XTBG

Proceedings of the 2nd Xishuangbanna International Symposium

BIODIVERSITY CONSERVATION

Research Imperatives for Scientific Institutions

Xishuangbanna, 1-2 January 2009

Hosted by Xishuangbanna Tropical Botanical Garden Chinese Academy of Sciences

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WELCOMING REMARKS

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CHEN Jin

Xishuangbanna Tropical Botanical Garden,CAS

Honored Guests, Ladies and Gentlemen,
Good afternoon!

I would like to extend my warmest welcome again to all distinguished guests and scholars, on behalf of Xishuangbanna Tropical Botanical Garden of the Chinese Academy of Sciences. We are so glad that all of you have joined us to attend this wonderful gathering for the 2nd Xishuangbanna International Symposium, during the 50th Anniversary of Xishuangbanna Tropical Botanical Garden, CAS.

The 1st Xishuangbanna International Symposium on "Biodiversity Conservation and Sustainable Development" held here 10 years ago in 1999, have led to a series of actions in the Greater Mekong Subregion including the implementation of a biodiversity conservation corridors initiative, which was endorsed by the Asian Development Bank. While progress has been made, much work remains to be done. Effective conservation actions will require long-term commitment from a wide range of stakeholders, including scientists, policy makers, concerned citizens, and the general public.

Research institutions enjoy the possibilities to provide scientifically sound and biologically relevant insights and answers to the many questions

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confronting human society. However, scientists generally enjoy using their own "language" and often have difficulty expressing themselves in plain and simple terms, therefore their important message can not be easily understood by everyone. A great deal of valuable information, relevant to biodiversity conservation, remains locked up and hidden away in the academic literature. Additionally, policy makers in many countries often exclude scientists from the decision process, for various reasons. How can scientific institutions do a better job of communication and more directly influence the policy making process? On the other hand, most applied conservation projects are carried out by NGOs, while scientists at research institutions assume these efforts are not appropriate for rigorous study. Often research projects are performed in parallel with applied projects with little interaction between the two. Mechanisms are required for the development and implementation of conservation programs that integrate both perspectives and approaches. How can scientific institutions become more actively involved in conservation actions? Finally, With the rapid development of new technology such as high resolution satellite imagery, DNA Bar-coding, next-gen sequencing, super computing capacity, and the integration of global networks of long-term monitoring data, what will be the best strategy for implementing these new technologies and databases to conserve biodiversity?

The 2nd Xishuangbanna International Symposium still features on Biodiversity Conservation, specifically on research imperatives for scientific institutions. We will review the progress made by scientific institutions in biodiversity conservation, and anticipate future conservation scenarios with technology advancement, therefore to build closer linkages between science and action. We will engage in informative discussion, with each participant contributing his/her knowledge and expertise. I am certain that this Symposium will achieve valuable results, and strengthen connections among us.

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.

AND, happy New Year to you all.

Prof. CHEN Jin, PhD
Director-General
Xishuangbanna Tropical Botanical Garden, CAS

1 January 2009, Xishuangbanna

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Priya Davidar

Association for Tropical Biology and Conservation: Asian-Pacific Chapter

Colleagues, Professors,
Thank you very much, Xiexie !

I am happy to be attend the 50th anniversary of the Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences and to participate in the Xishuangbanna International Symposium II titled: Biodiversity Conservation: Research imperatives for scientific institutions.

I must congratulate the XTBG for developing a world class botanical garden and research facility for tropical biological sciences within a short span of 50 years. The XTBG was established with vision to serve the community with a scientific approach. It has accomplished its goal of carrying out research at global standards and also to establish a good network among the local communities that will lead to their economic and cultural development. This is certainly a model for other research institutions in tropical countries.

I have known Prof. Dr. Jin CHEN and other scientists at XTBG for many years now. Prof. Dr. Jin CHEN and his excellent team of scientists and staff

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have been instrumental in developing XTBG into a world-class institution. Prof. Dr. Jin CHEN has been very active in the Association for Tropical Biology and Conservation (ATBC), serving as its councilor, and also being one of the founders of the Asia-Pacific chapter of ATBC. XTBG has helped to establish ATBC in Asia, provided financial support and helped create a network of Asian tropical biologists.

We wish the XTBG and Prof. Dr. Jin CHEN our congratulations for their accomplishments and onto greater achievements and growth.

Dr. Priya Davidar
President
ATBC Asian-Pacific Chapter
Professor and Dean, Pondichery University, India
1 January 2009, Xishuangbanna

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SU Ronghui
Bureau of Life Science and Biotechnology, CAS

Distinguished Guests, Ladies and Gentlemen,
Good afternoon!

It is my great pleasure to extend a sincere welcome to all of you who are participating in the 2nd Xishuangbanna International Symposium, being held here at the beautiful and elegant botanical garden.

Plant is one of the most important resources that human being depend on. Under such dramatic global climate change, effective conservation of plant diversity has become a pressing issue we have to face to.

The Chinese Academy of Sciences has paid great attention to the *ex situ* conservation and the works on botanical gardens. 50 years ago, we established this botanical garden in Xishuangbanna, for the conservation of the plant resources in the region with the richest biological diversity in China. 50 years from then, Xishuangbanna Tropical Botanical Garden has become one of the most important institutions in plant *ex situ* conservation, with plants species over 12,000 in its respective living collections.

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How to preserve the valuable plant resources effectively? And how to make research institutions more relevant to biodiversity conservation actions? It is valuable for us to pay much effort on these issues The symposium held here provided a platform for us to review, discuss and anticipate future conservation scenarios with technology advancement, therefore to build closer linkages between science and action.

On behalf of the Bureau of Life Science and Biotechnology, Chinese Academy of Sciences, I would like to thank you all for your presence and your support to the garden.

I sincerely hope the symposium succeeds and all the participants enjoy staying in the beautiful garden.

SU Ronghui

Deputy Director
Bureau of Life Science and Biotechnology, Chinese Academy of Sciences
1 January 2009, Xishuangbanna

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Joachim Gratzfeld

Botanic Gardens Conservation International (BGCI)

Distinguished scientists, ladies and gentlemen,

I feel very privileged to be able to participate in this Second Xishuangbanna International Symposium in conjunction with the celebration of an extraordinary half century of achievement by the Xishuangbanna Tropical Botanical Garden of the Chinese Academy of Sciences.

I would like to start my opening remarks by expressing BGCI's sincere gratitude to Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences and its Director, Prof. Jin Chen, as well as his dedicated team of distinguished scientists and students, for so generously and hospitably welcoming us in this beautiful venue of fabulous biological and cultural diversity. A special thank you also goes to Ms Fang Chunyan for so incredibly well organizing the logistics and administrative arrangements for the symposium.

The title and themes to be debated during the coming two days could not be more appropriately chosen in terms of timeliness and significance. Biodiversity

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Conservation: Research Imperatives for Scientific Institutions reminds us – the natural science community – of the vital importance and responsibility we have not only in aiming at excellence in science and research, but also in facilitating the application of scientific findings to conservation policy and – ultimately – practical conservation action on-the-ground. Still all too often, amazing discoveries and research results – especially from the plant kingdom – do not make it as forceful headlines into our various media channels, and end up in publications on bookshelves collecting dust, or nowadays are stored and locked in electronic databases and/or loaded on to the internet. Although the interested reader may ultimately find the information that he or she is looking for, targeted dissemination of scientific research findings using appropriate styles and jargon is lacking. As a result, scientists, policy makers and conservation practitioners often talk past each other in their own jargons and use of terms – a communication challenge that becomes even more compounded by the diversity of languages and dialects spoken from international to local levels.

While the international debate on global climate change has helped accelerate awareness of environmental challenges and biodiversity conservation issues facing society over the last 15 years, the scope to communicate the importance of maintaining plant diversity as the key pillar of functional ecosystems remains colossal. And who else other than botanic gardens and affiliated research institutions are the places to represent and stand for this expertise and raise the profile on the importance of maintaining and conserving plant diversity and biodiversity in its entirety? The role of botanic gardens in a globally changing world is changing too, but a key function and niche of botanic gardens remains untouched or becomes even more accentuated – interpreting and translating the scientific evidence base to guide policy formulation and inform practical conservation action.

The global plant community, if you allow me to call it so, led by the botanic gardens, has made a major step towards this endeavour of linking knowledge gained from research, policy formulation and conservation action. The Global Strategy for Plant Conservation adopted by the Parties to the Convention on Biological Diversity in 2002 has now been widely accepted as trend-setting for such an integrated approach. Developed through a multi-stakeholder consultation process including scientists as well as policy and decision-makers, the target-oriented outcomes formulated in this strategy aimed at being achieved by 2010 serve now as a model for the development

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and implementation of other programmes of work of the Convention. Alongside with its botanic garden members and partners – more than 800 in number – Botanic Gardens Conservation International has been instrumental in supporting the development and implementation of this global framework for plant conservation, be it through support to the development of national responses, policies and advocacy activities, or through practical conservation action on the ground.

BGCI is particularly proud to be associated with the development and implementation of the national response to this global strategy in China. In fact, it was here at Xishuangbanna Tropical Botanical Garden, when at the international conference on botanic gardens and sustainable development in 2004, the outline of a national agenda for botanic gardens was prepared incorporating the 2010 targets for botanic garden contributions in China to the Global Strategy for Plant Conservation.

Earlier in 2008, the China Strategy for Plant Conservation was launched with the support from the United Kingdom and BGCI. This document is a model of joint work between three major environmental institutions in China, the Chinese Academy of Sciences, the State Forestry Administration and the State Environmental Protection Agency. Their vision in developing China's Strategy for Plant Conservation is highly commendable, and it is one of BGCI's major tasks to continue to support China's commitment to plant conservation over the coming years – a significant task – with China's plant diversity accounting for more than 10% of the world's flora.

In fact, BGCI's association with botanic gardens in China spans already over many years, starting initially with activities in support of national training courses held in major centers such as in Beijing, Wuhan, Guangzhou, Shenzhen, Shanghai and Xishuangbanna in plant conservation, environmental education, medicinal plants conservation and sustainable use, botanic garden interpretation and many other subjects. Today we are very happy to collaborate with many gardens and their affiliated research institutions in practical conservation programmes focusing on integrated ex and in situ conservation measures for rare and threatened groups of plants such as species of magnolias and maples, or species with equally uncommon and curiously sounding names – perhaps even to scientists let alone policy and decision makers – such as *Bretschneidera sinensis* or *Dipteronia dyeriana*.

Any here lies also one of our conservation challenges ahead for botanic gardens, in times of rapid environmental change and degradation,

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we need to develop pragmatic approaches to conserving habitats and species. But which ones should come first? The rarest, crop wild relatives, species of vital economic importance? It is difficult to make choices and focus on selected species especially for botanists who have put heart and soul into the cause of maintaining biodiversity in its entirety. And it is even more challenging to identify research priorities in the context of the enormous scope remaining to identify and describe the still unknown diversity, make predictions about the future of biodiversity and develop related conservation measures. I would like paraphrase here the former US secretary of defense Donald Rumsfeld, not because I am particularly fond of his ideas – on the contrary, but because his 'Rumsfeldian triplicity theory' of the 'unkown unknowns' has become proverbial and is almost ingenius in its complexity and enmeshment – 'We know many unknowns, but it is the unknown unknowns (the ones we don't know we don't know) we must prepare for'.

Be this as it may, by having chosen this theme for this symposium, Xishuangbanna Tropical Botanical Garden continues to show its commitment to tackle the biodiversity conservation challenges of our time with a very forward looking perspective aiming to anticipate future scenarios of conservation with advances in technology and scientific research to improve the links between science, conservation policy and action. I am sure this symposium will assist in identifying priority areas of work in view of the approaching cut-off date set by the international community – the 2010 Biodiversity Target, and will help pave the way for developing a set of interesting and inspiring recommendations and activities to continue our efforts to biodiversity conservation and sustainable use of the goods and services derived from our biological heritage.

Thank you!

Joachim Gratzfeld
Director of Regional Programmes
Botanic Gardens Conservation International (BGCI)
1 January 2009, Xishuangbanna

Biodiversity conservation in the era of technology advancement

14:00-17:30 Thursday, 1 January 2009

Chairman:
Prof. Dr. Theodore H. Fleming
Emeritus Professor of Biology, University of Miami, USA

14:00-14:45 The 'IBISCA' approach: large scale international collaborations - a vital tool for future biodiversity studies
Prof. Dr. Roger Kitching
Faculty of Environmental Sciences, Nathan campus, Griffith University, Australia

14:45-15:30 DNA barcoding in plants - from genes to genomics in the conservation of tropical biodiversity
Dr. W. John Kress
National Museum of Natural History, Smithsonian Institution, USA

15:30-16:00 Coffee Break and Poster

16:00-16:45 Biodiversity conservation in global change
Prof. Dr. Xu Jianchu
World Agroforestry Center

16:45-17:30 Scaling up: using technology to extrapolate from plot-based studies for the regional planning of biodiversity conservation
Prof. Dr. Richard Corlett
Department of Biological Sciences, National University of Singapore, Singapore

The 'IBISCA' approach: large scale international collaborations -- a vital tool for future biodiversity studies

Prof. Dr. Roger Kitching
Faculty of Environmental Sciences, Nathan campus, Griffith University, Australia

Greetings to Xishuangbanna tropical botanical garden for the 50 anniversary, and thank the organizers of the symposium for been so sensible for our participants. What I would like to talk about today is ways in the sense of the essence of collaboration. I've learned from the Xishuangbanna people the word collaboration and I would like to tell you a particular style of collaboration that I have been involved in over the last years. I hope my pictures have showed shortly a few minutes ago. I'd like to say we call this approach IBISCA approach. This was because the original programme of this coop kind that was based in Panama which is called Investigating the Biodiversity of Soil and Canopy Arthropods, and that has the IBISCA in English, French and Spanish. However, I must add that we have now generalized it to be a short time for the approach we're taking in general. So we have been investigated like most studies in BETA diversity the way in which species diversity changes from place to place, either within patches of the same ecosystem or from ecosystem to ecosystem. It is

essentially a comparative approach and in a sense to be contrasted with the gradual accumulation of knowledge, the herbariums, which are particularly interested in total diversity, not only ALPHA diversity, because BETA diversity has been the basis for more or less one extrapolations about global diversity. But we found it more useful as a basis for generating hypothesis about the processes underline ecosystem function and the maintenance of biodiversity. It is also an essential tool for monitoring. This is the management connection that will be dwelling on. Of course monitoring is an essentially comparative process to have things changed.

