chinese living fossil plants *Metasequoia glyptostroboides* Hu & Cheng (dawn redwood), *Ginkgo biloba* L. (maiden hair), *Cathaya argyrophylla* Chun & Kuang (Cathay silver fir), *Davidia involucrata* Baill. (dove tree) and *Liriodendron chinense*(Hemsl.) Sarg. (Chinese tulip tree) etc.

A number of Tertiary relict trees occur in particular, unstable wet lower slopes and in stream valleys within the warm, humid transitional zone between the evergreen and the deciduous broadleaved forests. And these habitats highly overlapped with the human life zone. Land clearance and conversion to agriculture and plantation forestry have led to loss of actual and potential habitats in these areas, decreasing the chances of regeneration induced by natural disturbance. However, some traditional human land use, influenced by cultural values, such as created heterogeneous forest margins, roadsides, light gaps, bare forest floors etc., has supplemented infrequent natural disturbances, providing regeneration niches favorable for the Tertiary remnant species near villages in mountain valleys.

Thus, many Tertiary remnant species have survived through a kind of symbiotic relationship with the human population, while on uninhabited mountain slopes the species depends on natural disturbances to survive.

A2 Second plenary lecture

Mon. January 13
14:40-15:20 pm
Guo-Yi ZHOU

Prof. Guo-Yi ZHOU is the director of the Dinghushan Forest Ecosystem Research Station, South China Botanical Garden, CAS. His research focuses on the quantitative relationships between the structure and function of forest ecosystems on multiple scales. He was the leading contributor of the second prize for the National Science Achievement Award of China (2008).

Global Climate Changes on Land Surface Hydrological Processes and Their Consequent Effects on Reorganization for China's Biomes of Tropical and Subtropical Forests

Guo-Yi ZHOU

South China Botanical Garden, Chinese Academy of Sciences, Guangzhou 510650, China

Responses of hydrological processes to climate change are key components in the Intergovernmental Panel for Climate Change (IPCC) assessment. Understanding these responses is critical for developing appropriate mitigation and adaptation strategies for sustainable water resources management and protection of public safety. However, these responses are not well understood and few long-term experimental evidences are available. Here, we show how climate change (increased air temperature and storm intensity) can affect soil moisture dynamics and hydrological variables based on both long-term observation and model simulations using the Soil and Water Assessment Tool (SWAT) in an intact forested watershed in Southern China. Our results show that, although total annual precipitation indicated little change during the period of 1950 to 2009, soil moisture decreased significantly. A significant decline was also found in the monthly 7-day low flow and annual ratio of streamflow to precipitation in the past ten years. These significant decreasing trends on soil moisture and low flow variables suggest that the study watershed moves towards more droughty conditions. However, the maximum daily streamflow in the wet season and unconfined groundwater tables have significantly increased since the same past ten years. Our analysis indicates that the intensification of rainfall storms and the increasing number of annual no-rain days were responsible for the increasing chance of both droughts and floods. We conclude that that climate change has indeed induced more extreme hydrological events (e.g., droughts and floods) in Southern China. This study also demonstrated usefulness of our research methodology and its possible applications on quantifying the impacts of climate

change on hydrology in any other watersheds where long-term data are available and human disturbance is negligible.

There is evidence that climate change induced tree mortalities in boreal and temperate forests and increased forest turnover rates (both mortality and recruitment rates) in Amazon forests. However, no study has examined China's tropical and subtropical evergreen broadleaved forests (TEBF) that cover >26% of China's terrestrial land. The sustainability of this biome is vital to the maintenance of local ecosystem services (e.g., carbon sequestration, biodiversity conservation, climatic regulation etc.), many of which may influence patterns of atmospheric circulation and composition at regional to global scales. Here we analyze time-series data collected from thirteen permanent plots within China's unmanaged TEBF to study whether and how this biome has changed over recent decades. We find that the numbers of individuals and species for shrub and small tree have increased since 1978, whereas the numbers of individuals and species for tree have decreased over this same time period. The shift in species composition is accompanied by a decrease in the mean DBH (diameter at breast height) for all individuals combined. China's TEBF may thereby be transitioning from cohorts of fewer and larger individuals to ones of more and smaller individuals, which shows a unique change pattern differing from the documented. Regional-scale drying is likely responsible for the biome's reorganization. This biome-wide reconstitution would deeply impact the regimes of carbon sequestration and biodiversity conservation and have implications for the sustainability of economic development in the area.

Second oral session (O5-O11)

Mon. January 13
15:40-18:00 pm

O5 | The Late Early Pleistocene Climate Dynamic in Southern Primory'e (Far East of Russia)

Olesya V. BONDARENKO[1], Torsten UTESCHER[2,3], Nadezhda I. BLOKHINA[1]

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The Early Pleistocene climate dynamic in the Russian Far East (southern Primory'e) was obtained from a total of 8 macrofloras (woods, leaves, fruits and seeds,) and 18 microfloras collected from a 10 m thick, terrigenous succession exposed in the Pavlovskoe brown coal field. According to magnetostratigraphy, the studied section covers the last 200 kyr of the Calabrian and comprises the early/middle Pleistocene transition. In order to reconstruct the climate, multiple quantitative techniques (Growth Ring Analysis, Multivariate Anatomical Analysis, Leaf Margin Analysis, Climate Leaf Analysis Multivariate Program, and Coexistence Approach) were employed on the different organs, partly originating from the same layer. In order to measure the East Asian Monsoon intensity during the Early Pleistocene, various indices were calculated.

In the result, the climate data obtained from the various methods are proven to be largely consistent. The late Calabrian of the southern Primory'e was characterized by overall cooling and drying. Our climate record displays two small scale cycles. Warm peaks (at 19.4–19.8 and 14.0–14.8 m) are tentatively correlated to the global isotope stages MIS 25 and MIS 21, respectively. In the warm phases, the Calabrian climate of southern Primory'e was significantly warmer and wetter when compared to present, especially regarding the cold season while in cold phases, climate was similar to modern or event slightly cooler. As today, Early Pleistocene climate of southern Primory'e was warmer and wetter than neighbouring areas of the south Russian Far East. The effect of the East Asian Monsoon Systems on the climate of the southern Primory'e was less pronounced compared to present.

Second oral session (O5-O11)

Mon. January 13
15:40-18:00 pm

O6 | Evapotranspiration Decreases While Temperature Increases- A Yunnan Province Case Study

Axel THOMAS[1], Ze-Xin FAN[2]

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Of the two elements of the water balance - precipitation and evaporation - evaporation receives only limited attention. Under climatic warming condition it is generally expected that evaporation should increase. A large numbers of studies instead have shown that potential evapotranspiration (the combined effects of soil evaporation and plant transpiration) have decreased worldwide over the last decades. We use data from Yunnan Province to show how the meteorological elements solar radiation, wind, temperature and humidity act together to affect evapotranspiration rates. We demonstrate that declining sunshine duration and wind speeds and not increasing temperature govern evapotranspiration rates not only in Yunnan Province but on a global scale. Studies that rely on temperature alone to estimate evaporation rates in climate change studies will therefore lead to incorrect results. This has far reaching implications for research on drought and irrigation.

Second oral session (O5-O11)

Mon. January 13
15:40-18:00 pm

O7 | A Progress Reporting 2005-2013 of the GLORIA Climate & Vegetation Change Monitoring in NW Yunnan, China

Zhen-Dong FANG

Shangri-La Alpine Botanic Garden, Diqing Prefecture, Yunnan Province, China

From 2005 to 2013, under the cooperation of The Nature Conservancy, Missouri Botanical Garden USA, Vienna University Austria and Shangri-la Alpine Botanical Garden China, 17 permanent monitoring peaks have been built in 5 areas of NW Yunnan, such as Runzila Mt. and Meilishui Mt. of Deqin County, Daxueshan Mt. of Xianggelila County, Majiwa Mt. of Weixi County, Laojunshan Mt. of Yulong County. The monitoring and research of the project have been taken in accordance with the unified Gloria's methodology. Gloria is an abbreviation of Global Observation Research Initiative in Alpine Environments. From 2012 to 2013, a repetitive monitoring every seven years has been carried out, respectively in Daxueshan, Runzila and Majiwa Mts. And same monitoring will be made in Meilishui and Laojunshan Mts. in 2015. The monitoring has produced fruitful outcomes from vegetation, flora and temperature data. A research paper was published in 2009. Further analysis of data and outputs are still in progress.

Second oral session (O5-O11)

Mon. January 13
15:40-18:00 pm

O8 | Has Water-Use Efficiency of China's Old-Growth Forests Increased with Carbon Dioxide Concentrations in the Past Decade?

Zheng-Hong TAN[1,*], Gui-Rui YU[2], Yi-Ping ZHANG[1], Min CAO[1], Jun-Hua YAN[3], Shi-Jie HAN[4], Xiao-Bao DENG[1], Yun DENG[1], Wen-Jie LIU[1], Jian-Wei TANG[1], Sheng-Gong LI[2], Yue-Lin LI[3], Jun-Hui ZHANG[4], Qing-Hai SONG[1], Lei-Ming ZHANG[2], Hong-Lin HE[2], Wen SU[2], Jun-Fu ZHAO[1], Liang SONG[1]

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In the present study, we attempt to determine whether forest water-use efficiency (Wei) increases with atmospheric carbon dioxide concentrations ([CO2]) in tropical and subtropical regions by using long-term eddy covariance observations in three old-growth forests in China. We find a significant decreasing trend of Wei in subtropical forests and an increasing, but not significant, trend in tropical forests. Thus, the hypothesis that forest Wei increases as [CO2] rises in subtropical and tropical forests cannot be confirmed. Nevertheless, the hypothesis remains of interest, because the confounding effects of other environmental or biotic factors could not be ruled out. More data are needed to fully test the proposed relationship.
Keywords: CO2 fertilization, confounding effect, gross ecosystem production, evapotranspiration, water stress, solar radiation, subtropical and tropical forest.

Second oral session (O5-O11)

Mon. January 13
15:40-18:00 pm

O9 | Do the Rubber Plantations in Tropical China Act as Large Carbon Sinks?

Qing-Hai SONG, Zheng-Hong TAN, Yi-Ping ZHANG, Li-Qing SHA

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The regrowth of tropical secondary forests and plantations cannot offset the carbon release caused by tropical deforestation, consequently determining net carbon losses on tropical lands. However, large uncertainties remain in relation to this assumption. Here, we used a biometric method to estimate the net dry matter production and net ecosystem production in a rubber forest, the most widespread plantation type in tropical Southeast Asia. According to biometric estimates made during the study, the ecosystem was a carbon sink (790 gC m^{-2} yr^{-1}). Net ecosystem carbon fluxes were measured by the eddy covariance method. The carbon budget estimated using the FluxNet procedure (904 gC m^{-2} yr^{-1}) was closer to the biometric estimates in comparison to a method based on data measured during neutral atmospheric conditions. Overall, when considering the whole life cycle, including deforestation of the prior-existing tropical forest, the hypothesis of plantations serving as large carbon sinks is not supported by our study.