This slide is to remind me to remind you that unlike most of you, I am not a botanist but an entomologist. When I speak of diversity I am talking essentially about arthropod, the insects and their relatives. This is a enigma in concerned with the biodiversity of arthropods. First of all, there are millions of them. We won't debate how many million but an awful lot. Many of them are undescribed. There are additional numbers of taxonomists may or may not set out to help we ecologist. However, they are to rescue biodiversity in terms of talking about species number and cost other distinguished ecologist efforts that give many many ecological processes. However, arthropods studies and biodiversity studies are very slow to product and taxonomic restricted and mutually, partly for those reasons, been ignored in policy management. Let me just give you an example of this. I was privilege to come to Xishuangbanna in 2004 as a guest of the academy to study botany diversity in a field course over a 5-6 week period. I uncovered an astonishing diversity of lots of species that eyes have not seen anywhere in the world, including tropical rainforest in the neo-tropics and Borneo. I was concerned with contrasting diversity on Live Stone rainforest compared with those on Arubean. Sadly, that work is still to come to product for a lot of reasons. Fieldwork is easy and enjoyable, but life for lab is much more drawback. I am sure you also have the same of a million of things to do. Particular problem in this case is the relevant taxonomic introduce in Chinese. But, this is the problem for me, not for you. This was an individual that I took on without particular collaboration. I am glad to say this to my host. We are willing to participate and do whatever they do best on those plots often within the course of 12-month period. This involved with an international band of scientists in each of the 4 IBISCA projects that have taken place. It is highly collaborative, relatively short term, and ultimately we hope to produce synthesis because we are dealing with a bunch of data sets, which will actually collect simultaneously on a common

set of sites rather than the usual way of seeking synthesis which is drew together from many studies. We are generally speaking we are carrying that with other purposes in mind. These have been four of these projects so far. The first was in Panama which we compare what was going on in the grand zone in the lower rainforest with what was going on in the canopy. This was followed then by the Queensland responsible for organizing. There was a short project in the Pacific Garden of Panama too, which was for altitudinal transect, particularly concerned with the idea of trying to figure out how climate represented by adjacent altitudes changes biodiversity. There is another one going on in the central France, which is looking at the impacts of different long historical periods of different forest management on biodiversity. IBISCA-Queensland project which I have been responsible for developing and running is about altitude, diversity plants, arthropods, vertebrates, and climate change. Of course I do not need to tell this audience climate change is the key environmental management issue. We are all going to face it the rest of our careers, the rest of our lives. It is happening. It will affect biodiversity, and will have an impact on the community level. It can certainly only be managed, if can be managed at all, if we can monitor biodiversity changes which are going on in response to that.

So I have already gone through the importance of arthropods form my point of view. Let me just talk a little about monitoring. Monitoring is part of every management plan you ever come across, every national strategy or international strategy. However, despite of that, it is actually seldom done when you talk about biodiversity. It has to be a comparison with some baselines. This I believe is, great tasks for we biodiversity scientists to generate those baselines against which future change can be assessed. The monitoring programme should be rationally designed. So we set out to device some rational monitoring based on multiple taxa and on a formal baseline study of adjacent climate. That was the argument that led to the IBISCA-Queensland project and also plants along the subtropical rainforest gradient. We set out to develop biodiversity tools which can be used subsequently for detecting the taxa climate change, and to do this integrative continuous subtropical rainforest gradient locating 2 hours drive from the central of Brisbane over a thousand meter altitude range. That maybe not seem like much in a country possesses the great chunk of Himalayas, but a thousand meters altitudinal range in Australia is a lot. As far as I can see, looking at altitudinal transects is the only way to study climate change right now. Well-addressed altitudes can be taken to represent adjacent climates. Indeed, in

some actually monitoring of climate on these five altitudes we have examined that does impact fortunately. This is about one-degree average differences but every 200m alleviation changes.

Our project is testing hypothesis about species turn over then along these gradients. We have along the way established permanent monitoring transects based on 20 botanical surveys and also biodiversity inventory locally within Australia about geographic hot spots. We produced all sorts of material. It also has been enormously invaluable exercising collaboration in capacity building for volunteers and students and in the public communication of science. We established 5 locations, 5 different altitudes. We established 4 permanent sites, each with a 20*20 botanical plot at the centre at each of those 5 locations and then along that transect we invited in the end about 50 scientists from 16 countries to come and look at the taxa or using methods that they developed elsewhere, and apply them along transects. It is supposed to be in Queensland of Australia, It is down along the International Park of Queensland. There is an area showed on the yellow land that represents our transects. It runs continuously from the undisturbed rainforest in the National Park which was established in 1912 so it is really prestige which runs for a very tropical style although subtropical multi-species broadly forest continuously up to Nothofagus dominated forest with relatively low canopy diversity by 1100m. We talked about research planning more than research results here. What we did were 5 periods of field work but three of them, Aug. 2006, Jan.2007 and Jan.2008 involved international scientists. The two in between were relatively small baseline sampling exercise which we did just so we have the 4 of 20 reference sites.

Total cost of the project is about 1.5 million of Australian dollars, which is about 600,000 dollars, and was raised in cash. It is mostly supported by the Queensland Government, with matching funds from various institutions including Griffith University and the canopy programme based in Oxford. I talked this up to show you that this kind of action does raise money for these very basic biodiversity surveys. If you take what I am calling alternative approach this is cocktail founding with beaching pieces from all over the place. However, these programmes that brought for scientists to a particular place from around the world have enormous PR values for the funding institutions and that is something that is always worthwhile to remember when you are trying to make things happen. There's just a few of the people involved a few of the countries involved by one develop

that. A few of the people we look awhile from France and specialists from Oxford, Pro. Sérvio from the Brazil, Dan Fitzar for Pafalogeni, Mr. Brown or specialist who joint this from elsewhere of Australia and many many others. The core of the project was a series of the core pretty consisting first of botanic surveys with every every tree in our central plots that label marked and measured and identified which is very useful for entomologists to some going to try to interpret the bobstay catch up these plots. But then we have a whole bunch of basic and complementary e-set sampling methods which we will run as you can see at the different times of the year. We organize this central sampling programme many of the visiting scientists then could dip into the samples to get whatever it was they will be particularly interested in. In addition, there is one much more specialized project which scientists come along, propose to us and which they then came at execute on one or two occasions during the year. Result system coming in those of the actually climate results for some of them. We have similar soil results that showing changes. We didn't set out to let show that all of our sciences where on the basic, substrate, or we all have essentially the same aspect and we all actually want a single catchment. But, it's the biological results that we are particular interest. What we found with the botanical results that is responsible in my colleague's work. It's that the high elevation forests, that is to say have a very distinctive community structure that is reflected both in the canopy and in the upper storey. These are the forests which are greatest conservation concern on the even a small ladder of climate change. The lower elevation of next elevation down there so intimate situation. But it looks these two elevations here, the botanic structure depends very much on clade cover, not direct rainfall. Then there is a gradual telegraph to lower elevations. There are some very interesting dynamics going on somewhere in the middle here where it would appear on the upper storey and over storey absent meant for each other and one of my colleague coming up all sorts of ideas to wide that mind a bit. My particular interest was sampling plots. Again I just show you there's a very distinct gradation this is ordination on just one of the samples that we took. There's a very distinct predation and we can then tell into the synthesis which particular taxa of species, genera, sometimes families, are producing this very distinctive gradient. Ants work of Christopher Well and Anky Mora at the Queen's Museum, probably one of our participating institutions have showed a similar, I am going to do this quickly I am happy to show to anybody particularly interested later. That's why I want to show again a very distinctive correlation as you go up to the altitudes.

It is true that every analysis that we've done so far and there are many more analysis still to come. But, it is important to notice that the high elevation stuff. Even though it's connected continuously to the rest of the forest, it has the most distinction. If you wish to look for the endemic format. It isn't always like that though. This is another classification we did for the colinbla. Unlike the previous organisms, they are decomposes. They are soil drove and liter dwelling organisms and what we found is that although the high elevation community jumps out, all the rest are mixed up. That's important because it is showing us perhaps something about the decomposing community in the leaf litter also in the soil that is different from the above ground community. So we look for emerging generalization since I said in the beginning many studies of a single design which is the core of the idea allow legitimately, particularly legitimate cross taxa, cross method generalizations. As I just said for our study, maybe the plants associated with herbs are responding more directly and clearly to the climate change that is represented by the altitude of gradient, but decomposers are perhaps less sensitive. However, for all of the groups that we have looked at so far, the high elevation community on the top of the range are the ones that are most different and of course, most endangered from just a couple of degrees of climate change. It's quite possible in those elevation situations that the actual canopy species, but not ficus trees, will process overly, generally through over spaces eradiate anyway and they are very very good at existing and vegetating clones for thousands of years. But I am very much doubt on the warmer two degrees of global warming whether the associated animal community and the functions that goes with it will process. But many form of application this sort of work of course is to produce the model to predict the site of taxa which can be used to measure the climate change in the future on that 10years, 20 years, 40 years whatever that basis. My view is that such a predict section should be multi-taxa, the taxa that clearly should be those that show very clear patterns in an extensive baseline survey. That site should encompass functional diversity, herby molls, predators, decomposers, plants, animals, should not just be my taxon, I am an ant spots, not an ant specialist but I hear people say I am an ant specialist therefore you should of course use ants to modify whatever you like. This is understandable but isn't really a logical approach. But once you decided under a far more taxa but fulfill those first three requirements then you could possibly use. So then you could bring in considerations of how easy are they to sample, how easy are they to sort, identify database or whatever. We have not yet derived the predict set

from our, we are still awaiting further analysis.

You would hope, in a management connection that the understanding of how biodiversity changes would then lead to particular management triggers with management agencies changes if you like, in management procedures. I leave that as an open question because that is certainly far beyond where we are at.

Other products of our project in Queensland would be some excellent collaboration with high schools, getting the 11 to 12 grade senior high school students coming up and working with scientists along weekends and Queensland Park Association which is an NGO founded back. We generated school curriculum material; we've been engage with many many volunteers; we've been interviewed and filmed by the media endlessly. There will be a long going engagement with national parks and management groups and those being climbing training groups.

All sorts of further products are ants we are currently looking at as our first publication the special issue about the Queens of Museum next year. And there will be cross 'IBISCA', before 'IBISCA' projects. We will be presenting some results of ant symposium at the International Congress of Ecology which will be held in Queensland this year in August.

The other 'IBISCA's as I already said, are taking place around the world, and future 'IBISCA's, there is already discussion and fund-raising going on through my colleagues in Pro-Nature International based in Paris about running a project of this kind in northern Mozambique as a round of different projects because of the particular environment, whether they will happen or not I really don't know. But there is activity trying to identify the questions, get local collaborators and raise funds. I would like to suggest though, if I may, as an outsider of the evolvement with Xishuangbanna and biodiversity affairs in China, that there is a wonderful opportunity to run a project of this kind there in China. There are many requirements of the 'IBISCA' project. One of course is a good question. We had two projects which have concern themselves with altitude transects, which have been justified on the basis of climate change and future climate change monitory those in the Queensland.

The first 'IBISCA' project in Panama was simply a comparison of what's going on on the ground and what's going in the canopy that's not simple at all. But that was the concern the first project in Panama. The project currently going on in France is a work in, actually there is no original vegetation left in most of Europe so what you're looking at is artificial ecosystems which should

be managed artificially for many many years. We can work in the Forêt de la Comté, in the Oven, which has been managed for grazing, for timber, for all sorts of things, for hunting for 5,000 years, quite a long time. So the question there will be how is the long-term land use that is well documented in Europe, affected the biodiversities on the ground. So the first thing you need is a good question. I think altitude will translate all the way to go but there are many other questions related to environmental history, landscape history. However it isn't sufficient to just have a good question and the place you could do things. If you are going to bring in a large number of scientists from around the world and allow them to come for, say one or two or four week periods, they need to grant money. They can't spend a week or ten days trying to figure out how to do what they are going to do in a particular place. Four weeks is a very short amount of time to change something. So there are some logistic issues. The reason we carried out our Australian project, Atlantic International Park, close to Brisbane City rather than, say tropical forest in the far north, is the logistics will be very easy for places to stay, fuels, and easy access to field course transportation, volunteers, students and so forth, and there's a lot of background information so there are a lot of logistics.

The other thing is a local group of people who are incredibly enthusiastic prepared to have their lives altered for 2 or 3 years to run one of these projects. But the potential is there, and you get really useful biodiversity results in a relatively short period of time which is not easy to reach in other ways.

Thank you very much.

Q&A

Person 1

Q1: I am from Bogor Batanical gardens. You mentioned that most of your study area is in high altitude, more than 1800 meters, is that right?

A1: The higher elevation is with lower diversity and lower number of individuals. But they were more different from the other elevations. The lowest elevation is actually the richest in terms of individuals but in terms of how particular an elevation is from the others, high elevation is very special in lots of local endemics species. It is certainly less diversity on the top, but it is more different.

Q2: Yes. But in Indonesia, it is not easy to find a place to raise from the lowland up to the top of a mountain then you can compare the different forest type. The major landscape here is lowland and the most forest damage happens in the lowland, so usually we consider

the lowland to be the most important in collecting speciemens rather than the highland.