Second oral session (O5-O11)

Mon. January 13
15:40-18:00 pm

O10 | Managing Carbon Sinks in Rubber (*Hevea brasilensis*) Plantation by Changing Rotation Length in SW China

Nizami Syed MOAZZAM[1], Yi-Ping ZJANG[1], Li-Qing SHA[1], Wei ZHAO[1, 2], Xiag Zhang[1,2]

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Elongation of the rotation length in forest management has been highlighted in Article 3.4 of the Kyoto Protocol to help the countries in their commitments for reduction in greenhouse emissions. CO2 FIX model Ver.3.1 was used to analyse how the carbon stock of the rubber plantation in South Western China shows dynamics with the changing rotation age. To estimate the efficiency of increasing rotation length as an Article 3.4 activity, study predicted that the C stocks of the ecosystem increased with the increasing rotation (25, 30, 35, 40 and 45 years). When the rate of increase in each rotation was compared it was found that at the rotation length of 40 years the rate of increase is maximum 4.24 tC $ha^{-1}yr^{-1}$ comprising of 2.86 and 1.37 tC ha^{-1} yr^{-1} in both above and belowground C stocks respectively. The total C stocks in ecosystem after the end of first 40 years rotation was 169.98 constituting 114.79 and 55.19 tC ha^{-1} respectively from trees and soil. After elongation of 40 years rotation to four consecutive rotations it was pointed out that the total C stock of the ecosystem was 186.65 tC ha^{-1} comprising 114.79 t C ha^{-1} of tree biomass and 71.86tC ha^{-1} from soil. The longer rotation lengths showed comparatively increased C stocks in below ground C stock after consecutive four rotations. The application of computer model has not only effectively simulated the C stock of the forest ecosystem, but showed the dynamic of C sequestration in simulated periods. Therefore, the computer simulation is a relatively convenient, economical and effective method to estimate C stock of forest ecosystem of large-scale area. The study has developed carbon mitigation based on four rotation scenarios. The possible stimulated increase in C stocks of the entire ecosystem after consecutive long rotations indicates that emphasis must be paid on deciding the rotation of rubber plantation in SW China for reporting under article 3.4 of the Kyoto Protocol.

Second oral session (O5-O11)

Mon. January 13
15:40-18:00 pm

O11 | Elevation, Latitude and Fragmentation: Monitoring Forest Biodiversity in the Era of Global Anthropocene

Aki NAKAMURA[1,2], K. TOMLINSON[1], X. YANG[1], A. HUGHES[1], Y. SURGET-GROBA[1], C. BURWELL[2,3], R. KITCHING[2,1] and M. CAO[1,]

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3. Queensland Museum, South Brisbane, Brisbane, Queensland

Climate change is one of the most serious threats facing global biodiversity. Changes in temperature and humidity regimes are predicted to cause shifts in species' geographical ranges which may result in the extinction of species and destructive changes in ecosystem functioning. As part of the Queensland and Chinese Academy of Sciences Joint Biotechnology Project, we established a series of elevational transects spanning a range of latitudes in Yunnan province (China) and Queensland (Australia) to generate a baseline dataset describing the elevational distribution of invertebrates and plants. This is our first step to develop networks of sites in which forest biodiversity can be monitored to quantify the impacts of future climate change. Our current elevational transects, however, are located in relatively undisturbed forests away from anthropogenic disturbances. In the era of the global Anthropocene, we must consider the potential impacts of climate change in conjunction with other human disturbances. Forest fragmentation, for example, may reduce ecosystem resilience and habitat connectivity which is vital to enable species to shift (latitudinally and/or elevationally) their distributions in response to a changing climate. Here we provide preliminary results of our elevational surveys, and propose a new project which will incorporate fragmented forests and surrounding matrix habitats in the survey design. To make global predictions of the impacts of climate change, a variety of research bodies, including botanical gardens, must cooperate to conduct fully standardized surveys that generate data that can be shared and analyzed quantitatively.

A3 Third plenary lecture

Tue. January 14
9:00-9:40 am
Jian-Chu XU

Prof. Jian-Chu XU is a professor of Ethnoecology at the Kunming Institute of Botany, CAS. His research interests are the ethnoecology and human dimensions of global environmental change, including community-based conservation, land use/cover change, climate change impacts, and forest transitions and their implications for environmental service provision in mountain regions.

Plant Phenology and Climate Change: The Role of Botanic Gardens

Jian-Chu Xu[1,2]

1. World Agroforestry Center
2. Kunming Institute of Botany, Chinese Academy of Sciences

Plants are finely tuned to the seasonality of their ecosystems, particularly shifting climatic conditions that may lead to specific shifts in the timing of plant activities. Phenology has emerged as strong indicator for climate change studies. Researchers across disciplines have observed shifting phenology at multiple scales, including spring flowering in individual plants and spring green-up of vegetation revealed in satellite images. Using field observation, experiments and modeling approaches, scientists have sought to identify mechanisms causing these shifts and to make projections regarding potential consequences. Botanic gardens are important sites for such phenological studies. Gardens offer multiple resources: living collections and herbarium specimens, field observation sites, experimental growing conditions and networks of knowledgeable, multi-disciplinary researchers and staff spanning wide geographic areas. Botanical gardens have already contributed significantly to our understanding of biological responses to climate change, particularly the effects of temperature on the timing of flowering and leaf-out in China and elsewhere. Now is the time for more coordinated work. We can begin with greater cooperation among Chinese botanic gardens in phenology studies including data sharing, monitoring, and methodological development. Special attention is needed for field observations throughout China on the implications of climate change for horticulture, plant/fruit breeding and commercial crops. We can also work to build regional coordination between China and other botanic gardens across Southeast Asia.

A4 Fourth plenary lecture

Tue. January 14
9:40-10:20 am
Sara OLDFIELD

Dr. Sara Oldfield, with a career in international plant conservation spanning over 30 years, joined Botanic Gardens Conservation International (BGCI) as Secretary General in May 2005. Previously she worked as Global Programmes Director for Fauna & Flora International. Sara is also Chair of the IUCN/SSC Global Tree Specialist Group, responsible for promoting and implementing projects to identify and protect globally Red Listed tree species. She has published a number of research papers and books, the most recent of which is "Botanic Gardens: Modern Day Arks".

Conserving and Restoring Plant Diversity – A Response to Climate Change

Sara OLDFIELD

Botanical Garden Conservation International, 199 Kew Road, Richmond, TW9 3BW, UK

The Global Strategy for Plant Conservation (GSPC) of the Convention on Biological Diversity provides international policy relevance for the conservation work of botanic gardens. The 16 challenging targets of the GSPC were revised in 2010 to reflect the urgency of addressing climate change. In 2014 a mid-term review of the GSPC will be undertaken as part of an overall review of the Strategic Plan for Biodiversity. This paper will review progress towards the conservation and ecological restoration targets of the GSPC focusing on the work of botanic gardens. It will emphasise the importance of the plant resources, expertise and skills of the botanic garden community with relevance to new research priorities. Issues of climate change adaptation and mitigations will be considered. Linkages with GSPC targets on sustainable management of production lands will be addressed together with the need for botanic gardens to demonstrate the fundamental importance of plants to human welfare.

Third oral session (O12-O15)

Tue. January 14
10:40-12:00 am

O12 | Using Data from Botanic Gardens to Calibrate Predictive Models of the Effect of Climate Change on Species Distributions into the Future

Alice C.HUGHES

Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Menglun, Mengla, Yunnan 666303, P R China

Predictive models have become increasingly popular over recent years in attempts to project and understand the potential effect of environmental change on species distributions and diversity, yet they frequently fail to integrate species physiology and inter-specific interactions.
The range limits of a species are rarely solely a function of the species physiological tolerances, (except in the case of extreme environments) but instead reflect the relative fitness of an organism compared to other species in addition to biogeographic factors. As a result of this it is difficult to tell what species physiological threshold of environmental tolerance is to environmental conditions are, as they are excluded from areas which they could survive in due to competitive exclusion.

However the resources and facilities available in botanic gardens make it possible to examine the tolerance limits of plants, through a combination of growth trials under various conditions in addition to reciprocal transplant experiments. This provides insights into how relative fitness of different species varies under different conditions and thus allows future projections to be calibrated to better reflect the probable effect of environmental change on species distributions and diversity.

Third oral session (O12-O15)

Tue. January 14
10:40-12:00 am

O13 | Using the Common Garden Trees for Estimation of Water Use, Their Response to Climatic Factors and Implications for Climate Change

Zafar SIDDIQ[1,3] and Kun-Fang CAO[1,2]

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2. State Key Laboratory for Conservation and Utilization of Subtropical Agro-bioresources, and College of Forestry, Guangxi University, Nanning, Guangxi, China.
3. Department of Botany, Government College University, Lahore Pakistan

The purpose of present study was to characterize the water use by the trees in mature plantation of Xishuangbanna Tropical Botanical Garden (XTBG). Taking the advantage of tree's diversity in XTBG we continuously measured the sap flow of multiple individuals of twenty tree species from nine different families. The sap flow sensors were made following the Granier's design. The species were taxonomically divided into three groups i.e., Dipterocarps, Legumes and rest of the species (non dipterocarps and non-legumes). While based upon the leaf phenology we divided these same species groups into deciduous and evergreen. We analyzed the response of sap flow and its relationship with climatic factors like vapor pressure deficit (VPD) and solar radiation during the rainy season (June to September 2013). Our preliminary results suggest that the sap flow response to VPD was maximum by the group of rest of species followed by dipterocarps and the legumes, while on the basis of phenology the evergreen were showing more response than deciduous species. Regarding the response to solar radiations, legumes were showing the maximum response followed by the group of rest of species and dipterocarps were showing the least response. In case of deciduous and evergreen, deciduous species showed more response to solar radiation than evergreen species. Our data can provide useful insights for observing the species response to increasing drought in the future scenarios of climate change. It can also be useful for planning regarding the appropriate trees selection for forming.

Third oral session (O12-O15)

Tue. January 14
10:40-12:00 am

O14 | Water-Use Advantage of Lianas over Trees in Seasonal Tropical Forests

Ya-Jun CHEN[1,2], Stefan A. SCHNITZER[3], Ze-Xin FAN[1], Jiao-Lin ZHANG[1], Yong-Jiang ZHANG[1], Kun-Fang CAO[1]

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3. University of Wisconsin-Milwaukee, Milwaukee, Wisconsin, Department of Biological Sciences, PO Box 413,53201, USA

Lianas are increasing in abundance in the tropics, which is hypothesized to arise from a dry season growth advantage of lianas. However, this hypothesis has not been fully tested and the underlying mechanisms are poorly understood. In this study, we compared the water source constitution, whole-plant water use, gas exchange and leaf water status of 13 lianas and 12 co-occurring trees in the dry and rainy seasons in two types of rainforests and a common garden in southern Yunnan, southwestern China. Our results showed that both lianas and trees switched to use deeper soil water in the dry season in the karst rainforest and the ravine seasonal rainforest. However, lianas utilized a higher proportion of water from the deep soil profile than did trees. The physiological adjustment of lianas played an important role in the dry season. With strong stomatal control, lianas could maximize the carbon fixation at a lower vapor pressure deficit, and thus saving more water in the dry season. Relatively higher photosynthetic capacity enabled lianas to bear higher competitive advantages over co-occurring trees in the dry season. Furthermore, lianas had higher water transport efficiency than did trees, which could meet the transpiring demand due to their canopy proliferation and larger leaf area. Our results support the dry season growth advantage hypothesis. The more access of deep soil water and strong physiological adjustment capacity may explain the higher liana abundance in seasonally dry forests in tropics.

Third oral session (O12-O15)

Tue. January 14
10:40-12:00 am

O15 | Physiological Responses and Adaptations of Urban Garden Plants to Global Climate Change

Xing-Yuan HE, Sheng XU, Wei CHEN

State Key Laboratory of Forest and Soil Ecology, Institute of Applied Ecology, Chinese Academy of Sciences, 110016, China

Tropospheric O_3 levels are increasing parallel to CO_2 concentrations around urban areas, therefore, in the future urban garden plants will be simultaneously experiencing elevated CO_2 and O_3 levels. As a sample in Shenyang city, the physiological responses and adaptations of some garden plants to climate change by the simulation of elevated CO_2 and O_3 concentrations were studied in open top chambers (OTCs). *Ginkgo biloba*, *Pinus tabulaeformis*, *Quercus mongolica*, *Salix matsudana*, *Poplus alba* × *P. Berolinensis*, *Robinia pseudoacacia*, *Ligustrum obtusifolium*, *Syringa oblate*, *Poa pratensis*, *Trifolium repens* were fumigated from 2006 to 2013 by increasing CO_2 or/and O_3 in OTCs. Here, we reported visible injury, growth, photosynthesis, volatile organic compounds (VOCs) and antioxidative results of some garden plants under different gases fumigation. Our results showed that elevated CO_2 alleviated the adverse impacts of elevated O_3 on urban garden plants. It was a helpful response and active adaptation for most of urban plants to keep higher level in net photosynthetic rate, antioxidative enzyme activities, antioxidants contents under elevated O_3 than those under ambient O_3. Herbaceous plants were more O_3-sensitive than shrubs and trees. Symptoms of injury induced by elevated O_3 to different plants varied with gas concentrations, fumigation time, plant ages. These results will provide insights into physiological mechanisms of urban garden plants in response or adaptation to increasing tropospheric CO_2 and O_3, and further necessary selection for garden plants of northern cities in China under climate change.

A5 Fifth plenary lecture

Tue. January 14
13:40-14:20 pm
Stephen BLACKMORE

Prof. Stephen Blackmore was Regius Keeper of the Royal Botanic Garden Edinburgh from 1999 to 2013 and before this was Keeper of Botany at the Natural History Museum in London. His main interests are palynology, plant biodiversity, conservation and sustainable development. He is the Chairman of the UK Government's Darwin Initiative and Chair of Botanic Gardens Conservation International (BGCI). His recent books include "Gardening the Earth: Gateways to a Sustainable Future" (2009), "Green Universe: A Microscopic Voyage into the Plant Cell" (2012) and "Plants of China" (2103, jointly edited with Hong De-Yuan).

Climate Change – Where do Botanic Gardens Fit in?

Stephen BLACKMORE

Queen's Botanist and Honorary Fellow of the Royal Botanic Garden Edinburgh

This talk will examine the fundamental connections between plants and climate change emphasising the role of plants in mediating many of the processes that created and maintain the biosphere. It will explore the relationships between such factors as the rising global human population, changes in the vegetation cover of the planet and climate change including the increasing frequency of extreme weather events. Against the background of a global environment that is changing more rapidly than at any time in human histories, where do botanic gardens fit in? How is climate change likely to influence the research, collections, conservation and public engagement priorities for botanic gardens in the future?

A6 Sixth plenary lecture

Tue. January 14
14:20-15:00 pm
Richard B. PRIMACK

Prof. Richard B. Primack is a Professor of Biology at Boston University. His current research focuses on the impacts of climate change on flowering and leafing-out times of plants and the spring arrival of birds in Massachusetts, Japan, and South Korea, and the potential for ecological mismatches among species caused by climate change. Prof. Primack serves as Editor-in-Chief of the international journal Biological Conservation.

Opportunities for Botanical Gardens in Climate Change Research

Richard B. PRIMACK

Biology Department, Boston University, Boston, USA

Botanical gardens are in a unique position to investigate the biological responses to climate change by using the diversity of plants growing on their grounds and the surrounding areas. This approach can be even more powerful through using creative use of historical information and establishing international networks of botanical gardens. For the past 11 years we have been carrying out a climate change research program at the Arnold Arboretum of Harvard University with a variety of approaches. Using old herbarium specimens and photographs, it has been determined that plants are now flowering 10 days earlier than in the past. Stable isotope analysis of leaf samples from herbarium specimens and living trees shows that plants are not under more water stress now than in the past, though the density of leaf stomata is now lower. Experiments using twigs collected from the grounds show that invasive shrubs have lower winter chilling requirements than native trees and shrubs. Observations of leaf out times in spring and leaf color change and drop in the autumn are being used to characterize different species responses to a varying climate. This research program takes advantage of the diverse assemblage of species at botanical gardens, and is strengthened through international collaborations.

Fourth oral session (O16-O23)

Tue. January 14
15:20-18:00 pm

O16 | Climate Change and the Role of Botanical Gardens: Going Beyond the Safe House Concept

Rakan A. ZAHAWI

Wilson Botanical Garden & Las Cruces Biological Station, Organization for Tropical Studies, Costa Rica

In anticipation of the impending effects of climate change, one clear role for botanical gardens is to act as repositories for plant species that have limited geographical ranges, or for species that are endangered or threatened with extinction due to habitat loss. In addition to this more 'traditional' safe house role, however, larger botanical gardens that have well-developed infrastructure and staffing could play more proactive roles in quantifying climate change data and making it publically available, and in studying the potential impacts that climate change may have on the local vegetation. These tasks can be as simple as the precise collection and proofing of meteorological data, to the active encouragement and even participation in research projects that study some aspect of the impact of climate change on vegetation and way to combat or address the problem. In this presentation, I outline what the Wilson Botanical Garden (WBG) in southern Costa Rica is doing as a safe house for endangered plants and in terms of baseline data generation and management. I also highlight two research projects that are currently underway in the area whose establishment has been facilitated by the work of WBG.

Fourth oral session (O16-O23)

Tue. January 14
15:20-18:00 pm

O17 | Climatic Factors Influence Flowering Periodicity in the Seasonal Rainforest Trees of South-West China: A Comparative Phenology Study of Botanical Garden *vs.* Nature Reserve Forest

Dharmalingam MOHANDASS[1], Qing-Jun LI[1], Yong-Mei XIA[1], Xin-Sheng CHEN[1, 2], Xing-Fu ZHU[1], and Xiao-Bao DENG[1]

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2. Graduate University of Chinese Academy of Sciences, Beijing 100039, China

Studies of flowering phenology as compared with botanical garden and nature reserve forest would be an important tool to assess the impact of climate change. Thus, we examined flowering phenology for 195 woody tree species in the seasonal rainforest nature reserves (SRNR) of south-west China. Within the seasonal rainforests, two permanent plots phenology records were used, namely the 55 KM plot in Menglun (one-ha) and the Bubeng plot in Mengla (20-ha). We then compared the timing of flowering of these 195 woody tree species between SRNR and the long-term phenology records of Xishuangbanna Tropical Botanical Garden (XTBG) from 1963-2012 at five year intervals. Our results showed that seasonal annual flowering was predominant and regular at the species level in both SRNR and XTBG sites while irregular flowering was predominant at the community level in both one-ha and 20-ha plots. However, the XTBG flowering pattern showed that there was less irregular flowering even among trees of the same species compared with those we observed in SRNR plots. Thus, irregular flowering was significantly lower in XTBG than in SRNR sites. Because seasonal drought or low rainfall influences irregular flowering in the SRNR sites. However, in XTBG, seasonal drought did not show any significant impact on irregular flowering among tree community. In SRNR, flowering phenology was highly related to sun-related climatic factors rather than rainfall. It is therefore implied that flowering periodicity was stable and seasonal drought might not be influencing the irregular flowering in the Xishuangbanna Tropical Botanical Garden, southwest China.

Fourth oral session (O16-O23)

Tue. January 14
15:20-18:00 pm

O18 | The Effect of Soil Fauna on Litter Decomposition among Elevation Gradient in Subtropical Evergreen Broadleaf Forest, Southwestern China

Xiao-Dong YANG[1, *], Hai-Lang QING [1, 2]

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Soil fauna influence the decomposition and nutrient mineralization of leaf litter; however, the specific contributions of macro-, mesofauna diversity and activity to litter decomposition and nutrient mineralization, and their interactions with litter quality and diversity among elevation gradient require further study.

The aim of this field experiment was to quantify the contribution of soil fauna to four different elevation plant litter (litter from 2000m, 2200m, 2400m and 2600m, respectively) decomposition in these four elevation gradients forest sites under natural conditions in Ailao mountain, southwestern China. We conducted a survey of soil fauna communities, the forest floor litter and investigated mass loss of mixed tree species leaf litter which form each four elevation plot for one year in a evergreen broadleaf forest. Exclusion treatments of different sized soil fauna (macro, meso-microfauna) from the leaf litter by using varying mesh size litter bags (2 mm and 0.5 mm) were also performed. Mass loss and C and N concentrations in litter bag leaf materials were determined to address following questions: How do soil fauna communities vary across elevation gradient in subtropical evergreen broadleaf forest? What is the contribution of soil fauna to the decomposition of different plant litter form four elevation habits? How their contribution correspond to elevation change? What is the mechanism for regulating soil fauna function in different forest ecosystem across different elevation site?

We found that: 1)There was lower soil moisture (0-10cm) in 2000m elevation plot than in others, soil pH (0-10cm) decreased from 4.6 at 2000m to 4.3 at 2600m plots along elevation gradient in this forest; Microbial biomass C and N, soil fauna abundance showed opposite variation pattern among different elevation plots in dry and rainy season.