A2: In terms of the past history of clearing and modification, that is exactly the situation in Australia. We have lost around 80% of our lowland forest in both subtropics and tropics. They were cleared for dairy farming, for occupation, for building parks and all sorts of things. But we are talking about climate changes here, not other sorts of impacts. I am not saying that other impacts are not important and of course they are. But when you have, as we have a subtropical rainforest with highly unique community of plants and animal sitting on the tropical mountain, I mean literally in the last 200 meters of alleviation before the land stops, then a small amount of climate change. I do not think we can avoid 3 or 4 degrees of global warming over the next century. Then it is that topper will simply go. A question then is all of the similar communities of all the mountaintops further in the southern hemisphere for the south or if you wish to have them further north. We really do not know that but what I am talking about is the likely impacts of climate change and how we should be responsible for that.

Person 2

Q1: What do you think about the parataxonomy lack of the supply from public communities? How much time does it take to get necessary funding?

A1: OK. The second question is easy. It took me two years of full time work, not full time, we have other things to do but, like teaching and my own research. It took me two years to make this project happen from first thinking of it. As an ecologist we actually take parataxonomic approach. But of course the more you work on a particular group of organism as an ecologist, the more you become constrained with your own taxonomies or your own close collaborator with your taxonomies. I think this sort of project though connecting biodiversity and taxonomy through to notions like climate change can actually only be good for taxonomy in terms of building the Ramstore support. I personally do not understand why taxonomy is not seen as the most exciting thing in the world that we can get something out shortly because the new development in taxonomy are mind-blowing and exciting intellectually but yet, it is an ongoing problem if we wish to chat of ecological questions related biodiversity as entomologist and almost anything else, we just have to confront that and deal with it either through parataxonomy or coming out from taxonomies.

Person 3

Q1: I have a question about your biodiversity study using this approach to analyse diversity changes along

altitude. I think that one place, in your case, will not be general solution for the whole world. I think doing the same analysis in different places will get different results, and then we can get a better answer for the question.

A1: I have been involved in rainforest with enormous sites in central east Australia. However we all know that from such results generalization are made and then become hypothesis to be tested against data elsewhere. But yes, we have 2 or 3 thousand of these altitudinal transects similarly studied around the world. Then we can bring them together to predict what is going to happen.

Person 4

Q1: To set up such a research at a mountain that has a higher altitude can be a better place for studies because 1000 meters is really not a high mountain. From my experience in Tibet, mountains have very different biodiversity changes along the altitude from other places.

A1: Sure. As I said, Australia is a very lowland country and 1000 meters is a descent altitudinal gradient in Australia. Though I was comparing 4 or 5 different kinds of broad-leave rainforests, there was no dramatic change in biotype as we went from the lowest elevation to the highest elevation. So in a sense we were comparing apples with apples and trying to isolate the impacts of altitude. Whereas if you take a 10,000 meter mountain, or whatever, you have gradients, then you are going to get such dramatic ecological changes that to some extend you might compare the tundra with a tropical rainforest then there is going to be very little similarity. Whereas working within forest ecosystems and rainforest ecosystems, you get perhaps some notional supports of the sensitivities.

DNA barcoding in plants - from genes to genomics in the conservation of tropical biodiversity

Dr. W. John Kress
National Museum of Natural History, Smithsonian Institution, USA

That was a really funny joke. I thought I have 45 minutes so I have to speed up a little. What I would like to do is to spend 10 minuets on the background of what is barcoding cause I know a lot of people are not really familiar with the concept of DNA barcoding. I will tell you how it actually came about. Determine what could be the effective barcode of plants and finally talking about some news initiatives, which be marked using barcoding. I am a taxonomist basically. One of my job is in the National Museum of Natural History, particularly when I was the head of the US national bureau, who have 4.7 million botanic specimens which determine new ways of extracting the information out of the specimens. We use a kind of traditional way looking at distribution, describing plants with specimens of geographic variations. While the idea is can we use all these specimens to calculate the wholly billions of biological collection around the world now. Can we use this in different ways using new technology? I put my mind to that concerning the usage of barcoding, it seems like an excellent opportunity to extract information from the specimens in a new way, where we can actually tell something new about these plants, something to identify through evolutionary ecology.

What is DNA barcoding? The most simple description or definition is a short, universal gene sequence taken from a standardize portion of the

genome used to identify species. So species identify is much like we have a leaf structure or a flower structure or some sort of structure that could help identify to species level. DNA barcoding is used in a number of ways.

For the straight basic use of barcoding, one is a research tools to us as taxonomists or ecologists or evolutionary biologist for conservations. It is a "find" tool, and also a "discover" tool as well. The research tool is significant for the taxonomist. Would not it be great to have some sort of tools that no matter what part of the plant you have, we could identify. Taxonomies always need leaf structure, flower structure and some structure we don't have to identify species. The DNA is a kind of universal present in all the structures of plants and animals. So a universal barcode to identify will be a very handy tool. So we use it as a tool, to look at different life stages, in terms of identifications or other diagnosis. Also it may be a test of consistency of species definition since we do not have a single type of character to identify species. Now we can get it(barcode) cross species, cross major lineages of plants and animals and see how species transects in genetic sense between animals, plants, micro organisms, probably gingers, legumes, or whatever. In terms of an applied tool for taxonomy, this is a really good tool for those who do not know how to identify any plants or animals that they don't have a taxonomy next to him. For invasive species, or species that are controlling the boarder cross, you have such universal identifier.

Also to test the purity and identity of biological product I will give you an example about how we do barcoding looking at the natural medicinal products in terms of what is really in those jars. Finally, a possible discovery tool that will pervade our DNA barcodes for extra number of species, and find plant species or animal species that does not match those known species. Then we can go and look at that individual or population. We will take a closer look to say this is a new species or just represents a variant of another species. So that's the three basic uses. Barcoding process includes two basic processes. One is to build up a library of barcode. Unless we have some thing to compare and then identify specimen to, barcode will not make sense or be useful. So the first thing we need to do or what we are doing now is to build up a library of DNA barcodes. I think the for insects, fishes and birds, the libraries are been built very rapidly, particular birds. We have almost complete the barcode library for birds now, so if you find a feather somewhere you can probably tell what species that bird is.

So once we have that library of barcodes, then we can use that library

to blast an unknown individual or unidentified individual according to the sequence of that barcode. The DNA barcoding pipeline is taking the specimen, extracting DNA, going through the PCR process, sequencing, editing the DNA sequence and we come out of the short sequence of DNA, and then we take that sequence, put it into the library, like now the library we are using or what is called the barcode live database or BOLD, which is been maintained in Guelph universities in Canada. Eventually that library will be established in major DNA repository institutions around the world, such as Genebank in US. Then ultimately as you have that barcode linked to species name and there will be a species page such as what we have in the encyclopedia, and tells us what you want to know about that species, or we just add it to whatever. So this is a big process and a lot of emphasis is on this now. There are some major initiatives in terms of barcoding going on right now because the barcode library has been set up 3 or 4 years ago are based on Smithsonian but it is an independent organization to promote the usage of DNA barcoding. The coordinate activities that I know include some Chinese institutions which are involved in international barcoding with the aim of barcoding 5 million specimen representing 500 thousand species in 5 years that cost 150 million dollars. This is a big project and the Canadian government has promised $ 50,000,000 and now we are looking for matching from other countries.

Now, what is barcoding and how it develops. First of all, Paul Hebert, a Canadian biologist works on insects first propose the idea of barcoding in 2003. So you can see it is a very young science. He wanted the barcode to be applicable in all forms of life, plants, animals, and microorganisms. He suggested that COI (cytochrome oxidise I) gene in the mitochondria genome was a good place to start because he knew and it has been showed in a lot of biogenetic studies that COI gene is quite variable in a species level in animal groups. So far COI seems to work quite well in many groups of animals. Now what about plants? Plants are actually behind right now but quickly catching up in terms of barcoding world. COI did not work on plants at all. It's too slow and didn't serve a species level identifier. Also the botanical community think that 50 degree of COI didn't work then what barcode works? So we spent in the botany world the last 3 or 4 years doing a lot of experiments and try to find out what will place COI as an effective way of barcoding plants. Now quit a few papers on the controversy of barcoding of the plants, both in Science and Nature. I think we probably have reached the consensus now on what are going to be the most effective barcode.

Now what criteria would one use

to determine what a good barcode is? First of all we need some sort of gene sequences, standardized gene sequence. While you have none variation in that sequence, but you can discriminate it with things like *rbc*L, some of you may know that. It has been used a lot in phylogeny. It is very slow. The same as COI, which will only give you family if you are lucky, not to a species level. So you need something that discriminate at the species level . You also need conserve plants in this gene region, with universal primers to easily pull out that gene from any organism. That is always a problem for both plants and animals. Finally, you could use current sequencing technology, which I think Chuck Cannon will talk about. By using the current technology, we suggest the barcode should be between 300-800 bp. COI gene is about 600 bp. So we start searching for barcode by using this criteria to screen through different gene regions plants genomes, and see what works best. There are three genomes in plants, which are mitochondria genome, nuclear genome and a special chloroplast genome. The mitochondria genome, where the COI gene is works not very well because in plants mitochondria genome evolve much slower. The nuclear genome is quite fast in discriminating power but for some technical reasons genes in nuclear genome are very difficult to find universal primers. So partly we just did nuclear genome as the sources of barcode. Focus is on the chloroplast. There are multi- copy of chloroplast in each cell, relatively conserved structure, you can find universal primers, etc. We focus most of our effects on chloroplast genome and this is what we did back in 2004. There are only several complete chloroplast genomes available for plants, so we took two relatively closely related genomes, in Solanaceae. We took these two complete genomes in the same family and compare how variable each gene region of chloroplast genome are.

So look at that, there is a 2% divergence. We cut out everything less than 2% divergence. Firstly we went to 1% divergence, and this in the figure means this region is less than 1% divergence. So we have a number of regions. Then we also look at the 2% divergence. So these are the 9 most divergent sections in chloroplast genome. It turns out that each these 9 regions are intergenic spacer regions. These are regions that do not code for any genes and are very variable because there are no real restrictions on them. We took those 9 regions and compared them across the whole other 9 different genera. Let's take a look at this to see if we can identify all the plants in a region. We took a little island, 20 miles from Washington D.C. and we looked at all the 96 collections from that island and compared all the regions. It makes a long story shortly became up with one of the spacers, the

*trn*H-*psb*A, which fits all of our criteria better than any other regions. It was on the average about 450 bp long. We had a from 93%- 100% success in getting it out of the different plants. We also find it out from a 100 year old herbarium specimens back to our idea that how can you use botanic collections in a new and novel way. In terms of variability it has the highest percentage of variation from all the taxa.

Then we want more tests. We took a favorite genus, a tropical genus, and sequenced 110 different species for *trn*H-*psb*A. We can tell 95% of them apart. The result is pretty good. This has other evidence that this genus began to diversify 22 million years ago. It is not a very recent gene, which can tell most of the species apart. We also tried on another genus, which is a legume genus of trees in neo tropics. We only have 50% resolutions among the species. But no genes, even ITS was in discriminate for this genus. We think that's because these evidence shows this genus probably began to diversify 6 million years ago, so it's much longer genus. The reason I put these two examples up is to point out the DNA barcoding is not going to be the solution to all our problems. So a lot of variation come to race about evolution, and the time in evolution diversity also have been taken into consideration.

So even though we had in 2005 published that the *trn*H-*psb*A has the best possibilities of plant barcode, other labs including those associated with botanic garden such as Kew are still trying to identify new barcodes. There are a lot of other candidates that are still out there on table. Admittedly it was not only the chloroplast genome any more. The whole genomes are in the choices again more or less the same fashion. We look species in pairs across angiosperms.

Here just a sampling, APG, angiosperm phylogeny based trees on land plants including CO1 just for universality whatever you see means a box of gene extracted from that region whereas a clear box means spacer. We also compared them for universality criteria. Here are those 10 regions(in the figure), *trn*H-*psb*A, *rbc*L, ITS, *etc*. Blue indicates the universality and *trn*H-*psb*A was about 95%. Things like *mat*K was only about 40%. *rbc*L was also quite good. The yellow means the ability to discriminate the queen species in the pair we tested. You see something like ITS is really good. *mat*K is pretty good in terms of things we got sequence for. Then the final box should be red when you can combine these things for the universality and the ability to discriminate. So this is the final box that you really want to look at.

Now, there are problems with using spacers. As we pointed out that a number of plants that been recognized that first of all, those spacers are

probably variable and there are a lot of insertions and deletions which makes it very difficult to align. You can see all the wholes when you compared these 57 species. There is a lot of insertions and deletions so align can be a problem. There are also a lot of things called common polymer repeats. That's when you have a single base pair like aaaa or ttttt. That is a problem in terms of getting the sequence quality in both directions. But we believe that genome informatics will help us in terms of getting over some of the problems of alignment or common polymer repeats or such things. So we propose a paper in 2007 to use of two of these genes. One wasn't so good. Combining together with two low of this barcode, would actually work quite well. So we chose rbcL with ended up polymer anchor. Because it is not that variable to discriminate from species but it is very universal to get easily any sample into a family or genus. The problem of alignment did not disappear in terms of spacer. Right now even though we came out with this two-locus barcode synthesis, we really should add one more in so probably we will have among those two or three locus census barcode probably are made all from *mat*K gene. There are some advances in developing universal primers for matK, at least for angiosperm. Here to make a much more higher profile in choosing barcode.

Here is one example you want to test out these two-locus barcode. Where is the apply use of barcode. I walked in my whole fruit store and looked at the entire two of medicinal herb plants. How we really know it is in all those jars and something across the boarder? So we take the top thousand, actually 1150 species get material of those barcodes and see how many we can discriminate. We ended up only about 800 species of medicinal plants but most of the top ones in 168 genera in 113 families using this two- locus barcode over 90% species, and using BLAST, we are able to identify almost all of them. Here is our two- locus barcode approach. Here is the anchor *rbc*L, just playing the alleles. This is one section of the tree, for the aligned alleles they all come out new things such as method or means, which can discriminate the *rbc*L. Then we use the *trn*H-*psb*A to identify those species. Now anybody could use this barcode library to check their nature products. We can also check how pure any particular products also by using this.

Let's go back and look at the forestic approach of barcoding. What did you have in an island or barcode in a tropical forest? We want to discriminate or identify all the spices in that plot with barcoding work. So we went down to Barro Colorado, in Panama, which is an island in the Panama Canal. It is a reserve, run by Smithsonian and University of Panama. Smithsonian has set up 50 hectare plot on that island,

and we took 300 species in that plot. They are all identified and we know what they are, and we are trying to see if we can apply this barcoding to identify each species. There are 295 tree species that within 180 genera and 49 families. This is a pretty easy exercise because half of the genera only have a single species. *rbc*L can tell us. But the other one assembles a larger genera which has numerous species.

The other thing we want to do is that there is some interesting work going on the BCI right now. In the plot, new theory of phylogeny diversity came out of this mutual theory. How does the concept of phylogeny fit into community assemble? We have species in the plot or forest. We have traits of those species. Those two combinations of traits and species are really linked together by phylogeny. But often we do not have a phylogeny of species in the forest in terms of understanding this linkage of species assembly and community structure traits, and how those species are related because the phylogeny are quite important in terms of how these species evolve in relation to one another. So if we take this phylogeny component, our barcoding not only serve for the identification purposes but also serves in terms of understanding of evolution and eventually conservation of forest. So one of our goal is to use barcode to see if we could actually develop community phylogeny of plants from BCI. Here are the first results. *trn*H-*psb*A was very successful on the 290 species sequenced which is about, or above 95% of them. *rbc*L is even better, 96% of species that we could get sequence for, and both of them are about 96% species. So we can get the sequence our of almost all the species on that island. In terms of species identification using the same BLAST just basic locus aligns used by gene bank, it is rather a crude way of comparing unknown or unidentified sequences to a library of sequences. It seems to work very well. Essentially we get the result of 97% (280 out of those 295 species we got). That's pretty high. That is not the most strict case, because in the 3% of the species that we could not assign correctly to 4 genera, including ficus. So even though we have some problems on some genera, if you have insect eating a plant, we can take that insect, grand it up and extract the DNA to tell you what that insect is eating.

Let's go on and look at the phylogeny in the next few minutes. So then we decide how we will create this phylogeny alignable matrix of *trn*H-*psb*A the spacer. Because we cannot really align those 200 species in phylogeny, although we do have *rbc*L which we can align among all the species. Erickson and I decided to make a super matrix approach in which we only align *trn*H-*psb*A within boarders. Then we set this up in this character taxonomy matrix.

This is just a example and this is just how we set it up. For Magnolia, and the order Magnoliales, we would align all the *trn*H-*psb*A within that, but then include missing data, or all the other orders we have aligned. So essentially, we use *rbc*L as background and *trn*H-*psb*A as within order identifier to create the super matrix to build the phylogeny.

Here it is. We have now the phylogeny of 200 named species using that super matrix approach. How good is it? We have phylogeny of many things. What we did is to put all the orders, about 80 orders on BCI, and compared the relationship between them in terms of phylogeny. We compared that with the orders according to the latest consensus idea of the APG group. You can see the resolutions are quite good. Everything it put more or less in the right place, and that's all because of rbcL . If we go to the family level and do the same thing. Here is APG on this side and here is BCI. You can see APG has not yet resolved some relationship the miss yet. We resolved those a little bit, but they are still altogether. So the resolution in putting things is actually quite well.Here is *mat*K, and here is the 3-gene barcode maker. Our resolution is even getting better because *mat*K helps us align some things to the family level as well.

So to sum up, the idea now is to take what we learned in the 50 hector plot in BCI. Now anybody who wants to do a study on BCI, a herbarium study or seed dispersal study can use this barcode library, or use the phylogeny to begin, or look at the functional trait analysis. Doing this actually involves the other 22 CTFS plots that are around the world including one near the XTBG. There are 22 established sites, most of them in the tropics, and 12 candidate sites. We have initiated barcoding in 11 of those sites. Here is BCI over here, forest in Porto Rico, and some sites out of Washington. We begin to discuss collecting tissue from the Xishuangbanna site and also Singapore. All of this is moving ahead and we now begin to construct the phylogeny and compare this phylogeny of these plots wherever they are around the world. Here is the plot in Xishuangbanna that I was able to go just a month ago, twisted my arm when I was collecting the tissue. CTFS is now also called SIGO observatories begin to compare these sites across both the temperate, and tropical regions, look at this effect of climate change across the tropical and subtropical forests using these 50 hector or smaller plots as our baseline strategy for understanding forest change.

At the end, in the title of this talk, "from genes to genomics", DNA barcoding at this point is a locus-based approach to identify community phylogeny. Today's technology is clear that high throughput, larger genomic sequencing is just around the corner. It is not quite as

simple as locus-based sequencing. But when you think about DNA barcoding, you will be looking at all of the species, while the genomics right now is just looking at a few species. DNA barcoding is really using one to three of the gene regions while genomics looks at all the regions. I think as time goes on, we will move to one end which we have all the genomics for all of the other things, maybe in my life time.

Q&A

Person 1

Q1: Through your lecture we know that barcoding is a really useful approach. So when the barcoding classification results are different from the classical classification, which one is right? The barcoding or the classical?

Q2: In the BCI, the barcoding results of four genomes are found different from the classical classification, it means they are special or something else?

A: the 1st one I there is no doubt that the barcoding is the best one.

The 2nd: Barcoding is simply one of many tools. It is a general way of looking at the nature. When you get contrary result from barcoding, just go back and see why. Are the species transects too narrow, narrower than the barcoding can go? Or just because the species concepts are different. One of the purposes of DNA barcoding is also to look at the concept of species. There is no way that I am going to fit barcoding over psychology or something else without going back and check. The four genera on BCI have problems because they are the largest genera on the island.

Person 2

Q1: The idea of this barcoding is that we will have a device to go into the field and point at the plant to identify it. Is there a technology that we are able to go without going into the lab and extract DNA and sequence them or we still have to do the amplification and so on with such device?

A1: I was surprised at the first international barcoding conference in Kew in London natural in 2005. There were at least 3 or 4 bio companies talking about manipulation of sequencing technology. All of them were very optimistic about reducing sequencing to a handheld device. The way we think of it now will not be chip based and we will have one chip for sequence and identification. That is what I understand so far. I think the situation is identical to the use of GPS system. The first GPS I took into the field 20 years ago was a giant thing and now we have our GPS on our wrest.

Biodiversity conservation in global change

Prof. Dr. Xu Jianchu
World Agroforestry Center

Good afternoon,I always would like to remind my two years of professional career started with botanic garden in 1986. Also thanks particularly for CHEN Jin, my former classmate, for inviting me to share my experience and talk about the landscape of this region. I think the logic lie down very nicely about biodiversity here and I also would like to emphasize the link in the Hymalaya region which also applied to the Southeast Asia

In this presentation, I will try to cover these topics: 1, why biodiversity matter; the second, the region: Highlands of Asia, including SE Asia; in global change I will focus on land use and climate change under human activity; also what is the impacts on biodiversity; scientific uncertainty and opportunities; building biodiversity and carbon assets for global change.

I would like to start with why biodiversity matters in global change. In Chinese philosophy, to formalize a harmonized system, you need 5 elements, gold, land/earth, energy/fire, water, and wood. The biodiversity are all covered in these 5 element as a harmonized ecosystem. As for gold, it is no doubt that biodiversity in Yunnan is very rich and provide very important support for poor mountane ethnical minority. For instance, one species, *Matsutake* of Yunnan province, which is collected by local farmers, generates 60 million$

per year, just selling to Japanese market. The future options are very important, such as variety of biodiversity adapting to climate change. As for wood, besides timber, Wood products, the Carbon storage in terrestrial ecosystem is very important. As for water, usually we look at blue water in lakes, rivers and wetlands, and forgot the water holding in vegetation in ecosystem what we call now green water. There is a lot of study on it now. Also the hydropower contained in water is an important landuse solution. As for fire, the fire regime in vegetation succession is very important, the rural energy depends of biodiversity and bio-energy by looking at the story of *Jatropha*. Water also relates to land. Biodiversity can contribute to soil conservation and Landslide control, such as species selected elsewhere can prevent the landslide. Nutritional cycle is very foundamental in Biodiversity.

Highlands are the Water Towers of Asian. Ten rivers originated from Asian highlands provide more than half of freshwater for downstream. It also produces a range of niche products. This region is rich in cultural and biological diversity which is suggested by yesterday's performance and covered by many speakers. I also would like to say that there is a place with large-scale poverty and social conflicts. The mountain top people are providing very foundamental ecosystem services not only for highland people but also for lowland. About 3 billion people in Asia depend on the 10 rivers from highlands.

If we look at the biological diversity in this region, you will find it a very important global area for biodiversity. It is one of four richest vascular plant regions that you can see in this picture. It also has the richest Gymnosperms in the world as you can see this region (red in the picture). The four global biodiversity hotspots, SW China, Indo-Burma, Himalayas, Central Asia are all covered in this region. Also look at the ecosystem. This is the natural resource base for human activities. They are very rich ecosystems from highland, to lowland, and finally to the tropical area.

So what happened to biodiversity? There are two big drivers, land use or land cover change and climate change. The two drivers are connected. First, land use or land cover change contributes almost 30% of climate change, or global warming. Also the global warming continuously effect the temperature and water supply that affect land use. Land use; again, contribute to mitigate the climate change through the carbon sequestration.

Now let's look at the land use or land cover change of the ten major rivers in central Asia, Indus, Ganges, Brahmaputra, Irrawaddy, Salween,

Mekong, Yangtse, the Yellow River, Tarim and Amu Darya. We found most of the natural forests are lost with little remaining on the mountain top.

So what's the change of land use in this region, particularly in the SE Asia? I would like to say, intensive agriculture in lowland has caused agribiodiversity lose. There are extensive agroforestry mosaic landscapes in uplands and also do not forget the the sediment chemical pollution with collapse of aquatic ecosystem, like Dianchi Lake in Kunming and also the natural forest along the upstream of big rivers in this region.

Also we need to look at the forest transitions in this region. We get some increment in forest cover now in China and Vietnam, but deforestation in Laos, even in Miama. We should differentiate between forest cover and forest density. High density area is usually limited in the upstream with limited area.

In the past two decades, China has experienced the forest transition. The area of natural forest has declined while large area of plantation and agroforestry on the farming land are gained. If we compare China with this global picture, we plant twenty years of forestration, the Chinese forest density still maintain the same. This means we increased the forest cover, while the forest density is somewhat not increasing at all.

I would like to come back to the rubber plantation in Xishuangbanna where I did local study. You can see the smallholder plantation is going up. This is from government figures. But the official rubber plantation that Xishuangbanna government declares is about 200,000ha. However, according to a recent spot imagery, the number has doubled. The remote sensor data also suggests 20% of Xishuangbanna vegetation is mono-cultural rubber, while the protected areas is only about 12%. So the mono-cultural rubber is more than the protected area in Xishuangbanna.

Let's come back to the second driver, climate change. There are many paleoclimatic models. Climate Change is nothing new in Highland Asia because the rising of Himalaya and the temperature are always changing. However, the magnitude and trend of change is new. I try to put the temperature gradings in Himalaya. As you can see, the southern Himalaya is quite different from the northern Himalaya. The southern Himalaya is of course much warmer because they get a lot of heat the from the Asia monsoon from the India Ocean. You can also see the increasing altitude and decreasing temperature. It is always below -10°C. We have a lot of data supporting that with the increase of altitude, the

temperature gets warmer almost three times faster than the global average.

How might changes in climate affect both ecosystem and society We have long-term predominant drivers like climate change but also lately we have historical evidence. In Xinjiang Province, there are evidence of the collapse of Loulan Ancient Kingdom because of the climate change. In Tarim basin in Xinjiang in Northern Himalaya region, all the human societies and ecosystems changed for the departure of vegetation reproduction during the glacier change. That is the picture that easily can find in Himalaya region.

A new publication in Science by Chinese scientists from Nanjing University shows that Asia monsoon variation was contributing to the collapsing of food production in Chinese history. You can find some shift over Tang Dynasty, Yuan Dynasty and Ming Dynasty. This shift is because when Asia monsoon gets stronger and marches towards the northern China, it brings along a lot of rain. That is very good for food production and represents the dynasties with good food supply. Whereas the Asia monsoon gets weaker, and retreats to the south, the food production gets lower for the supply of the local people. So that is the picture trying to tell from the history.

There are also some new studies from my former student who is now pursuing a PHD degree in ANU. She found some species are very suitable for studying the climate change. Look at the blue poppy, *Meconopsis*. The species are located in the alpine area, and based on the alpine grassland, and conifer forest. These species are pollinated by different insects. Those insects are very sensitive to temperature and rainfall. Now the biggest uncertainty about this region is the trend of rainfall pattern. So you can see, some species population are getting lower because of the shift of rainfall. Nevertheless, if we put a broader picture to look at the rangeland ecosystem, particularly the Tibetan upper rangeland where the stocks in the low elevation in winter move to high elevation in spring. These processes of grazing are very vulnerable to climate change. But these grazing stocks are very important for Tibetan people who defend on the solar energy for primary production of the rangeland ecosystem and the ranglands in turn produce hay for the grazing animals from which people can get milk, cheese, dung and meat. The dung are very good energy source for cooking, heating for local communities.

In the 1970s, the Hymalaya degradation are concerned in many publication. Now we are facing new dilemma also because of deforestration. A lot of woody vegetation are moving up. This is an evidence also from

northwest Yunnan in Meili upland rangeland area. One reason for this woody vegetation invasion is climate change, and the other is that Chinese government does not allow tranditional burning of grassland that contributes to the woody vegetation's upward to the high elevation.

So the potential of shift of life zones assuming there is a 5°C rising is a projections from IPCC recently. A policy is tied together and shows that when the life zones shift upwards with a 5°C increase, there is a significant decrease in alpine life zones, oak forest, and evergreen forest, which are very rich in biodiversity. So of course it is still unknown what is the impact in this area and the low elevation.