2) Soil fauna had no significant effect on both 4 kinds of plant litter decomposition at the higher elevation sites (2400 and 2600m), but exclusion of soil macrofauna decreased these four plant litter mass loss and decomposition rates at lower elevation sites (2000 and 2200m), reducing decomposition rates by one third on average. The contribution of soil fauna on plan litter decreased from 22% at 2000m to 3% at 2600m. These results demonstrated that soil fauna can alter decay rate in subtropical forests systems and has large pronounced effect on leaf litter which from high to low elevation; Furthermore, soil fauna play important roles in plant litter decomposition and C emission that are independent of climate and litter quality variables.

3) Litter quality and diversity, elevate environment and soil faunal all independently affected decomposition, but the magnitude depended upon site. Soil fauna diversity were regulate by litter diversity and quality because soil fauna guild have positive correlation with plant quality and diversity in subtropical forests. The contribution of soil fauna on C,N were influenced by litter quality, but litter diversity have more effect in subtropical evergreen broadleaf forest.

Fourth oral session (O16-O23)

Tue. January 14
15:20-18:00 pm

O19 | Conservation of Shade Plants Biodiversity under the Background of Climate Change——Studies on the Diversity of *Elatostema* (*Urticaceae*) from Karst Caves of Guangxi, China

Long-Fei FU[1], Ying LIU[1,2], Shi-Lian HUANG[1,2], Fang WEN[1], Yi-Gang WEI[1*]

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Habitat climatic variations effected the migration of shade plants to more suitable dwellings. In our study, we searched the karst caves of Guangxi and investigated populations of *Elatostema* using route survey methods. We also investigated the plant community using the quadrant method, while recording environmental factors and analyzing their influence on the diversity of species. The research added important information to the classification documents on *Elatostema* and add weight to the research on the need for the protection of shade plant biodiversity. The result showed: (1) 25 species (including varieties) of *Elatostema* distributed in karst caves of Guangxi, accounting for 35.71% of the population in Guangxi, and an additional 8 species only distributed in karst caves, accounting for 32% of the population, List and survival status were presented. (2) *Elatostema* includes two types, one is widespread in China which has lower habitat requirements and can adapt well, the other only distributed in karst caves due to migration since the original habitat has not survive, and they only gradually adapted here in a long-term evolution process. (3) Elevation changes led to the differences in plant communities. However, the species diversity index had no significant correlation with elevation changes, but did have significant positive correlation with cave opening areas. More and more caves were developed into tourist attractions or suffered from man-made destruction which endangered more plants and led to their extinction. Therefore, we need to make the conservation of caves with large openings a priority.

Fourth oral session (O16-O23)

Tue. January 14
15:20-18:00 pm

O20 | Global Warming and the Conservation of Gesneriaceae in China

Fang WEN[1, 2], Shi-Lian HUANG[1, 3], Yin LIU[1, 3], Yu-Zhen GE[1, 2], Yi-Gang WEI[1, 2]

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Global warming severely impacts the existence of plants, especially Gesneriaceae. The consequences: plant distribution areas are greatly reduced and the plants physiological functions are also disrupted, etc. To illustrate the situation, we chose Gesneriaceae [30 genera, 220 species (including varieties)] from Guangxi, South China as examples. We carefully tracked and assessed their existence status from 1993 to 2013. After determining the various measurements to be used to assess the criteria to determine their level of survival, we then quantified the endangered levels, and the importance of protection for Gesneriaceae species. The results showed that except for some anthropogenic factors, extreme weather events (e.g. extreme drought, extreme storm and its subsequent geological disaster) and severe changes of regional climate (e.g. warming effect) had a tremendous effect on the existence status of Gesneriaceae plants. For example, the distribution regions of *Oreocharis magnidens* Chun ex K. Y. Pan, *O. argyreia* Chun ex K. Y. Pan and *O.* × *heterandra* D. Fang & D.H. Qin have started to retreat from attitude ca. 1100 m to higher elevations, while at the same time, the flowering time has been postponed. All of these changes have provided additional data for research on endangered and rare Gesneriaceae and has also laid the foundation for follow-up studies on conservation (e.g. genetic diversity, *in situ* and *ex-situ* conservation). The Gesneriad Conservation Center of China (GCCC) was established by the Guangxi Institute of Botany (China) and the Gesneriad Society (USA) based on this aim.

Fourth oral session (O16-O23)

Tue. January 14
15:20-18:00 pm

O21 | Climate Change Adaptation Plan for Bangliang Gibbon Nature Reserve and Adjacent Communities

Hui-Ying Wu

Fauna & Flora International China Programe

The Bangliang Provincial Gibbon Nature Reserve (BNR) was established specifically for the conservation of Cao Vit Gibbbon (*Nomascus nasutus*). It is a flagship species of the subtropical karst forest ecosystem in southwest Guangxi, and is found in one of the 17 biodiversity hotspots in China. This area has experienced extreme weather, decreasing rainfall, increasing temperature and frequent drought in the past 15 years. The reserve and adjacent villages are especially vulnerable to drought because the whole area is lacking in surface water as rainfall drains quickly through the karst landscape. The data also shows that the annual temperature increased 0.13° per decade in the past 50 years in Guangxi. If these climate trends continue in Bangliang, the agriculture of local villages will be greatly impacted and could push the villagers to rely more heavily on the forest and NTFP products from the gibbon habitat which may further degrade the karst forest ecosystem. The gibbons may also suffer directly from the seasonal shortage of food supply due to the dramatic change of phenology of food trees.

The goal of this project is to build resilience of the biological diversity and ecosystem services underpinning the complex agricultural landscape in Bangliang Gibbon Nature Reserve and surrounding communities.

Steps of developing climate change adaptation plan include:

1. Prior to embarking on climate adaptation planning, please ensure there is a completed Situation Analysis for the project site
2. Identify vulnerabilities and the likely impacts of climate change at your project site
3. Improve understanding of vulnerabilities to biodiversity targets and how these may be exacerbated by the climate change. Explore initial adaptation responses.Research gaps in knowledge
4. Identify and prioritize climate adaptation strategies. Incorporate strategies into project plans
5. Action plan sharing with communities and other external stakeholders.

Fourth oral session (O16-O23)

Tue. January 14
15:20-18:00 pm

O22 | Influence of Elevated CO_2 in an Urban Area on the Leaf Secondary Metabolism of *Pinus tabulaeformis*

Zhou-li LIU，Xing-Yuan HE , Wei CHEN，Wei HUANG

State Key Laboratory of Forest and Soil Ecology, Institute of Applied Ecology, Chinese Academy of Sciences, Shenyang 110164, PR China

Carbon dioxide (CO_2) is the primary greenhouse gas emitted through human activities and cause climate change in urban area such as the heat island effect. In the present study, the influence of elevated CO_2 (700 μmol·mol^{-1}) on the leaf secondary metabolism of *Pinus tabulaeformis* was investigated by an open-top chamber experiment. In the short term (one growing season), it was shown that the content of starch, soluble sugar, soluble protein, tannins and total phenolics were increased with the increase of CO_2 concentration in needles of *Pinus tabulaeformis*, which indicated that the contents of secondary metabolites in *Pinus tabulaeformis* were increased. The increase of secondary metabolites will enhance the resistance of plant to environment stress. The study on the secondary metabolites of plant would be useful to have a better understanding for the effects of global change on tree physiology.

Fourth oral session (O16-O23)

Tue. January 14
15:20-18:00 pm

O23 | Labile Carbon Retention Compensates for CO_2 Released by Priming in Forest Soils

Na QIAO[1], Douglas SCHAEFER[1], Evgenia BLAGODATSKAYA[2,3], Xiao-Ming ZOU[1], Xing-Liang Xu[1,2], Yakov KUZYAKOV[2,3]

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3. Department of Soil Science of Temperate Ecosystems, University of Göttingen, Büsgenweg 2, Göttingen 37077, Germany

Increase of below-ground C allocation by plants under global warming or elevated CO_2 may promote decomposition of soil organic carbon (SOC) by priming and strongly affects SOC dynamics. The specific effects by priming of SOC depend on the amount and frequency of C inputs. Most previous priming studies have investigated single C additions, but they are not very representative for litterfall and root exudation in many terrestrial ecosystems. We evaluated effects of ^{13}C-labeled glucose added to soil in three temporal patterns: single, repeated, and continuous on SOC dynamics over 6 months. Total and ^{13}C labeled CO_2 were monitored to analyze priming dynamics and net C balance between SOC loss caused by priming and the retention of added glucose-C. Single addition induced more priming than repeated and continuous inputs. Therefore, single additions of available substrates may overestimate priming effects. The amount of added glucose C remaining in soil after 6 months was substantially higher than the C loss due to SOC decomposition caused by priming effect. This overcompensation of C losses was highest with continuous inputs and lowest with single inputs. Therefore, raised labile organic C input to soils by higher plant productivity will increase SOC content even though priming accelerates decomposition of native SOC. Consequently, higher continuous input of C belowground by plants under warming or elevated CO_2 can increase C stocks in soil despite accelerated cycling by priming in soils under subtropical and tropical forests.

Fifth oral session (O24-O29)

Tue. January 14
19:00-21:00 pm

O24 | The Observed Impacts of Recent Climate Change in Asia

Richard CORLETT

Center for Integrative Conservation, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Yunnan, China

Biological changes consistent with the trends in climate over the last 50 years have been widely reported in the northern half of Asia and at high altitudes, where rising temperatures have relaxed constraints on plant growth and the distributions of organisms. Few changes have been reported from tropical lowlands and none of these can be definitely linked to climate change. In humid temperate East Asia, phenological observations on plants and satellite measurements of 'greenness' (NDVI) show a trend to earlier leafing in spring since the 1980s, averaging 2 days a decade, although details vary between sites, species and periods. Earlier spring flowering and delayed autumn leaf senescence have also been recorded. Earlier greening has also been reported from the boreal and the Himalayan regions, but with spatial and temporal heterogeneity, and trends in semi-arid temperate regions and in Central Asia were also heterogeneous. On the Tibetan Plateau, spring growth advanced until the mid-1990s, but the trend subsequently differs between areas and NDVI datasets.
Satellite NDVI for Asia during the growing season shows a general greening trend (a rough proxy for increasing plant growth) in recent decades, except where water is limiting In East Asia, growth rates have generally increased with warming in areas where temperature limits tree growth, while where drought limits growth, there have been increases or decreases reflecting decreasing or increasing water stress. Changes in species distributions consistent with a response to warming have also been widely reported: either upwards in elevation or northwards. In the north and at high altitudes, trees are invading treeless vegetation and forest understories are being invaded from adjacent biomes. Permafrost degradation has been reported from parts of Siberia, Central Asia, and the Tibetan Plateau.