The idea is that species can move up in himalya in a way we call Island Effects of mountains, desserts, rivers and prevention for species migration. Look at this Almaty Dhaka transect. You give this largest migration, but you get the last long distance desert in this region. Also look at the Lanzhou Calkutta transect. You have many different river cut differently which prevent species migration again.

So, by confidence of climate change and also land use change, we can simply map what is called land use in different zones from highland rangeland, mountane forest, upland agriculture to lowland tropic forest. What is the trend? I do not like to read this all through, but I would like to emphasize the trends are positive according to the activity of raining. As for biodiversity, this means an increasement of invasive species. About 30% species are at risk due to climate change in high altitudes and also in some areas where may have been better forest areas in the upper zone but already have very low biodiversity because of the plantation. Lowland area is less affected but biodiversity is also dropping due to agricultural Intensification. Then what is happening to carbon, water, and livelihood of local people? Still a lot of uncertainties.

Now it is time to think whether the Protected Areas approach works or not, in the mountain region like highland in Asia, particularly in Southeast Asia. So you can see huge protected areas in Tibetan Plateau, but very rich biodiversity regions in the mountains in northwest Yunnan, where a lot of international rivers emerged, get very tiny little protection. So that is the situation. I have on paper published to discuss about the protected area can not prevent any intervention of human activity from nearby region, and also will not work for future climate change adaptation.

So what do we understand about this region? The tiny dots represent the 4th IPCC report, the evidence about the impact of climate change. What

happened to highland Asia and SE Asia? We get nothing here, which means in the past several decades we do not contribute too much scientifically to this region about what is the mean climate change impact to biodiversity, to conservation.

So we need to deal with uncertainties. One certainty is of course the climate change. But also there is uncertainty of the impact that cast from ecosystem to human society, from the high altitude to the low altitude. We have some observed change, models and modeling that we have knowledge about but also recognized uncertainty of scientific community that we talked about in this circle. We still have a lot imaginable outcome we may see in the future but also, for scientists, still a lot of unasked questions and probable future.

The impacts to different ecosystems are also very important. Glacier and snow are the first to response to climate change. The tipping point is the year 2025, when a lot of small glacier, along with small cultivated area, ecosystems and species will disappear. Then the permafrost which we will talk about later is followed by wetlands& lakes, rangelands, montane forest, upland agriculture. You should pay attention to the large-scale feedback then from the Hymalaya region to the Asian monsoon. Runoff and river flows will response to climate change most likely later on.

The climate change is all about knowledge. We need different knowledge like public knowledge, bureaucratic knowledge for decision makers, local knowledge and scientific knowledge. You can find no one have perfect knowledge so we need to work together. So the climate change is about knowledge, adaption is about water, mitigation is about land use and biodiversity. So we need multi-functional landscape to coping with change particularly the climate change.

But the climate change is not all bad. When I visited Tibet in 1988 for the first time, I saw no single chilly pepper, no single green vegetable produced in Lasa. Now Lasa is surrounded by greenhouses. Because it is almost 3-5 °C in the winter now. Also with new technology like greenhouse local people adapt quickly. So the climate change is about adaptation of our knowledge, our thinking and our action.

We need to manage forest not only for biodiversity but also for carbon. Very closely I was invited by the China State Forestry Administration to work on the sixth forest inventory. We calculated the forest density of China, which is only 84m3/ha. In the next 5 years, they planned to reach 200 m^3/ha. By the way, German forest density is about 320 m3/ha. In this carbon formula you can see that China will have 174 million ha forest and 35 Gt CO_2 can be sequestrated through it, which is

equivalent to 7 years of total emission in China. They are not only state forests, but also collective forests and private forests. You can see (in the diagram) that most of the plantation is done by the communities, and private owners also.

So what should we plant? There are more than 100 framework species for ecosystem restoration in Gaoligong Mountain. The criteria for selection are: endemic, endangered, economic; fast growing; good canopy for weed control; attraction to other species; and fire-resistance. We work closely with the government on a large scale and help to decide what to plant in different areas.

There is a new action near the Mekong, which is supported by BMZ and GTZ and Implemented by ICRAF, XTBG, KIB, CMU, NAFRI, AIT, Forest Department of Myanmar. They came out this Making the Mekong Connected (MMC) proposal, which aims at developing carbon & biodiversity assets for multifunctional landscape in the Mekong region. The idea is to connect the secondary forest landscape as bio-corridors, identifying stepping stone 10x10km^2 and then building carbon and biodiversity assets, and finally we will try to market biodiversity and carbon assets through valuation and payment for these assets. Why the scale is set to be 10x10? Because the minimum union of forest ecosystem restoration for the carbon that you have generated is 2 km^2. With this 10x10, you will get 25 minimum union, which is significantly to the industry. Another good news in this type of conference or meeting, forest management proposed by Chinese government is already adapted by the international society, not only avoiding deforestation like the case in Indonesia.

We try to have China mountain climate change blueprint including, synthesizing existing data and assessing impacts of global change in mountain region of China; identifying vulnerable areas and priority areas for action; designing conservation and adaptation programs; connecting protected areas, conservation sites; restoring degraded ecosystem; transboundary and regional approach for biodiversity conservation; developing baseline and scenarios for carbon and biodiversity assets; establishing national and region carbon market; promoting sustainable forest management.

We should also look at not only one discipline, but multiple disciplines, such as mountain region of China, the change in temperature and rainfall, climate impact on droughts and floods, socio-economic status, change in ecosystem services, ecological vulnerable areas, dry land ecosystem, rangeland ecosystem, forest ecosystem, and most importantly, how to integrate

them into the strategy design in West region.

Another important thing is we need transboundary data collection and scientific collaboration to deal with scientific uncertainties. Let's care biodiversity for harmonized ecosystem and society.

Thank you.

Q&A

Person 1

Q1: I am wondering who is the director of the ecosystem that allows the huge destruction along the road from Jinghong to XTBG.

A1: I think that is a very good question and that is the struggling between the central government and local government. Firstly, the central government is trying to spend a lot of money to restore ecosystem, but now come to reality not so many declared forests are, you know, which are called to restore. But the most mattered issue is that local governments try to promote the economic development, like case of rubber plantation in Xishuangbanna, was promoted by the local government in the past two decades, and now you can see lots of.That is why I would suggest to protect the secondary forest system. But also for ecosystem restoration, China is promoting two programmes, one is the Large Scale Forest Restoration Programme and the other is also Lowland Conservation Programme. But again, the species are limited. How to restore the ecosystem? We tried to work with forest bureau in a different way of forest restoration by introducing multiple functional species.

Person 2

Q1: I would like to ask a question about the landuse influence on carbon storage, especially in Xishuangbanna. You know the area of rubber plantation is increasing year by year. Now, how do you think of carbon storage in this region since large part of the natural forest has become rubber plantation now. How do you think about that?

A1: It is actually a very question. There is a new project started by DMZ try to cover these two aspects, plantation and carbon. We try to develop the methodology that means to build the carbon forest land use. We try to look at two parts. One is rubber plantation. We assume that rubber plantation is low carbon because the low carbon has been stored in the soil, and also the low carbon above. That is one land use and the second is secondary forest. You can see already rich secondary forest coverage with high wood density. It is not too much plantation in common arrangement in international market now. Secondary forest is good

forest carbon. So we need to develop scenario to avoid deforestation through the management of the secondary forest. We need to calculate how much CO_2 leaking from the deforestation of converting very good secondary forest continuously into normal kind of rubber plantation. A lot of work is needed to develop this kind of baseline under international accepted standards.

Person 3

Q1: Farmers are making much money and government gets higher GDP from rubber plantation. So the landuse will be changed to economic forestation. How do you think of these policies from government's perspective?

A1: Firstly, I think for policy makers and farmers, they need to take a lesson. Look at rubber, you got a big jump at first then a big collapse now. It is only 1/3 the production comparing to the beginning. Secondly, we need provide opportunity. What is opportunity? We try to develop biodiversity in carbon assets, which can be marketed in the international market. Someone needs to pay for biodiversity conservation, similar to carbon. So this is the opportunity available now on the name of climate change.

Person 4

Q1: As a scientist we need to deliver the message to the society. When discuss about the importance of the situation in the protected area, we need always say that protected areas and natural reserves in China are fine, but not good enough. Otherwise the messages will be misleading. The government will say OK, that area is not good enough so we can give up. The second question will be that now it is a new fashion in Yunnan Province to develop some kind of National Parks that try to use of the protected area to develop equal circumstance. What's your comment on that?

A1: Firstly I think for conservation in these protected areas are always not enough. So how to manage protected area effectively? The government noticed that they cannot do anything because of the restrict standards. They try to use soft standards such as the national park idea that you brought up. It is more kind of soft protection that allows local committee and local government to generate income. Again, it is always capacity issues and also if we manage protected area, or soft-protected area like National Park, where we hope can always make better both for people and the ecosystem. But I always would like to argue that protected areas and national parks are still not enough. We need functional landscape, which is missing in Chinese government decision-makings.

Scaling up: using technology to extrapolate from plot-based studies for the regional planning of biodiversity conservation

Prof. Dr. Richard Corlett
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Good Afternoon, Everybody!

I know Mr. Roger raped the time so my last for a long day and a late time from last night. I spent the last two years, most of the last two years, to my recent book on The Ecology of Tropical East Asia. And one of the things I had learned from this is truth in Southeast Asia. We know huge amount about this small area, but we know huge amount about the species stressful in Southeast Asia. And it is clear from this previous talk and some of the forests, although that we really need to spare a lot on ecological knowledge, so we can make ecological comments on the whole nature.

OK, over last hundreds of years, we basically move in biology from mechanical organism scaling scale till to cellular and molecular processes and up to population community and ecosystem processes. Within the last ten or fifty years, like in Pakistan to talk about Hamas, there's being a lot of key facts from the molecular scale to broad scales' ecology processes. So most of all, we know about ecology instinctively of bits in biomass ecology in Southeast Asia is on relatively small scales, lasting a 4 m, a few hundred hectares most and relatively in small temporal scales, generally be capable run it is very key plot studies. Most of the methods that ecologists use for small spatial scales just one work has a larger scale. You can't have larger study areas on foot. There are too many individuals. You can

map every tree, or genotype every individual, or measure every plant or animals, and just too much spatial heterogeneity on large scales, partly nature and particularly in this region and anthropogenic while the majority of landscapes, something like this.

Yet many of the key ecological questions as we thought of current interest concern these larger spatial scales and in some case longer time scales as well. The anthropogenic impacts on carbon budgets obviously of major interest, responses to climate change which currently in highlight, migrations over tens or hundreds of kilometers and conservation questions involve in large progress on the species live in a low densities, migratory species which are many in this region, can not be answered by studies that based on plots of a few hectares. So how can we scale up, particularly in space to some extents also in time, though I don't have a lot time to talk about that.

The major plot–based studies in the region include the CTFS box which go heard of and a number of other similar forest-dynamics plots, up to fifty-two hectares, a largest of in plots, which every tree for 1cm and diameter be measured, identified and re-measured interval. Uh, this is a map of the CTFS plots. The initial one which could show me a native speaker.

We also have a large number of studies looking at carbon flux in a variety of natural and man-made ecosystems. A review that just out said there's 84 active sites using eddy covariance methods to measure carbon flux. Currently these data has yet been published. This is just examples showing gross primary production, ecosystem respiration, and net ecosystem production. I noticed this is another one and post outside.

Obviously there is a whole work in front us. We don't know data sources. There are hundreds of small sites, pots generally less than 1 hectare, the inventories of plants, the inventories of a lot other organisms, there is long-time ecological studies, primates and various subspecies and the climatological data, hundreds of hundreds of weather stations in that century or more some sites.

All sources of information we have a larger spatial scales. Obviously this comes through my expansion. Aircraft can provide higher spatial resolution, higher spectral resolution, higher temporal resolution, higher signal to noise ratio, but is logically expensive. And remote sensing to aircraft is below important in North America, I think it comes expand in Australia, in Japan, but is been very little used in the tropics, so there need be some work, particular hybrid systems using spectrometer systems and lidar or radar from lasers

be particularly promising for looking at the physical and chemical properties of plant canopies. Satellite data is in general cheaper and more widely available, and tends to converge on aircraft data, so what you can get now from aircraft in ten years you probably to get from satellite. This now huge diversity of satellites with new missions be launched every few month.

We all know about Landsat which is now being going long enough to provide the most indictable data on land-use change, which is so important to Southeast Asia that last thirty years covers the expansionable time, the massive deforestation in Southeast Asia over that period. Higher spatial resolution available now I think comes WorldView, also Quickbird, which with the similar spatial resolution, half meter, which is about as good as you can do commercially. This is just in black and white, but there other satellite, the Hyperion center produces 220 spectral bans on the 30-meters special resolution. And what compromises between this is with Quickbird you can get most spectral data on a spatial resolution of a few meters. Then is radar which produce information through cloud and light viewable spatial resolution can be extremely high, high resolution with more horizontal resolution.

So examples of satellite products available presently shows fire data from the MODIS center on the Terra & Aqua satellites from August to October 2000 in equatorial Africa. This is the MOPPIT center also on Terra & Aqua satellites showing carbon dioxides in Southeast Asia. This is a tropical Rainfall Measuring Mission (TRMM) which measures rainfall cumulatively for a week in 2005. And this is using the Enhanced Vegetation Index (EVI), noticed to look at the spring greening in North America. And I couldn't find similar pictures to Southeast Asia, but data from Southeast Asia, comparing MODIS eddy covariance estimates suggests that this is very good predict of GPP.

Thus, a variety of new missions, the Orbiting Carbon Observatory will map carbon dioxide close to the ground. So it would be possible to identify major carbon dioxide sources and sinks from satellite. GOSAT, a Japanese satellite se, also European carbon mission, CO_2 mission, biomass mission, I am not quite sure the current states, will use radar, low-frequency radar to map global forest biomass at scales of about one hectare, extremely useful for looking carbon estimation.