Fifth oral session (O24-O29)

Tue. January 14
19:00-21:00 pm

O25 | Policy Conflict between Forest Land Use and Climate Change

Himangana GUPTA[1], R.K. KOHLI[2]

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Climate change and biodiversity are considered two sides of the same coin. But climate change gets more attention in mainstream debate. The policies that have been ineffective in tackling climate change are considered the panacea for protection of biodiversity based on the argument that climate change is the major driver of biodiversity loss. However, the fact is that the same reckless industrialisation that has led to climate change has also brought us to the brink of sixth historical extinction. This paper attempts to show the negative impact of climate change policy on biodiversity through case studies of private sector forestry projects in India under the Clean Development Mechanism (CDM) of the Kyoto Protocol. Three 'reforestation projects' approved for planting Eucalyptus monocultures in the forest-rich Chhattisgarh, Odisha and Andhra Pradesh states of India have been selected for study. There is an abundance of academic literature that shows the disastrous impact of Eucalyptus plantations on biodiversity and total ecological economics. The study finds that the project areas have been declared as 'severely degraded' on flawed basis. The projects are on the lands owned by poor tribal people who have been weaned away from subsistence farming. This is an example of how the market based mechanisms of the Kyoto Protocol add to the pressure on biodiversity. The failure to ensure that climate initiatives are also biodiversity-friendly could inadvertently accelerate the major global extinction crisis and would also undermine the ability of the local people to adapt to climate change.

Fifth oral session (O24-O29)

Tue. January 14
19:00-21:00 pm

O26 | Vital Role of Clonal Integration in Canopy Rather Than Understory --A Case of Ferns

Hua-Zheng LU[1], Wen-Yao LIU[1], Shu-Gang LU[2]

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2. School of Life Science, Yunnan University

Clonal integration within clones often increases their combined performance, but the benefits of clonal integration vary among species and environments. The pattern and benefit of clonal integration has been widely studied on terrestrial seed plants, but little is known about that of rhizomatous ferns especially epiphytic ferns. Because the trade-off between the benefit of clonal integration and the cost of maintaining connections may be complicated by storage and anchoring functions of rhizomes of epiphytic ferns, it remains unclear whether there exists clonal integration within clones in stressful conditions.

We investigated the effects of connection severance on performance of individual ramets of a facultative epiphytic fern (*Phymatopteris griffithiana*). Meanwhile we explored the influence of different-size edge-severed plots on performance of plot- ramets of *P. griffithiana* in epiphytic and terrestrial habitats during dry and chilly winter. The severance of connection between ramets significantly affected survivorship, ratio of variable to maximum fluorescence (Fv/Fm), biomass conservation and plot population dynamics in both habitats in dry and cold non-growing seasons. The effect area of clonal integration was larger in epiphytic habitat than in terrestrial habitats. Epiphytic ramets benefited more from clonal integration than terrestrial ramets, and distal ramets benefited more than proximal ramets in epiphytic habitat.

These findings indicate that besides the storage and anchoring functions of rhizome, clonal integration plays an important role in surviving stressful winter and habitat adaptation for facultative epiphytic ferns, especially in epiphytic habitat. This may shed light on studies of evolution of epiphytism and ecological conservation of existing ferns.

Fifth oral session (O24-O29)

Tue. January 14
19:00-21:00 pm

O27 | Integrating the Importance of Novel Chemical Weapons and Adaptation in the New Ranges of a Tropical Invader

Yu-Long ZHENG

Key Laboratory of Tropical Forest Ecology, Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Kunming, Yunnan Province 650223, China

The evolution of increased competitive ability (EICA) hypothesis and the novel weapons hypothesis (NWH) are two non-mutually exclusive mechanisms for exotic plant invasions, but few studies have simultaneously tested their relative importance. Here, we explored these two hypotheses in the context of *Chromolaena odorata* invasions. In common conditions, *Chromolaena* plants grown from seeds collected from populations in the non-native range were better competitors than plants from the native range, either with or without the experimental manipulation of consumers. *Chromolaena* plants from the non-native range were also more poorly defended against aboveground insect herbivores. In contrast, *Chromolaena* plants from the non-native range were better defended against soil-borne enemies than plants from the native range. Despite their superior competitive ability, *Chromolaena* plants from the non-native range were not larger than those from the native range. However, *Chromolaena* plants from the non-native range produced higher concentrations of odoratin (a compound that appears to be unique to *Chromolaena*) and elicited stronger allelopathic effects on species native to China, the non-native range of the invader than natives of Mexico, the native range of the invader. Our results suggest that invasive plant species may evolve increased competitive ability after being introduced by increasing the production of novel allelochemicals, and decreased defense, potentially in response to escape from natural enemies. Our results emphasize the importance of integrating different mechanisms in studies of exotic invasion.

Fifth oral session (O24-O29)

Tue. January 14
19:00-21:00 pm

O28 | Phylogenic Patterns in Wood Decomposition: A Common Garden Experiment in a Botanical Garden

Gbadamassi G. O. DOSSA[1,2,3,4*], Ekananda PAUDEL[1,2,3,4], Kun-fang CAO[1,5], Douglas SCHAEFER[1], Rhett D. HARRISON[2,3,6]

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Assessing and predicting climate change impacts on ecosystems and ecosystem functioning remains a challenge. To address this, a deeper understanding of global carbon cycle is required. However, this requires a broad mechanistic understanding and long-term monitoring of different components of the cycle. This has been more or less achieved for photosynthesis, but respiration is less well understood. In addition, for most research projects there is a mis-match between the duration of funding cycles and the requirement for long-term monitoring. Botanical gardens provide an ideal institutional environment to conduct long-term experiments on diverse living collections using a common garden approach. At Xishuangbanna Tropical Botanical Garden we are conducting a long-term experiment on the role of phylogeny in the decomposition of coarse woody debris (CWD). CWD is an important terrestrial carbon pool contributing an estimated 10-20% globally, and can over 50% of the carbon is some forests. Using the garden's plant collections we sampled fresh wood from 25 species selected across the phylogeny of higher plants. These are being incubated in a patch of secondary rain forest within the garden, where they will be monitored for respiration and mass loss periodically. In addition to phylogeny we collected data on wood density, wood chemistry, and structural properties. Through the phylogenic approach we hope to produce a predictive model that can be used to calibrate CWD decomposition globally based on knowledge of forest composition.

Second oral session (O24-O29)

Tue. January 14
19:00-21:00 pm

O29 | "Age" and "Climate Shift" Effects on Long-Term Changes of Tree-Growth–Climate Relationships：A Case of Chinese Pine in Southern Northeast China

Teng LI[1,2] and Zhen-Ju CHEN[1,2,3*]

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To address how climate change influences tree growth under the background of global warming, the tree-ring growth response of Chinese pine *(Pinus tabulaeformis Carr.*) to climate was studied in Liaoning province, Northeast China. The study area is situated within a warm temperate zone on Mountain Qian. We explored the age effects and the long-term variability of tree growth–climate relationships in residual chronologies of Chinese pine using the evolutionary mode of bootstrapped response function method. Bootstrapped response functions calculated for the period of 1951-2010 for ca. 50, ca. 100 and ca. 200 year age class trees, respectively, confirmed that mean April precipitation is the most significant and a stable limiting factor of Chinese pine's radial growth. Our results show that the tree growth-climate relationships are generally consistent across age groups; no significant differences exist in tree growth-climate correlations between different age groups; the trees of 100-year and 200-year age class showed insignificantly responses to summer temperature since 1962; and the sensitivity of age effects of the tree growth to climate vary within regions or species. More studies focusing on multiple species sampling along different longitude, latitude and altitude gradients may provide better understanding of the climate–growth relationships within the background of global change.

A7 Seventh plenary lecture

Wed. January 15
9:40-10:20 am
Jennifer SCHWARZ

Jennifer SCHWARZ, Ph.D. is the Associate Vice President of Education at the Chicago Botanic Garden. Since joining the Garden in 2005, she has focused on educational equity and climate change education in formal and informal contexts. Most recently, she authored curricula that engage students ages 12-18 in investigating the impacts of climate change on plants, ecosystems, and human society. Her current interests include exploring how an asset based approach to community engagement can be used to support broad-based action around climate change mitigation and adaptation.

The Role of Botanic Gardens in Climate Change Education

Jennifer SCHWARZ

Chicago Botanic Garden, USA

As stewards of our global natural resources, botanic gardens have an unique opportunity, in fact an obligation, to ensure that the international community understands the impacts of climate change on ecosystems and on human civilization, and is motivated to act sooner rather than later to reduce carbon emissions and work towards climate change mitigation and adaptation strategies. This is particularly important in light of the political, social, and economic barriers to transitioning to a more sustainable model of development; the overall failure of the formal education system to even address the topic; and the absence of strategy by which we effectively prepare young people to address future challenges. Despite strong global and national networks, access to corporate and political leaders, and an immense global visitor-ship, botanic gardens collectively have not taken a leadership role in climate change education to date. This talk is a call to action for botanic gardens to leverage their strengths, develop a consistent and comprehensive message around climate change, and work collaboratively to educate and advocate at all levels for a viable, sustainable future.

Sixth oral session (O30-O35)

Wed. January 15
10:40-12:40 am

O30 | Climate Change Education in Chinese Botanical Gardens: An Educator's Perspective

Guang-Yu LIU, Zhen YANG, Wei-Zhe ZHANG, Jin CHEN

Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, Menlun Mengla, Yunnan 666303, China

Botanical gardens (BGs) are comprehensively connected with climate change, not just in plant collection, flora conservation and scientific research, but also in public education. Every year millions of people visit BGs in China, which makes BGs are ideal place to undertake climate change education (CCE). Without doubt, BG educators' perception and attitude are particularly important for CCE carried out, which was almost unknown for Chinese BGs. Based on an environmental education training course in Xishuangbanna Tropical Botanic Garden on September 2013, we assessed the CCE situation from the BG educators' perspective, also analyzed the possible reasons affect the education program in China. Totally 46 educators from 21 BGs answered the questionnaire survey, we found that most educators believe, worry and concern the increasing climate change, affirm the CCE's significance in BGs (Mean>4). However, very few CCE activities were developed in Chinese BGs in the last decades (Mean<3), even the climate change researches were carried out broadly in China. Possible barriers for BG educators to do CCE are lack of reasonable knowledge, financial support and direct experience on climate change research programs (Mean<3).

Sixth oral session (O30-O35)

Wed. January 15
10:40-12:40 am

O31 | Gardens by the Bay: Creating Awareness of Climate Change

Kenneth ER, Boon Gee NG

Gardens by the Bay, 18 Marina Gardens Drive, Singapore

The Botanic Gardens Conservation International's agenda for botanic gardens give emphasis to how botanic gardens worldwide could address climate change. Beyond research and conservation of plant species susceptible to climate change, botanic gardens should seek ways to raise public awareness of climate change. To achieve this, botanic gardens must continue to attract visitors as choice leisure destinations with strong educational content. Increasingly, this has been a challenge in view of the competition from other leisure attractions and the advent of digital media in the internet age.