The Argos system is come to use to track positions of animals with transmitters, if you get that, you can also transmit the GPS device which can give

you an accuracy within 100 meters. Unfortunately, the lightest current Argos/GPS transmitter is about 22 g, which if you put it on boob, it wouldn't be able to detect out. But that's fit for larger. And website suggestion that the ultimate will probably on 5g and you could probably get available GPS transmitter down to 5g. And it's a drop here just show you 5g comes a weight distribution mammals. The majority of mammals and the majority of birds are too small to take ERDAS GPS transmitter. But this project, the International Cooperation for Animal Research using Space which is proposing a new satellite mission that would allow 1g tags for the most or less than 1g which would allow tracking by satellite automatically just download the results every day. Almost any mammals and most of birds for instance including boobs, not including wide eyes unfortunately, not including bees, pretty good in racking individual large seeds, caused about hundreds of million yuan.

Now, in theory we could use the 'spectroscopic imaging' from satellite plus widely available climatological data to extrapolate from plot-based studies to broad spatial scales. So if you are using high-resolution satellite images I think you need to have some sort of automatic or semi-automatic interpretation of the images. There is no way you can sit down and draw lines on satellite images of half-meter resolution over the whole ignore of terrain. You have to be analysis, a bit of talent person so you can be down in demonstration project.

This is a whole easier to do carbon budgets than biodiversity and there is a lot of recent studies that looked at this and with a new satellite been launched over the next few years. It looks going to be practical to come up with carbon budgets from quite fine spatial scale and high temporal resolution. Doing with diversity which was the originally my top is a lot more difficult. I estimated about 100 billion trees in the tropically East Asia about 20000 species, so tree-dies, individual tree-dies forest model the ideal way of looking at the forest are really not going to be practical. We going to have somehow putting these 20000 species into a small number of functional groups or use some previously applied approach. And if you thought all rest of biodiversity, it gets really difficult. But that would be difficult if the whole region was covered with continuous forest. We have to deal with fragmentation, the edge effects, matrix effects with loading in fires, air pollution, nitrogen deposition, hunting, the exportation of forestry products etc. Some of these things you could model from satellite data is you has sufficient information, for instance, fragmentation, edge effects, matrix effects you could model from satellite data if you have

enough local studies and that's being some well-down in the Amazon we really demonstrated how the local studies here. In this region we have data from relatively uniform forest pots. We have very few edge studies, fragment studies and studies with the matrix. Similarly working in fires could be modeled from satellite data even though net logging is detectable from behind resolution satellite.

Air pollution which is massive, probably the massive biodiversity degradation in this region completely under-studied because it is almost know none of the data on air pollution of the region is actually quite a lot in Southeast China. But most satellite stations with no data outside cities, nitrogen deposition too. Satellite data is available ozone, CO, but ground-based needed for others.

Hunting obviously the harvesting of none forest products from canopy can not be assessed directly. Base accessibility we can model enforcement, cultural factors, local assessment. And hunting I think is going to be a highlighted interference because massive problems to most of the region if we looked at those plots I think existing in CTFS forest sites in the region, only Mudumalai and Huai Kha Khaeng have got more or less intact megafauna with all of our photographs in contrast Lambir, for instance, in Sarawak I've got hardly anything left. I means down to one home build and none of the one home build species, none of the large vertebrates at all. You can't detect these facts, so possibly you could model on the bases of possibility within one region, much look like a……Ur, sorry, I'll give up.

Examples of these sort things that might be possible to do is been suggested that El Niño years, a model for China is going to be lacking in normal years towards the end of the century. I realized it probably not true but it has be suggested that this is possible models, and it thus possible to look at El Niño years, we get tree growth and mortality data from the CTFS plots and similar plots we can get carbon flux data from the AsiaFlux sites and other similar sites. We can get climate from weather stations and satellites, fires, CO, CO_2 from satellites, plant phenology from satellites, bird migration from satellites, we get this ecosystem. And always data could be confined to get on broad spatial scales, the impact of the El Niño year which might give us some idea in El Niño tends to warm this region. What is going to be like fifty years or more in the future?

Other sorts of questions could be looked at the combination of plot-based and satellite studies and modeling. Satellites are very good for looking at

post-clearance land-management practices. Radar, particularly I'll be looking at radar images and you could distinguish considerable detail different sources of land-management practices. Radar if you extract for information that you get individually.

It's potentially possible to monitor protected areas with satellite data and hence have a semi-automated alteration that keeps tell land-use changes as a result of the interpretations of the area. I am like to do this, look at bird migration in relation to plant phenology in the region. Every winter hundreds of millions of birds flying south into the northern part of tropically East Asia, it also down into Thailand they stop similarly go down to the Philippine, some go as far as northern Indonesia. And it's very interesting to look at this in relation to phenology and data on in abundance in relation to phenology. In else, it would be possible to model animal species distribution directly from data you get from satellites.

So in conclusion, I'd like to say the currently available satellite data for regional species and utilize these satellite data would be available in the near future, can potentially be used to extrapolate from largely plot-based studies to regional and global scales. However, doing this anything more complex in carbon that I think is going to be practical. I think within five years, we'll going to have the ability to look at carbon on a source spatial scale, we going into the global carbon distribution. During this focus by diversity we're going to need a lot more local-based studies that at calibrating satellite images. Doing this for this region, for tropically East Asia, the political fragmentation is going to need leadership and coordination, which is currently lacking. Thank you!

Q & A

Person1

Q: My dearest Corlett, people use the El Niño year as a model on climate change. I would think that would be end of the tropic forests in ensuing.

A: Yes, the idea the El Niño years are model for future climate change I think is a degree has to be suggested. I am not sure. I mean if many of vertebrates results suggest many of the species in tropic Asia. Pretty odd, they go back in fluctuating with frequency to climate. I think this fluctuating climate, currently the El Niño in which many of the species we have today currently survive. So whether it would be end I don't know.

Q: There would be severe drop and lots of fire in boreal forests

A: Yeah

Q: Why become savanna of boreal

forest?

A: The combination of El Niño, people, not El Niño by itself.

Person2

Q: Would you please elaborate a bit about an example I've seen that you mention about semi-automated early warning system for land-use changes? Another question track for animals mostly use for diversity, you said animal on the, animal like, because I think today on that particular species, I think always in the data.

A: Yeah, just start from the second question. I previously said that were gone on the tracking wild in a certainty using the Argos system tracking the animals. It be tracked in Miama, in Sri Lanka, I think probably also to track large mammals the current system is sufficient. All the large birds and mammals been tracked well. This was actually just based on the particular paper that I was reading two days ago where the suggestion was made. Using this multi-spectral data which you can get from Hyperion center, which used on a spatial resolution, like 30m, you can use these to detect land-use change, small spatial scales like changes in the spectral of the reflectors. If you could compare the satellite images taken at the same year of your national park you could detect land-use changes on the scale of meters to be enough to detect illegal logging, detect logging trials, landslides etc. So in theory these you could alternate and just download previous images say one-year interval and look for changes. Of course, in the tropics, with the cloud that's easier said than done, maybe to do with radar.

Person3

Q: Do you think radar date be able to natural turnover dynamics in forests through time? Is that can radar be able to have a history of nature works?

A: I don't know. The time depth is not and I am not sure about the spatial resolution. The most widely available radar data, spatial resolutions of 50m, you can get with that be enough you can get with the turnover. I don't know. But there is new planned and also planned radar using lasers instead of radar that can potentially give you much greater spatial resolution. The high resolution, so potentially you'll solve this.

Dissemination of scientific knowledge for biodiversity conservation

09:00-12:15 Friday, 2 January 2009

Chairman:
Prof. Dr. Noel Holbrook
Harvard University, USA

09:00-09:45 Botanic gardens, science and the conservation of plant diversity
Prof. Sir Peter Crane
Department of the Geophysical Sciences, The University of Chicago, USA

09:45-10:30 Strategies for plant conservation in South Asia
Prof. Dr. Priya Davidar
Department of Ecology and Environmental Sciences, Pondichery University, India

10:30-10:45 Coffee and Poster

10:45-11:30 Science and conservation policy- Two sides of the same coin?
Dr. Joachim Gratzfeld
Botanic Gardens Conservation International, UK

11:30-12:15 Seven pillars of biodiversity (we are not alone)
Prof. Dr. Chuck Cannon
Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, China

Botanic gardens, science and the conservation of plant diversity

Prof. Sir Peter Crane
Department of the Geophysical Sciences, The University of Chicago, USA

Thank you very much. It's a great pleasure to be back here again at this wonderful garden. I think that all of us should come from overseas with great humility and admiration for what have been accomplished here over the last fifty years. We have been just for a short period of time and it really is marvelous to see just how lively the study of plant diversity and conservation is here at XTBG. What I want to do today is to talk a little bit about the conservation of plant diversity from a prospective gained both from academic and administration of large botanic gardens.

Botanic gardens are really the experts in plant diversity. If they are not concerned with plant diversity, then who will be. What I want to do today is to give you two little stories, and then a few general conclusions and that'll be my full of thirty-five minutes, I think.

This year is an important one in the development of our science. We will celebrate in 2009 the 200 anniversary of the birth Charles Darwin, and we will celebrate the 150 anniversary of the publication of the Origin of Species. Darwin's 200-birthday party will take place in the middle of February. As a former director of Kew, I would like to make the connection between the two, Darwin and botanic gardens, which is from the connection between Darwin and Hooker. Darwin very much laid on Hooker for botanical materials, botanical ideas, support and encouragement to

His career. I want to say a little bit about one aspect of Darwin's work that I think is relevant to my talk this morning and Darwin and Hooker made important contributions in this area. Darwin was a botanical collector until his best man turned up. What I want to talk about today is Darwin's work on insectivorous plants, and Hooker himself was working on the insectivorous plants too.

The history of Darwin's work on insectivorous plants is connected with the writing of the Origin of Species. Because in the summer of 1860, after the Origin of Species had been published in November of 1859, Darwin retreated with his family to this house, south of London, to reject copy and only stand on the edge of Ashdown forest. Forest area made him deeper. Darwin describes at beginning of his book on the Insectivorous Plants, "going up and down of the hills looking for orchids, and finding instead these little curious things." Sun-dew, Drosera, a common insectivorous plant around the world, and he wrote to Hooker in July of that year, "I've done nothing here; but at first I amused myself with a few observations on the insect catching powers of Drosera, and I must consult you some time whether my "twaddle" is worth communicating to the Linnean Society".

Darwin eventually much later published his book on insectivorous plants, in which he describes how insectivorous plants work, considering not only Drosera, but also a range of other insectivorous plants of which this is one to be fly-trap pioneer.

Darwin mentioned in that book in 1875, "This plant, commonly called Venus's fly-trap, from the rapidity and force of its movements, is one of the most wonderful in the world". He illustrated how it works. What was really interested him, I think, was how this remarkable plant evolve. So he said in his book: "Can any light be thrown on the steps by which these remarkable powers were gradually acquired?"

In his book, he uses a variety of approaches to try to think about how something seemly strange accumulated to be a fly-trap might be evolved. He uses essentially comparative approach, where he relied on much of the expertise of Hooker about hypothetical ancestors and transitional forms. He looks at a variety of different species of insectivorous plants: *Drosera*, *Dionaea*, *Aldrovanda*, the Droseraceae, and *Drosophyllum* in the Droseraceae, and couple of other plants.

We now have a much better picture of the full diversity of insectivorous plants that were available and we recognize the relationships among some of the plants. So *Drosera*, *Dionaea*, *Aldrovanda* and Droseraceae also

Drosophyllum and one described much more recently in Dioncophyllaceae the genus Triphyophyllum described more recently actual based on material collected. There are various insectivorous plants, but were ruined, so they eventually need to get some conservation.

We now know those insectivorous plants have genetic contact occurring in four different places in Angiosperm Phylogeny. With that knowledge now, we have a few interesting questions to answer. Here I'll just point to one of them, which is the remarkable parallel evolution of pitfall traps in three different groups, Nepenthes, Cephalotus, and Heliamphora. So one interesting question that comes out of the science of insectivorous plants what we've learned since Darwin is what lies behind the amazing parallel evolution of these kinds of pitfall traps.

But that's not what I really want to talk about today. What I want to speak a little bit more about is the position of the Venus's fly-trap. We now have a context for these fly-traps that illuminate some of the issues Darwin was concerned about among the things that they know about such as Drosophyllum, and also thing they didn't know about such as Triphyophyllum, a tropical liana that occurs in West Africa. It is not insectivorous for the whole life circle. It passes through the insectivorous phase just before moves into liana's phase of life circle.

We also associate what Darwin did in Aldrovanda with Venus's fly-trap. Aldrovanda is a particularly interesting plant. Venus's fly-trap is endemic to the southeast of North America while Aldrovanda is much more widely spread in the old world, and it's water plant. But it has the same kind of trapping mechanism, that we see in Venus's fly-trap.

So we now know through a phylogenetic work, that *Dionaea* and *Aldrovanda* are sister taxa, one new world, one old world. They are related to a diverse group, Drosera spp. and then the sister group to this combination, including *Nepenthes*, *Drosophyllum* and *Triphyophyllum*, the particular insectivorous liana.

What's interesting about this group? I think from a conservation point of view, there are lots of species in Drosera and quite a few species in Nepenthes. But the rest of these groups are pretty species poor. It turns out that some of these species are not in great change from a conservation point of view. Dionaea is an extremely restrictive plant; it occurs only, in the wild, a few counties in South Carolina, and a few more in North Carolina. It occurs in places like beach that are easy from them to spread dramatically. Darwin was on to this himself: "Of the six genera,

Drosera has been incomparably the most successful in the battle for life..... It presents a marked contrast with the five other genera". He also pointed out: "It is strange fact that Dionaea, which is one of the most beautifully adapted plants in the vegetable kingdom, should apparently be on the high road to extinction". The habitat in which it occurs are lowlands and plains of South Carolina and North Carolina. The moisture has to be just right and the shade cover has to be just right. It is a plant that today in the wild, is not so easy to find. It will not go extinct of course, because we have it in cultivation and we will continue to grow it. But then it might only exist in cultivation.