Gardens by the Bay (GB) is a collection of 3 waterfront gardens in Singapore's Downtown (Bay South, Bay East and Bay Central). Complementing the Singapore Botanic Gardens, GB focuses on applied botany and horticulture. Opened recently in July 2012, Bay South Gardens was designed to cater to those who do not normally go to gardens, while incorporating a rich layering of botanical and horticultural collection and content.

Visitor comfort in a warm, humid and wet tropical climate outdoor environment was addressed through careful landscaping guided by climatic studies and land sculpting, and the provision of helter and shade. A series of horticultural -themed gardens was curated to reflect the cultural and ethnobotanical association between plants and people in Singapore and the region. The tropical rainforest is presented in its deconstructed form with its botanical components. This was a first step towards understanding the cultural affinities to plants and the importance of plants in the proper functioning of the tropical ecosystem.

Incorporated strategically into the Gardens were the Conservatories and SuperTrees, which provided the "wow" and conditions to present the plant world in a compelling way that reflected the impact of Man's activities, especially climate change on our ecosystems. The Conservatories (Flower Dome and Cloud Forest) simulated cool dry and cool moist conditions to allow the display and flowering of plants from the Mediterranean-type and Tropical Montane regions in the world, which are highly impacted by climate change. These garden arks under glass were

sustained by a suite of energy-efficient building technologies and cooled using electricity generated from horticultural waste from the Gardens and elsewhere in Singapore. This energy cycle was used to further illustrate the carbon cycle in nature.

The SuperTrees were inspired by the dominant trees in the tropical rainforest and supported a vertical garden of epiphytes, ferns and flowering climbers. Just as trees capture solar energy to sustain their life functions via photosynthesis, the SuperTrees were itted with photovoltaic cells to harness solar energy. This was used to power the lighting of the SuperTrees. The SuperTrees have become architectural icons, and illustrated the importance of trees as carbon sinks in the mitigation of climate change.

The Gardens is a prime example of how landscape design, architecture, engineering, botany and horticulture could be integrated to create optimal conditions for visitors and plants. Through this integration, the cycles in nature, the importance of plants to the functioning of the ecosystem and Man's affinity and impact to plants could be better appreciated.

Sixth oral session (O30-O35)

Wed. January 15
10:40-12:40 am

O32 | Making Climate Change Education Effective

Sophie WILLIAMS

School of Environment, Natural Resources and Geography, Bangor University

Environmental education is often promoted as a way of increasing knowledge about biodiversity loss and climate change. This is based on the assumption that changing knowledge will influence attitudes, and translate into behaviour change. However, evidence to support this is lacking. I will present the 'lessons learned' from carrying out environmental education research in botanic gardens. The climate change rhetoric often leaves individuals feeling powerless and too small to make any contribution to change. In this talk I will highlight how positive messages can stimulate greater impact on behaviour. Using models from social psychology such as the theory of planned behaviour, I will demonstrate why it is important to communicate messages that increase personal self-belief and empowerment, in addition to increasing knowledge.

With over 2500 botanic gardens around the world these institutions are ideally placed to communicate science to the general public. There is increasing focus on the social role of botanic gardens with emphasis on broadening community engagement with botanic gardens. By communicating practical approaches for people to adapt to climate change botanic gardens can contribute to influencing peoples' behaviour and increase community participation with botanic gardens. I will conclude by outlining the importance of environmental education evaluation to assess the effectiveness of our programmes and to inform best practice.

Sixth oral session (O30-O35)

Wed. January 15
10:40-12:40 am

O33 | An International Plant Sentinel Network

Ellie BARHAM[1], Suzanne SHARROCK[1], Charles LANE[2], Richard BAKER[2]

1. Botanic Gardens Conservation International, 199 Kew Road, Richmond, TW9 3BW, UK
2. The Food and Environment Research Agency, Sand Hutton, York, YO41 1LZ, UK

The increasing globalisation of trade in plants and plant material, together with the impacts of climate change, has led to a recent increase in the introduction and spread of new and damaging plant pests and diseases. Botanic gardens are in a unique position to help detect potential invasive threats to a country's plant health; within their collections they play host to numerous expatriate plants that can act as sentinels for potentially invasive pests. The International Plant Sentinel Network (IPSN) is being established as part of a European-funded (EUPHRESCO) project led by the UK's Food and Environment Research Agency (FERA). The project will be implemented in collaboration with Botanic Gardens Conservation International (BGCI) and with partners in Europe (Julius Kühn-Institut, Germany, National Plant Protection Organisation, Netherlands and DiBAF, Italy). The network will facilitate collaboration amongst institutions in Europe and beyond, with a focus on linking botanic gardens and arboreta, National Plant Protection Organisations and plant protection scientists. This presentation will describe the aims of the project, including improving the ability of garden staff to identify alien plant pathogens and diseases, by seeking best practice, developing standardised approaches and providing training materials and methodologies for monitoring and surveying. It will also aim to provide professional diagnostic support that can help promote early detection and rapid response to new pest incursions. The network will build on data already available through a number of databases, including BGCI's Plant and GardenSearch databases and CABI's Crop Protection, Forestry and Invasive Species Compendia.

Sixth oral session (O30-O35)

Wed. January 15
10:40-12:40 am

O34 | Networking Botanic Gardens for Conservation – the Role of BGCI's Databases in a Time of Global Change

Suzanne SHARROCK[1], Abby HIRD[2], Meirion JONES[1] and Adam SMITH[3]

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3. Center for Conservation and Sustainable Development, Missouri Botanical Garden, POB 299, Saint Louis, MO 63166, USA

An important objective of BGCI is to promote and link the plant conservation work of botanic gardens around the world. In support of this, BGCI maintains two publicly accessible databases – GardenSearch and PlantSearch. These databases are linked and all records are updated and edited by the gardens themselves. GardenSearch includes information on over 3,000 gardens, providing details on the collective conservation and research resources available within the global botanic garden community. PlantSearch is the only global database of plants in cultivation in botanic gardens (over 1 million records), with links to global and national Red Lists and other relevant data. PlantSearch aims to connect scientists, conservationists, and educators to ex situ collections. It also provides an invaluable monitoring tool for assessing the number of threatened plants in ex situ collections (Target 8 of the Global Strategy for Plant Conservation). BGCI's databases are increasingly being used to provide data for studies related to climate change. For example, one on-going study is examining the potential for botanic garden to provide a network for the 'chaperoned' assisted migration of species in response to climate change, while another has focused on identifying rare species in botanic garden collections where mean annual temperature conditions that are several Centigrade degrees warmer than those within their natural distributions. This presentation will introduce the databases and discuss their ongoing and potential uses to support plant conservation in a time of global change.

Sixth oral session (O30-O35)

Wed. January 15
10:40-12:40 am

O35 | Singapore Botanic Gardens and Climate Change: Some Preliminary Measures

Elango VELAUTHAM

Singapore Botanic Gardens, No 1 Cluny Road, Singapore

Singapore Botanic Gardens (SBG) occupies 74 hectares within 71610 hectares of land in Singapore. Within Sundaland, Singapore's tiny size would almost have to surrender to extreme climate change dynamics without much resistance. However, in anticipation of climate change, the accumulative impacts, when subtle can be monitored and environmental variables studied to shape the future of not just SBG but other botanic gardens too. Weather stations are critical in documenting temperature, humidity, wind speed and other data within the Gardens and efforts are under way to explore this long-term. Aerial documentation using 3D-modelling is also being proposed to capture high-resolution imagery of tree canopies using Unmanned Aerial Vehicles (UAVs) to study relationships between above-canopy data and under-canopy data from weather stations. This, pitched against decades of data collected by National Environment Agency (NEA) of Singapore would provide baseline information for comparisons in the future. Similar studies can be initiated in collaborations with other botanical gardens, rainforests and even green urban areas, which could be useful in decision-making at regional and global levels in mitigating climate change. Regional collaborations are critical, especially for Singapore, where surrounding nations can come together, creating a robust and well-buffered environment against long-term impacts of climate change. SBG aims to lead such collaborations with neighbouring countries in biodiversity, conservation, environmental education and research with climate change in mind. There is great pressure on SBG in land-scarce Singapore, and this pressure can only intensify with current trends in biodiversity loss, especially when climate change fully descends upon us.

Poster session (P1-P16)

Tue. January 14
13:00-13:40 pm

P1 | Characteristics of Carbon Cycle and the Effect of Carbon Sink in Karst Ecosystem

Chun-Lai ZHANG, Qiang Zhang, Jian-Hua CAO*

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Carbonate rock is the basic material of karst ecosystem, and its formation in geological era has an important role on the atmospheric CO_2 decreasing, about 99.5% of the carbon in the earth is sealed in carbonate rock; Karst ecosystem is characterized as rich calcium, alkaline, impacting carbon cycle: carbonate rock is the sedimentary rock deriving from clean ocean, its acidic insoluble matter is usually less than 10%, which lead shortage of the soil resources in karst area, therefore the total amount of limestone soil carbon in karst area is small. The high calcium makes more organic carbon stocked in shape of the slow and recalcitrant carbon pools, and improves the stability of limestone soil organic carbon. The proportion of underground biomass of vegetation in karst area may increase, because of shortage of soil resources, nutrients and water resources, the ration of underground/above vegetation biomass in the karst can be got to 30-50%, higher than non-karst area. The high content of HCO_3- in karst water stimulates the photosynthesis of aquatic plants, inorganic carbon can be converted to organic carbon, this process improves the stability of the carbon in water flow. This paper try to clarify the state, migration and transformation of carbon in the interface of system of carbonate rock-soil-vegetation-atmosphere- water in karst ecosystem, meanwhile put forward the approaches to promote karst processes and carbon sequestration.

Poster session (P1-P16)

Tue. January 14
13:00-13:40 pm

P2 | Tree-ring Based PDSI Reconstruction from AD 1804 for Hasi Mountain, Northwestern China

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A 206–year chronology was developed using *Pinus tabulaeformis* (Chinese Red Pine) tree–ring data from Hasi Mountain in northwestern China. On the basis of a correlation analysis between tree–ring width and climate data, a June–July PDSI series from AD 1804 to 2009 was reconstructed. The PDSI reconstruction showed that periods of wet years occurred in AD 1804–1805, 1868–1867, 1887–1895 and 1948–1952, whereas dry periods occurred in AD 1926–1932, 1990–1992 and 2005–2006. The period between AD 1808 and 1860s with a dry condition corresponds with the third cold sub–period of the Little Ice Age. The years AD 1926–1932 are the driest period in the reconstruction, coinciding with records from documents, missing rings and other reconstructions based on tree ring data. Four significant cycles with periods of 2.3, 2.6, 3.4 and 68 yr were found by spectral analysis in the reconstruction, and the high–frequency cycles of 2.3, 2.6 and 3.4 yr are related to Quasi–Biennial Oscillations and El Niño–Southern Oscillation. Significant correlations were found between the reconstruction and NINO3.4 index, the East Asian summer monsoon index and the South China Sea summer monsoon index, suggesting the drought variability in the study area have associations with large–scale ocean–atmosphere–land circulation systems.

Poster session (P1-P16)

Tue. January 14

13:00-13:40 pm

P3 | Distinguishing Nitrous Oxide Production from Nitrification and Dinitrification from Intramolecular Site Preference in N_2O Isotopmers

Fu-Li FANG

Institute of Environment and Sustainable Development in Agriculture , Chinese Academy of Agriculture Science

Nitrous oxide (N_2O) is an important greenhouse gas in which the single biggest anthropogenic source is agriculture. The applications of nitrogenous fertilizers enhance the microbial processes, which produced N_2O via nitrification and denitrification. The application in intramolecular distribution of 15N within the NNO molecule, which revealed a preference for the 15N/14N ratio at the cenral(α) or terminal (β) nitrogen position , express in this study as $\delta^{15}N^{\alpha}$, $\delta^{15}N^{\beta}$ and site preference (sp= $\delta^{15}N^{\alpha}$ - $\delta^{15}N^{\beta}$), at natural abundance levels, has the potential to characterize microbial pathways. Nitrous oxide trace gas samples overflowed in situ field in Drab Fluvo-aquic soil in the North China Plain from four fertilization categories :(1) urea,(2) kalium nitrate fertilizer,(3) organic manure,(4)organic manure combined with urea,(5) no fertilizer. The statistically different $\delta^{15}N^{bulk}$ emission weighted average among the treatments ,which include urea (-12.06‰±8.61‰), kalium nitrate fertilizer (3.12‰±1‰), organic manure (5.48‰±1‰), organic manure combined with urea (-9.32‰±6.45‰), no fertilizer (5.32‰±0.97‰)suggest that the $\delta^{15}N^{bulk}$ data are useful for distinguishing N_2O fluxes from different kinds of fertilization.

Based on SP values , which were reported for denitrification (-5 to 0‰), hydroxylamine oxidation(nitrification) and fungal denitrification(33~37‰), we found that the site preference of N_2O produced under different fertilizer: urea(14.9‰±5.44‰), kalium nitrate fertilizer(15.84‰±6.97‰), organic manure(15.0‰±7.77‰), organic manure combined with urea(14.95‰±7.35‰), no fertilizer (15.53‰±6.64‰), respectively, were not significant different between each other, indicating no influence of each substrate on site preference. Site preferences of ~14.9‰ to 15.84‰ are characteristic of combined effect of both nitrification and denitrification.

Poster session (P1-P16)

Tue. January 14
13:00-13:40 pm

P4 | Genetic Diversity Plays an Important Role for Species Growth to Face Climate Change

Huan NGUYEN

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Genetic diversity plays an important role in the survival and adaptability of a species. When a populations habitat changes, the population may have to adapt to survive. The ability of populations to cope with this environmental challenge depends on their capacity to adapt to their changing environment. The variation in the populations gene pool provides variable traits among the individuals of that population. These variable traits can be selected via natural selection and ultimately leading to an adaptive change in the population, allowing it to survive in the changed environment. If a population of a species has a very diverse gene pool then there will be more variability in the traits of individuals of that population and consequently more traits for natural selection to act upon to select the fittest individuals to survive.

High genetic diversity is also essential for a species to evolve. Species that have less genetic variation are at a greater risk. With very little gene variation within the species, healthy reproduction becomes increasingly difficult, and offspring are more likely to deal with problems such as inbreeding. The vulnerability of a population to certain types of diseases can also increase with reduction in genetic diversity.

Poster session (P1-P16)

Tue. January 14
13:00-13:40 pm

P5 | Effect of Long-Term Throughfall Exclusion on Soil Moisture and Soil Temperature in a Tropical Rainforest in Xishuangbanna, Southwest China

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Global warming has increased the frequency and intensity of drought events during last decades. To access the effects of drought on soil moisture and soil temperature, we conducted a throughfall exclusion experiment to simulate the drought stress in a tropical rainforest, and measured the soil water content and soil temperature for 3 years. The results showed that the seasonal patterns of soil moisture and soil temperature were not affected by longtime rainfall decrease. However, compared with the control group, the soil water content decreased distinctly as the throughfall was reduced by half. More specifically, although the absolute quantity of soil moisture in rainy season is higher than that in dry season, there was no differ between the decrease pattern of soil water content in dry season as well as in rainy season. As time went on, the effect of throughfall decrease on soil moisture became more and more distinct. The decreasing rate of soil water content increased from -3.2% to -22.0% in dry season, from -12.3% to -18.5% in rainy season, and from -10.2% to -20.0% for a whole year. While the effect of throughfall decrease on soil temperature was not significant, with a slight decrease pattern.

Poster session (P1-P16)

Tue. January 14
13:00-13:40 pm

P6 | Response of Fruit Phenology in China to Climate Variation and Change

Liang GUO

Kunming Institute of Botany, Chinese Academy of Sciences, World Agroforestry Centre, East-Asia Node

Climate change has affected plant phenology throughout the world, but few studies have evaluated climate responses of fruit trees in East Asia. In particular, the response of tree phenology to warming during different parts of the year has not been explored. We evaluated long-term records of chestnut first flowering, leaf coloring and length of the growing season from Beijing, China. Phenological dates were related with daily temperatures, using Partial Least Squares regression. For each phenological indicator, regression results identified two relevant phases, during which temperatures were correlated with event timing or growing season length.

First flowering dates in Beijing advanced by 1.6 days per decade, whereas leaf coloring showed no significant trend. The growing season expanded by 4.3 days per decade. First flowering was advanced by high temperatures between January and June, but delayed by warm conditions during the chill accumulation phase. Leaf coloring was advanced by warm conditions during most of the growing season, but delayed by high temperatures in fall. Variation in the length of the growing season was strongly correlated to variation in spring phenology.

All phenological indicators of chestnut appeared to respond to high temperatures during certain parts of the growing season in a way that ran counter to currently dominant effects. These secondary temperature responses may explain responses of certain plants that are not in line with general trends of advanced spring and delayed fall phases. It seems possible that the importance of these effects may increase as warming continues.

Poster session (P1-P16)

Tue. January 14
13:00-13:40 pm

P7 | Evolutionary Increases in Defense during a Biological Invasion

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Invasive plants generally escape from specialist herbivores of their native ranges but may receive serious damage from generalists. As a result, invasive plants may evolve increased resistance to generalists and tolerance to damage. To test these hypotheses, we carried out a common garden experiment comparing 15 invasive populations with 13 native populations of *Chromolaena odorata*, including putative source populations identified with molecular methods and binary choice feeding experiments using three generalist herbivores. Plants from invasive populations of *C. odorata* had both higher resistance to three generalists and higher tolerance to simulated herbivory (shoot removal) than plants from native populations. The higher resistance of plants from invasive populations was associated with higher leaf carbon content and densities of leaf trichomes and glandular scales, and lower leaf nitrogen and water contents. Growth costs were detected for tolerance but not for resistance, and plants from invasive populations of *C. odorata* showed lower growth costs of tolerance. Our results suggest that invasive plants may evolve to increase both resistance to generalists and tolerance to damage in introduced ranges, especially when the defense traits have low or no fitness costs. The greater defenses in invasive populations may facilitate invasion of *C. odorata* by reducing generalist impacts and increasing compensatory growth after damage has occurred.

Poster session (P1-P16)

Tue. January 14
13:00-13:40 pm

P8 | Growth Response of Sabina *tibetica* to Climate Factors along an Elevation Gradient and its Climatic Implications in South Tibet, Western China

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We examine the climate significance in tree-ring chronologies retrieved from *Sabina tibetica* Kom. (Tibetan juniper) at two sites ranging in elevation from 4124 to 4693 m above sea level (a.s.l.) in the Namling region, south Tibet. The study region is under the control of semi-arid plateau temperate climate. The samples were grouped into high- and low-elevation classes and standard ring-width chronologies for both classes were developed. Correlation analyses showed that radial growth in *S. tibetica* at the study sites was controlled by similar climatic factors, regardless of elevation; these factors comprised early winter (November) and early summer (May–June) temperatures as well as annual precipitation (July–June). The abundant precipitation through the year may have masked variations in tree growth on different elevation aspects. Based on tree grow/climate analysis, an annual (July–June) precipitation series from A.D.1485 to 2010 was reconstructed. This is the first well-calibrated precipitation reconstruction for the Namling region in south Tibet. Relatively wet/dry periods above/below the average were identified. Both the dry and wet intervals contemporaneously occurred in the southern and south-central Tibet on decadal scales, reflecting contemporaneous regional climatic variations. Power spectrum analysis reveals significant cycles at 141a, 94a, 70.5a, 56.4a, 3.7a and 3.6a over the past 526 years. Spatial correlation patterns between the reconstructed precipitation and NCDC v2 SST field were examined, where significant negative correlations between the reconstructed precipitation and the eastern Pacific Ocean were indicated during the 1956–2010, suggesting a teleconnection with large atmospheric circulation, such as ENSO.

Poster session (P1-P16)

Tue. January 14

13:00-13:40 pm

P9 | Light Use in Relation to Carbon Gain in Five Dominant Tree Species of the Different Stages of the Subtropical Forest Succession in South China

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To test our hypothesis that in the succession process, late-succession species have (1) the highest light-use efficiency (LUE) under low-light environment and (2) the greatest capacity for regulating light-energy utilization and dissipation, we tested tree species which included a pioneer species *Pinus massoniana*, medium-succession species *Schima superba* and *Castanopsis fissa*, and late-succession species *Cryptocarya concinna* and *Acmena acuminatissima*, all of which occur in Dinghushan subtropical forest, South China. Under the experimental irradiance gradient (100%, 30% and 12% of full sunlight), *C. concinna* and *A. acuminatissima* exhibited more effective photosynthetic regulation, and they showed relatively lower photosynthetic capacity (A_{max}), light compensation point (LCP), light saturation point (LSP), maximum rate of RuBP carboxylation (V_{cmax}), but a relatively higher apparent quantum yield (AQY). Under the three irradiance gradients, *P. massoniana* had the highest A_{max}, LCP, and LSP, but the lowest AQY. Contrary to our expectation, *S. superba* and *C. fissa* showed the highest LUE under 12% of full sunlight. Consistent with Part 2 of our hypothesis, *C. concinna* and *A. acuminatissima* had the largest xanthophyll pigments pool and de-epoxidation state (DEPs) under 100% of full sunlight; besides, they demonstrated relatively higher DEPs under 12% of full sunlight. Our results indicated that higher shade-tolerance and more effective photosynthetic regulation in late-succession species account for their successful replacement in forest succession.