Unfortunately, its sister group, Aldrovanda, is not so charismatic. It grows in a isolated lake in Eastern Poland, quite close to the former Soviet Union. It is on the way out. In Europe, it is extremely endangered. It doesn't have the attraction to move children in large quantities and therefore it does extinct in the wild and they probably would go completely.

This rather long but I hope interesting introduction is to make the point that these species are important. They are important part of the botanical world. I cannot point to the fact that they have great economic significance but they are important part of the botanical world. If botanical gardens are not concerned about conserving these species then I don't know who will be.

We are enthusiastic to talk about ecosystem services, and to talk about some of the large-scale problems. Botanical gardens in particular, which is one of the points I want to make here, should be concerned about the ongoing conservation of some of these remarkable species. Otherwise they will go. No one else could take the time to bother.

So "*Variety*", another quote from Darwin, "as geology tells us, is the prelude to extinction." Now this is the slide I often use to represent my philosophy of botanical gardens and I think it will be well exemplified by XTBG, and that is botanical gardens like zoos, have haltingly moved along this spectrum would be not just concerned with collections of topical plants, but with more practical conservation organizations. This is what we've heard yesterday from Botanic Gardens Conservation International, and I think most people would accept it.

It is very important that we do, because as Darwin said, "variety is the prelude to extinction." Plants are no exception to the general rule in biology that most species are rare. This is actual a combination of a very large number, I think over 100,000 species and their distribution accesses. But what I simply point out is that someone ignored the

65% of those species only occur in one TDWG level 3. While TDWG level 3 is pretty limited, but it does make the point that most species are pretty restricted. So, to use Darwin's analogy, most species are rare and they are endangered. So most of the world's plant species, fall into this level and botanic gardens are concerned about them.

So the question here is how we can increase the relevance and impact of botanic gardens in conserving plant diversity. I think very simply what we can do is implement, facilitate and encourage, not only in situ conservation, but also ex situ conservation, sustainable utilization, and also the restoration of habitats, by doing this things ourselves and by providing relevant information.

Now we come on to the second part, which is just to say a little bit more about what have been done with plant conservation in Madagascar. Madagascar is one of these biodiversity hotspots in this Norman Myers' map. It is largely based on the distribution of those plant species that are relatively restricted. Madagascar of this level's endemism is 89%.

The general understanding of is much more poorer than we would like to. This is a table actually from a Royal Society Report on conserving biodiversity that I worked on a few years ago. I think it's instructive to compare, for example, the knowledge for Madagascar flora against the knowledge for UK. In UK, we have lots of botanists, very few plants, and relatively small place. While in Madagascar, there are not so many botanists but much more challenge. In terms of global biodiversity, it is a much more important flora in terms of the high level of endemism.

We are finding new plant species all the time. This is just an example from BBC website about a year ago. Giant palm tree, a new species of giant self-destructing palm on the island of Madagascar where we finding new species all the time, is been found in Madagascar. That is a place with obvious ongoing massive changes in habitat. It's very rich of flora and the approach has been adopted in Kew, and also in Botanical Garden of Paris. It is not trying to cover the flora in Madagascar at this point, but to focus on some particular groups, orchids for example, or trees worked by George Schatz who wrote a book, *Generic Tree Flora of Madagascar*, focusing on things that can be done that are relatively trackable and can provide important baseline information for conservational biologists and ecologists to do their work in Madagascar.

Palms, legumes and other groups have been the focus. I am just going to highlight the data from the orchids,

palms and legumes works. Here you see the numbers of species described for Madagascar, and then you see the number of new species described in those books from orchids, palms and legumes. So, very large numbers of new species are still coming into light.

One question is how do the collections be accumulated for Madagascar, how well do they reflect the species we would find there. That's a size based on looking at one group, the legume, and the use in Madagascar is 400 dollars for a species. They will be assessed from the stand point of IUCN conservation categories. They will also be, in one the rarest examples, a database in the major herbaria that are half hold from Madagascar. So the major herbaria will be in Paris, Kew, Missouri and the herbarium of Madagascar itself. So all the legume in all these herbaria are now in a single database. So we can ask some questions about what those collections represent in terms of the species of Legumes.

So all of the 435 species of the Legumes represented in my collections are known from Madagascar. Half of them roughly are known from only one to ten specimens in the combined herbaria that are collected from Madagascar. But when we look at the numbers of species of legumes that are rare species, we find that 82% of those species has only one to ten specimens.

So basically what we can conclude from this analysis is just as Darwin said "things that are rare, tend to be endangered; things are rare, tend to be rare in the herbarium collections." Therefore by focusing on just those species that are represented by few specimens would get most herbaria species. So this provides us a way of attacking those species and identifying those species that are likely to be endangered in the wild, just because they are rare in the collections. It's not perfect, but it's good, it's good enough to make quite rapid progress. If you think about how you might digitize eight million specimens, it's much easier just to digitize a few hundred thousand of them. For those few hundred thousand, we've probably get most of the endangered species. It's not surprising that as we find new species, we can't tell which species will go extinct. I mean, so extinction is completely annoying when dealing with plant diversity.

Here is an example. This is a very interesting plant, *Takhtajania perrieri*, an endemic species to Madagascar. When I was interested in Winteraceae, which was none long ago, just a few specimens are collected in Paris Herbarium in 19 century. It was, about 80 years later, rediscovered in the wild. So we might conclude the *Takhtajania*

is not extinct; it is just endangered and have not been found in a moment. But it is still restricted in its distribution in the long term.

If you pull out all of these legumes collections on the map of Madagascar, it's also not so perfect. You see the collections are concentrated in some places. On the other hand, it's not bad. It does provide a basis for interacting with the kind of satellite images we heard about yesterday, and also with the geological ground maps of Madagascar with which we could start to construct vegetation maps and to understand the distribution of species.

Another important part of the conservation on Madagascar plant species is the work of seed bank maybe Pritchard will say more about it later. The seed band takes species that are rare in the wild, focusing on endemic endangered and species known as vulnerable.

What interests me about the seed bank is not just the business of getting seeds preserved ex situ, but the interaction between herbaria data that we've just discussed and the seed banking work itself. To do seed banking you have to send people into the field. To send people into the field you need to know where to send them. You could use the herbaria to figure out where to send them. This is the Madagascar example of Malawi, but this is the example that kinds of filed guide could have provided, highlighting target species where the collectors should go to get those target species and when they should go to find them. So a lot of information in the herbarium can be used for the practical work to guide field biologists, in this case seed bank collectors, to target their species in the field.

Then the other point I would make is this again that seed bank is not just about getting the seeds, you have to send people into the field. Going into the field they can provide you with the preliminary RDL assessment, they can provide field information on population status and threats; they do what to increased conservation capacity in the wild, and provide all kinds of other information about species relatively cheaper for each species.

Kew working with Conservation International and also working with Missouri Botanic Garden, is very interested in generating vegetation maps for the whole Madagascar and preparing tools for existing protected areas. That's particularly timely now because coming out of the circle of Durban Vision processes back in 2003; the government of Madagascar made a commitment to substantially increase international parks and reserves. Being an intern of that process has been a joint project by Conservation International, Kew, and Missouri Botanic Garden.

Here is a map of the vegetation in Madagascar that came out just last year and the Atlas allows us to see the kinds of primary vegetation. Secondary or disturbed in somewhere? How much it remains, where it remains, and very importantly, how the areas of the different kinds of forests have been changing through time. This is another general point I want to come back in a moment.

We made an early vegetation map in Madagascar, based on information back in the 70s, and then again in the 90s, then again in 21st century. I think this kind of information being able to follow trends through time is extremely important. So by vegetation type we can see which vegetation types are disappearing. So for example, we see the spiny forest here has been reduced by 30% whereas some of the other forests, such western dry forest has reduced by 40 percent and western sub-humid forest are 50% less. This also could be compared to those communities that are very protected in existing reserves to see which one is a relatively protected, what should be priority to Madagascar.

So these I think are very practical outcomes for how these different activities in herbaria and seed bank and remote sensing on the ground to be integrated in meaningful ways for both ex situ conservation and in situ conservation. So, what can we say in terms of general themes? I am just finishing up by making a couple of general point. The first is the incredible value that comes out of working in partnership, combining samples, (we often speak of collections, I think we could better speak of collecting samples of plant diversity) and focusing on producing user-oriented products. I think also incredibly important, taking the interrelation to the theme of this symposium, is producing information documents change through time. I think this has particular traction with policy makers and with the general public. How are things changed? We do find changes in the herbaria saying how things changed in a time scale.

In the herbarium world, we do have many duplicates, but we also have enormous number of specimens in sum, and enormous progress has been made to database. We heard yesterday that the herbarium here is pulling database and we need continued to do it. There are large amounts of effort going into it.

These are some important databases, the Kew electronic plant information center, TROPICOS, Encyclopedia Life, and Biodiversity Heritage Library, a digitization search engine and so on. We already have the Global Biodiversity Information Facilities, the African Plants Initiative, now the Latin American Facilities, and I hope soon with the collaboration of Chinese colleagues to be put Asian plants together with

digitized information on herbaria with new kinds of products like conservation chips, rapid reference collections field guides and so on.

In the UK, I said earlier that we have a perfect combination of not so many plants in a small place and lots of botanists. So we've been able to monitor changes through a series of surveys during the last thirty years and the most recent one is in 2003. Now we are able to start relate the kinds of changes that going on in the British flora to some of the factors behind. This is the species *Campanula latifolia*, and we seem to be losing it based on changes in nutrient status. Here are invasive species that we seem to be gaining in a relative short time. Those species seem to be expanding, like *Lemna minuta*, and *Epilobium brunnescens* as a result of climate change.

Those kinds of data show changes occurring over relevantly short time span. Here is another one which is becoming a problem in UK. This is not a plant but a leaf mining moth, *Cameraria ohridella*. It hits on chestnuts. This is its distribution in 2003, and this is in 2005. If it continues to increase, chestnuts will probably goes away.

What about large scale changes through time of plant diversity? One of the area I think we are not very good at is the using of IUCN red list criteria. Back in 1997, we had about ten percent to the total plant species scored for red list criteria. Now we have probable less than that.

We have a lot of work to do. We can use the information in herbaria to get a not perfect but quick and good red list assessment. So it is another one of the benefits that can come from georeferenced herbaria data. So we can do this in an automated, in a semiautomated way, once we get the data and we should, because what we want to do is to stop to follow the changes in red list data through time for species. This is already a process under way, of course not for plants, but we started to think about how it is moving for plants. A sample red list is a sample of plants that we can follow through time to get a general, overall sense of how plant diversity is falling through time. So that's one way to get into the overall questions.

Another way I want to mention here very quickly is the way of WWF. UK always told there are two important graphs they have to keep in mind. This is one of them, humanity's global footprint; this is the other one, the Global Living Planet Index. So the scientists may ask what's the global living planet index actually based on.

Global Living Planet Index is similar to the IUCN sampled red list, and it is

split up into tropical, tropical forests, dry lands, etc. What's it based on is population trends in about a thousand vertebrate species from around the world. The question is, it is just a sample of vertebrate species, and could botanical communities represent that trend? How would we design a sampling strategy to look at the fates of populations in different plant species, and would be followed through time to give us some kind of higher level assessment of plant diversity instead. So that I think is one of the new challenges.

I just want to finish by saying that we can do this but we also need to take action from *ex situ* conservation. When we discovered new species like *Wollemia nobilis* in the wild that has hundreds remaining individuals, we would be daft not to move those plants into *ex situ* conservation. I think the Sydney Botanic Garden did a very nice job in rising money for conservation. When we know of an endemic species on the island of Mauritius, where a quarter of the species have less than fifty individuals in the wild, we need to take actions to get those plants in conservation. Otherwise they would go.

We can do it in different ways in different places. In Chicago, we do it with rare plants and with crops we need to do the same thing.

I'll just show one slide that I think is very important and very interesting. There are about eighty thousand total accessions of cultivated chickpea in the seed banks of the world. About twenty seven percent of those accessions deal with related wild species. It seems to me to be really rather important in thinking about chickpea diversity and we need to get those species into seed bank.

Going back to this charismatic insectivorous plant *Aldrovanda* again, an action has been taken. We can talk about ecosystem services; we can talk about how we should approach these issues; but unless actual action of conservation, they will go extinct and it is the most important work of botanical gardens.
Thank you for your attentions.

Q & A

Person 1

Q: what are botanic gardens in Madagascar doing to preserve their flora vegetation?

A: They tried to get plants from the spiny forest into cultivation. So they are not dependent just on those species from going endangered in habitat. So these are some actives to do that. But ex situ conservation is a tricky thing that can't be done for species in a seed bank way. So the answer is they are doing a little, with their limited resources but obviously not as much as what we would like.

Obviously gardens in other parts of the world have some of those species in cultivation, but it doesn't make much sense for gardens in the temperate part of world to struggle growing Madagascar species in the glass houses. We must design, you know, much more effective ways. But nevertheless, I think in some circumstances it is important part of what the botanical gardens should be doing.

Person 2

Q: I want to connect your thought with yesterday's talk about barcode, because they are all about conservation and digitalizing the species by botanical gardens. But another issue is that I think it will be great if some kind of hand-hold device that can recognize species in the wild so that even a normal people not can know whether this species is endangered or not. Then the local people can take conservation actions. That will be very cheap.

A: well, I think as John said yesterday, I think it will probably come faster than we think. In the meantime, I think there are a lot that we can do. With herbarium specimen scanning, it is very easy to make a rapid field guide to a relatively restricted area which is so much better than a flora. Flora is a wonderful thing for botanical specialists, but to have a field guide with actual specimens supplemented photographs is a good intermediate stair.

But come back to your main point, the progress on databasing and digitalizing information related with the plant diversity is really extraordinary. I mean, the African Plants Initiative for example, went from zero to over two hundred thousand specimens within fifty institutions in about five years. Money made that happen. But I think, since we have the encyclopedia of life project, with this substantial founding, we have all initiatives going on there. I think they are already starting to come together and cooperate,. As John mentioned yesterday, they were also linked together on genetic levels.