Poster session (P1-P16)

Tue. January 14
13:00-13:40 pm

P10 | Exploring the Potential Strains for Wheat (*Triticum aestivum L.*) Inoculation Through Characterization and Identification using 16S rRNA Gene Sequencing

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Plant growth promoting rhizobacteria (PGPR) are capable to reduce the use of chemical fertilizers and reduce input cost of farmer. This study aimed to investigate and evaluate inoculation effect of indigenous rhizospheric bacteria on growth and yield of wheat (*Triticum aestivum L.*) under in vitro and in vivo condition using different treatments. Ten potential strains were selected on the bases of their ACC deaminase activity, sidrophore production, P-solubilization and production of indole acetic acid (IAA). Further these strains were tested in three different experiments (growth chamber, pot and field). We found significant increase in crop growth response to the inoculants in comparison with un-inoculated control. In pot and field trial we tested PGPR with recommended dose of inorganic fertilizers. The results of our study revealed that inoculation of bacterial strains with wheat seeds significantly increased plant growth and improve crop yield. Our results imply that these strains could be employed in different combination and we get higher yield in case of half recommended doses of inorganic fertilizers along with consortium of strains in compare with sole application of recommended dose of fertilizer and along with consortium of strains. These strains were further identified by 16Sr RNA gene, fatty acid profile and biolog. We concluded that indigenous microorganisms have more potential and it contributes in good crop quality and sufficient yield when they are applied in combination and also have potential with reverence to reduce the rate of inorganic fertilizers.

Poster session (P1-P16)

Tue. January 14
13:00-13:40 pm

P11 | A Tree-Ring Based Temperature Reconstruction for the Kaiduhe River Watershed, Northwestern China, since A.D. 1680: Linkages to the North Atlantic Oscillation

Tong-Wen ZHANG[1,2,3], Yu-Jiang YUAN[2*], Yu LIU[1*], Wen-Shou WEI[2], Rui-Bo ZHANG[2], Feng CHEN[2], Shu-Long YU[2], Hua-Ming SHANG[2], Li QIN[2]

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September–March mean temperature has been reconstructed back to A.D. 1680 for the Kaiduhe River watershed on the southern slope of the Tien Shan Mountains, China, using the *Picea schrenkiana* tree-ring width. The reconstruction explains the variance of 47% in the observed mean temperature from 1953 to 2011. Power spectral and wavelet analyses demonstrated the existence of significant 50-year and 2- to 7-year cycles of variability. The results of the spatial correlations suggest that our reconstruction contains climatic signals for Central Asia. Warm periods occurred during 1696–1708, 1730–1748, 1784–1804, 1832–1855, 1892–1903, 1924–1928, 1937–1943, and 1987–2006; while the periods of 1685–1695, 1709–1729, 1749–1783, 1805–1831, 1856–1891, 1904–1923, 1929–1936, and 1944–1986 were relatively cold. The significant correlation coefficient between our reconstruction and the temperature reconstruction for the Urumqi River source reveals that the temperature variations in the annual cold period for the southern and the northern slope of the central Tien Shan Mountains are roughly synchronous over the last nearly 300 years. A comparison between our reconstruction and three winter North Atlantic Oscillation indexes revealed similar long-term trends.

Poster session (P1-P16)

Tue. January 14
13:00-13:40 pm

P12 | The Phenophase Response of *Calligonum* L. in Turpan Eremophytes Botanic Garden to Temperature Change in Recent 29 Years

Yan-Fan ZHAO[2], Wei SHI[1], Bo-Rong PAN[1], Lin-Ke YIN[1], Rui-Xia LIU[1]

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2. Xinjiang Agricultural University，Urumqi 830052，China

Using the temperature data of Turpan from 1977 to 2006 offered by the Xinjiang Uygur Autonomous Region Meteorological Information Center， we investigated the effects of temperature change on the Phenophase of *Calligonum* L.. The results showed that: the average temperature trended to be warmer at a rate of 0.71 ℃ per decade in the studied area，the annual average temperature in Turpan has risen 2.06 ℃ in recent 29 years; in the past 29 years，the phenology of Sect. *Medusa* Sosk.et Alexandr of *Calligonum* L. was the latest; the beginning of leaf discoloration of Sect. *Calliphysa* (Fisch.et Mey.) Borszcz was later than Sect. *Pterococcus* (Pall.) Borszcz; however，as to the other 3 phenological period，the phenology of Sect. *Calliphysa* (Fisch.et Mey.) Borszcz was the earliest，the Sect. *Calligonum* and Sect. *Pterococcus* (Pall.) Borszcz were in middle. *Calligonum* L. in bud-expansion and beginning of leaf extension was mostly ahead of the trend，the beginning of leaf discoloration and beginning of leaf fall delayed; the bud expansion of *Calligonum* L. showed a significantly negative relationship ($p < 0.05$) with the annual average temperatures and the spring temperatures; a 1 ℃ rising of the annual average temperature may make the bud-expansion of Sect. *Calliphysa* (Fisch.et Mey.) Borszcz advance 4.5 d，Sect. *Medusa Sosk*.et Alexandr 4.3d，Sect. Calligonum 4.1d，Sect. *Pterococcus* (Pall.) Borszcz 8.3 d, respectively；beginning of leaf discoloration and beginning of leaf fall did not change significantly; the advancing of bud-expansion phenophase response to temperature was greater than that of beginning of leaf discoloration and beginning of leaf fall.

Poster session (P1-P16)

Tue. January 14
13:00-13:40 pm

P13 | The Research Progress of Lotus Genetic Breeding in China

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This article briefly introduced the progress of lotus genetic breeding in recent three decades in China . The progress consists of several points as follows : gather lotus resources , study lotus genetic basis and model , and adopt kinds of breeding methods including artificial cross breeding, distant hybridization , polyploid breeding, spatial (the firmament)breeding , radioactive (irradiation)breeding, ion implantation breeding , selection breeding and so on .

P14 | The Conservation of Zingiberaceae in Lao PDR.

Keooudone SOUVANNAKHOUMMANE

Pha Tad Ke Botanical Garden, Luang Prabang , Lao PDR

Surveys and collections of the Zingiberaceae plants have been undertaken between 2011 and 2013 in many provinces of the southern, central and northern parts of Laos. The total living collection number of ginger species obtained during this field study was 214, and among these only 54% (i.e. 76 species) were identified, while the remaining 46% need to reach the flowering stage to be identified. Up to now, the whole living collection is grown in the nursery in the Pha Tad Ke Botanical Garden for future planting of a Zingiberaceae garden for conservation, research and educational activities.

Poster session (P1-P16)

Tue. January 14
13:00-13:40 pm

P15 | Botanical Gardens and Climate Change in Myanmar

Yi-Yi HAN

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Climate change has emerged as one of the most crucial environmental challenges of the 21st century. It mainly threatened livelihood of rural people with limited adaptive capacity as well as fauna and flora. For addressing climate change, Myanmar Governmental organizations as well as Non-governmental organizations are being implemented capacity building programme, REDD plus, awareness raising, community forestry plantations, agroforestry to recover degraded areas of climate change. Myanmar is endowed with a unique set of plant resources, possessing about 12,000 vascular plant species. Nowadays, plant conservation is being interested by scientists in order to combat climate change to some extent. Botanical Gardens also play a vital role for recreation, education the public and to realize the values of plants, and conserving rare and endangered plant species. It can contribute a laboratory for the botanists, florists, researchers and students. In Myanmar Ministry of Environmental Conservation and Forestry established National Kandawgyi Garden in 1915. Trees of 514 local and 75 exotic species, 410 local medicinal plants, more than 300 orchids and 75 crotons and 75 bamboo species are conserved for supplementary to the existing taxonomic collections. Besides, climate change can seriously affect the timing of flowering and leaf-out that may face difficulties in management. Myanmar is still limited the number of Botanical Garden. Establishing and promoting numbers of Botanical Garden is urgently needed for the conservation and protection measures for endangered plant species (e.g. Agarwood (*Aquilaria agallocha* Roxb) and their habitat sooner than later before they disappear due to climate change.

Poster session (P1-P16)

Tue. January 14
13:00-13:40 pm

P16 | Research on Plant Endophytic Fungi Infection for Improve Wheat Drought Resistance

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As a new microbial resource Endophyte Fungi is being widespread concerned. Endophytic fungus are commonly found in gramineous Plants. And a range of adaptations of endophytic fungi - plant symbionts to biotic and abiotic stress has been identified, such as drought resistance. Endophytic fungi induce mechanisms of drought resistance in infected gramineous plants are clearly understood. Endophytic fungi inducing gramineous plants improve drought resistance mainly through a series of physiological and biochemical reaction to achieve , the accumulation and translocation of assimilates, affect the osmotic regulation substances , maintaining cell wall elasticity, affect the antioxidant protection system, and affect the growth of plant root and leaf, regulating stomatal opening and closing .The objective of this experiment was to assess the benefits of endophyte infection on drought stress tolerance of wheat. Seeds of Wheat (zhongmai-175) were exposed to heat treatment in bath (43℃15min, zhen 57℃35min) and then place on flowerpot that full of soil to get LI(low infected) plants. And the plots were fully watered two days before the experiment started. When to grow three-leaf stop water supply, began to twice drought stress and use the endophytic fungi which was separated from grass to infect the half part of the wheat plants to form a control group. So far, the experiment is still going on and the data and results need further collect and analysis.

USEFUL TO KNOW

There are no banks or ATMs in Menglun that accept foreign bank cards and nowhere that you can pay with a credit card or change foreign currency. If you do not have a Chinese bank account you need to bring sufficient Chinese cash for your stay. The nearest banks that can deal with international accounts are in Jinghong, an hour's drive away.

In January, mornings tends to be cool and foggy, and afternoons warm and sunny. Rain is not expected but is not unknown.

All participants should wear their name tags to enter the Garden and at mealtimes.

Transport will be provided between the hotels and the symposium venue, the XTBG Conference Hall, in the eastern part of the Garden. Alternatively, it is about 40 minutes' pleasant walk from the town, over the suspension bridge and through the Garden, or about 20 minutes from the XTBG hotel.

All meals will be provided at the XTBG canteen near the Conference Hall. You can also buy food in Menglun, which has many restaurants, two coffee shops (near the suspension bridge), an interesting farmers' market, and two supermarkets.

Most staff and students in the Research Center speak English and will be pleased to answer any queries.

For questions about hotels, food, transportation, medical services, and security, please contact Ms. Wei ZHANG, mobile number: 18666860906.

For questions about the symposium program, and other issues, please contact Ms. Chun-Yan FANG, mobile number: 18988119212.

Hotel telephone numbers:

XTBG Hotel: 86-691-8715043 (fax), 8717008

Cui Xin Yuan Hotel: 86-691-8715711

MAPS

Map of XTBG Research Center

Map of Menglun Town

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