So things are changing rapidly. But the key step to making these hebaria is to get that information in digitized form. For the administrators of those institutions, it is a tricky bonds between putting resources into the basic science, putting resources into getting new samples and putting resources into making better use of the samples. So that I think all of these is about balance and trade-off. It'll be messy, and there will be lots of activities on many different fronts. But I think it is preceding, I think the prospect of having more and more digital data in electronic forms is coming to us very quickly. I hope it will be a priority force in communities.

Strategies for plant conservation in South Asia

Prof. Dr. Priya Davidar
Department of Ecology and Environmental Sciences, Pondicherry University, India

I would like to talk about the challenges that we are facing on plant conservation in South Asia. I will mainly focus on India particularly the Western Ghats because of my familiarity with the situation.

I am introducing two species that summarize the problem of plant species conservation in South Asia. The first species is Eriochrysis rangacharii , a grass species endemic to a particular mountaintop in the Western Ghats. It is a rare genus that is also distributed in South Africa and Australia, which indicates a Gondwana origin. This grass was thought to have been extinct for a hundred years and was classified in the RDL as extinct. It was rediscovered 10 years ago. The is a parasitic shrub Dendrophthoe memecylifolia belonging to the family Loranthaceae. It can be listed as endangered as it has a limited distribution and highly specialized host preferences. However it is not in the RDL, but its host plant Eleaocarpus recurvatus, which is also a rare endemic is listed in the RDL. So we have possible threatened species that are not listed in RDL, species that are correctly listed, and species that are

wrongly classified. So in summary, those are the problems that we have in plant conservation in South Asia.

We have around 16000 species of angiosperms in South Asia. The level of endemism is fairly high with 31% of endemic species and 20% endemic genera. When we look at the Western Ghats-Sri Lanka biodiversity hotspot, we have 5000 angiosperms from 220 genera and 217 families of which 61% of the species and 37% of the genera are endemic.

Globally one in eight plant species are threatened; therefore about 13% of the world's flora are threatened. According to IUCN 2004, out of 3120 listed in India, 10% are threatened, and 46% have been classified as data deficient, which means that there is no data for these species. In Sri Lanka among the 3314 species only 8% are listed as threatened. Therefore for the large majority of plants in the subcontinent, we do not have much data. We have robust data for plants that have medicinal value because they are commercially important. They are quite well studied and monitored compared to other wild plants. Among the medicinal plants in India, 49% are threatened, 113 are endangered, and 44 are critically endangered. Over harvesting has resulted in the decline of medicinal plant species.

The major threats to wild plants in India are habitat loss. India is currently expanding forest cover and forest cover has increased by 1% from 1990 to 2005 (www.mongabay.com/deforestation), whereas Sri Lanka lost 17.6% of its forest cover during the same period (www.mongabay.com/deforestation). Therefore although India seems to be gaining forests, at the local level there is increasing degradation of forests due to non-sustainable harvesting of plants for leaves, fuel-wood and other products. Loss of primary forests in the Western Ghats due to land use changes is a cause of concern. The protected areas covers about 5% of the area in India and 9% in Sri Lanka, and have been located in open deciduous forests that are important for the conservation of large mammals such as tigers, but have low conservation value for plants.

I am going to focus mostly on Western Ghats. Western Ghats is a mountain range along the western side of India, which runs north to south along the western edge of the Deccan Plateau. It is a biodiversity hotspot with high levels of endemism and a unique biota. Advantages of working on these forests are that they have fewer plant species compared to forests of Southeast Asia and Amazonia. The flora are relatively well-known and species easy to identify since we have very good herbaria and many floras.

There are many unique floristic elements of the Western Ghats: There are about 1000 evergreen trees of which 60% are endemic to the Western Ghats. An example is Michelia nilagirica, a Magnoliaceae which occurs in the higher elevation forests. Another unique and charismatic groups is the genus Strobilanthes of the Acanthaceae. There are 52 species in peninsula India, 85% of them are endemic to WG. Strobilanthes has a monocarpic life history and for most of its life cycle it is in vegetation condition so it is hard to identify. It flowers gregariously in cycles of 6-12 years, which vary between species, and then it dies off. The best known species is Strobilanthes kunthianus, which covers the high elevation mountain tops of the Western and Eastern Ghats like a blue carpet during its flowering season. The other interesting groups are the gingers which are popular at XTBG. There are about 200 species of gingers from 21 genera in the Indian subcontinent, and 37% of the species are endemic to the Western Ghats.

In order to assess the vulnerability of species to habitat loss and climate change, we looked at two databases: one based on historical records gleaned from herbaria and literature on the distribution ranges of 356 species of endemic trees of the Western Ghats. This database was used to assess rarity. The second database consisting of 482 species of evergreen trees was to look at the environmental tolerances of species to assess their potential to adapt to climatic changes.

Rare species are more prone to extinction: As Darwin said, rarity is the prelude of extinction. In the database on 356 endemic tree species, we identified 84 species with less than 50 records and which have a latitudinal ranges less than 100 km. These species constitute 34% of these endemic trees. Of these 84 species, 22 have been listed Red Data book, of which 6 are listed as Extinct (known only from type specimen), 8 as Endangered, 2 Vulnerable and 6 as Rare. Remaining 62 spp. (73%) have not been listed at all. So many possibly endangered species are not included in the Red Data Book.

To assess the potential of trees to tolerate climate change, we assessed tree distributions in the Western Ghats across climatic gradients. What we found is that rainfall seasonality and temperature (which decrease with increasing altitudes) influence species diversity and rarity. Species with limited environmental tolerance, i. e. species restricted to narrow seasonality regimes and elevational ranges also have limited distributional ranges in the Western Ghats. About 32% of the rare species have narrow environmental ranges and might be more vulnerable to climate

change. Therefore in summary if rainfall seasonality increases due to climate change almost one-third of the tree flora in WG would be threatened and these species have very low migratory potential because they are very slow growing.

What should be the priority for In situ conservation? Databases should be upgraded with more data from plant inventories. We need to identify and monitor populations of threatened species. We need to increase the coverage of protected areas, and to maintain habitat connectivity and migratory potential. That means we have to maintain connectivity across latitudinal and attitudinal gradients so that species can migrate with regard to climate change. We also need ex situ propagation in botanical gardens and seed banks, etc. Field botanists and ecologists need to communicate with colleagues in botanical gardens to have coordinated in situ and ex situ conservation. We also need to plan regional networks for coordinating research and conservation. India-Nepal-Bhutan-China share many Himalayan species. Many rain forest species are common to India-Sri Lanka-Myanmar-Malaysia and other SE Asian countries. We need to maintain trans boundary connectivity for species. Finally, to conclude, this species, Gaultheria fragantissima is distributed in the mountains of South Asia, Eastern Himalayas. We all share this species.

Q & A

Person 1 (Cao Min)

Q: WG is an important region in terms of biodiversity conservation of the world. We saw some threats to the local plant species in your presentation. Climate change proved to be one of the factors that leading to the growth of endangered plant species. But I think human population growth is also another important factor.

A: Human population growth certainly is a big factor. Both of them are very important.

Person 2 (John Kress)

Q: Thanks very much for your presentation. I want to comment on this data deficient of IUCN category. I think it is extremely misleading which goes back to Peter's presentation as well. I would argue that it is not the data are not sufficient, but the analysis. Peter showed that there are about 250,000,000 herbarium specimens located around the world. That is enough data at least to provide preliminary conservation assessment above 75%. So the question is not we do not have the data but we do not know how to analyze the data.

A: Many people considered about getting these data together but the data

are not been Presented.

Person 3

Q: It is very clear that there are a lot of data out there in Southeast Asia. There is also a large number of institutions and trained people. This is what you said of translating into coordinate actions. I know there are network of botanical gardens. At the global scale, we are now developing very broadly based partnerships for plant conservation, including botanical gardens, herbaria, and NGOs. This could be a very effective way because we must communicate with each other. Are there any initiatives in Southeast Asia towards the regional partnerships on plant conservations?

A: Not much effort on that as far as I know. We have been trying to do things like that but it has not gone anywhere so far. We cannot cooperate effectively. We need to do that.

Person 4

Comment: You remind us a saying that when you lose a species, it is not only to loss that name, but also the functional traits. You hit on that at the very beginning by looking on that monocarp species.

Science and conservation policy – Two sides of the same coin?

Dr. Joachim Gratzfeld
Botanic Gardens Conservation International, UK

Thank you very much. In my presentation entitled “Science and conservation policy – Two sides of the same coin” I would like to talk about science-policy interfaces, the mechanisms and processes that encompass relations between scientists and policy and decision-makers and aim at ensuring that decisions are made on the basis of best available scientific knowledge and information. In the following, I would like to provide a few examples of scientific publications on the state of the environment and/or biodiversity, and discuss how their findings were policy relevant or indeed have influenced decision-making. In particular, I would like to highlight what is in those for the world of plants with a special emphasis on the Global Strategy for Plant Conservation as a programme of work of the Convention on Biological Diversity that puts science and conservation ideas into policy action.

The following slide lists a number of reports on and assessments of the state of affairs of biodiversity. It is by no means comprehensive and provides just the tip of the ice berg of publications that have been produced over the past two to three decades:

In 1987, more than twenty years ago, the Office of Technology Assessment of the US Congress which was the

technical agency at that time that provided Congress with analyses of major public policy issues related scientific and technological challenges, published the report Technologies to Maintain Biological Diversity. It was the first ever official document using the term biological diversity. The breadth of this report in terms of content and analysis is in fact quite amazing. It addresses all known dimensions of biodiversity and related management issues, including in and ex situ conservation measures. This report discusses the various dimensions of biodiversity loss in a very comprehensive manner with implications for policy going beyond addressing species extinctions only.

In 1990, IUCN and WRI published Conserving the World's Biological Diversity. This report highlighted that most of the major policy decisions that affect the use of natural resources are taken in urban environments removed from the realities of the rural areas. It aimed at reminding decision-makers on the value of biodiversity for human prosperity outside cities, and urged for the development of new policies that ensure a continuing flow of benefits from biological resources to humanity.

The UNEP-WCMC Biodiversity series reports launched in 1992 presented the results of projects carried out by WCMC in partnership with IUCN, WWF and other organizations. This series focuses on providing technical support to the Parties to the Convention on Biological Diversity, e.g. on freshwater biodiversity, biodiversity conservation in the tropics, or global ecological and economic analyses and assessments such as the significance of global coral trade.

UNEP's Global Biodiversity Assessment published in 1995 was a remarkable review and assessment of the knowledge of biodiversity at that time. It was a wide-ranging analysis of the science underpinning biological diversity. The review was funded in the order of two million US dollars from the Global Environment Facility, and was the work of more than 1500 scientists. Unfortunately, it failed to attract the recognition it deserved and did not achieve political legitimacy.

In 1997, UNEP launched the Global Environmental Outlook with the latest issue in this series published in 2007 (GEO 4). It highlights major threats to the planet such as climate change, the rate of extinction of species, and the challenge of feeding a growing population. Opportunities identified to address biodiversity loss include emphasizing the role of conservation within pro-poor policies; valuation of biodiversity and use of new market mechanisms; as well as conservation focusing on ecosystem services. The latest report concludes "enough is already known to make better decisions

on the conservation and wise use of biodiversity".

Unfortunately, as we all know, biodiversity is still declining despite this accumulated knowledge.

FAO's State of the World's Plant Genetic Resources for Food and Agriculture, published in 1998, provides the first comprehensive assessment of the state of plant genetic resources. It also assessed the effectiveness and capacity of relevant institutions to develop and implement initiatives for the conservation and sustainable use of plant genetic resources.

In 2002, the United Nations Secretary General commissioned the preparation of summary situation reports and forecasts for the sectors of Water, Energy, Health, Agriculture, Biodiversity, the so-called WEHAB series reports for the World Summit on Sustainable Development (WSSD) in Johannesburg, South Africa in autumn 2002. This was perhaps the first time biodiversity was given equal prominence in the global debate about sustainable development. As a result, the 2010 Biodiversity Target (which the Parties to the Convention on Biological Diversity had adopted earlier in 2002 to achieve a significant reduction of the current rate of biodiversity loss at the global, regional and national level by 2010) was endorsed by the WSSD and the United Nations General Assembly and was incorporated as a new target under the Millennium Development Goals.

Before moving to the next slide, I should also mention that as of 1995, in response to Article 6 of the Convention on Biological Diversity, a number of national and regional reports on the state of biological diversity are being produced. These national/regional biodiversity strategies and action plans (NBSAPs/RBSAPs) remind us that although biodiversity is an issue of global conservation concern, practically it can only be resolved at national levels.

I would like to turn now to the Millennium Ecosystem Assessment. Initiated by WRI, UNEP, the International Council for Science (ICSU) and UNESCO in 2000, and reported in 2005, it was an attempt to redo the Global Biodiversity Assessment I mentioned earlier, but this time with the needed political commitment and legitimacy as it was represented by a multi-stakeholder board including various Multilateral Environment Agreements, representatives from business, NGOs and government. The Millennium Ecosystem Assessment was the largest global assessment ever undertaken on the health of ecosystems. Some 1360 experts from 95 countries participated in this initiative. While its findings are highly policy relevant

they may nevertheless not be policy prescriptive.

The key conclusions of the Millennium Ecosystem Assessment: A reduction in the rate of biodiversity loss for certain components of biodiversity and for certain indicators, and in certain regions is possible; the majority of the targets that the Convention on Biological Diversity has established as part of its framework for assessing progress towards the 2010 Biodiversity Target are achievable, provided that the necessary actions are taken; and, for the most part, the tools needed to achieve the 2010 Biodiversity Target including programmes of work, principles and guidelines, have already been developed.

So why are we still losing biodiversity? Let us look at some more examples.

The second meeting of the Conference of the Parties to the Convention on Biologial Diversity in 1995 called for the preparation of a periodic report on the status of biological diversity, the Global Biodiversity Outlook, GBO. It suggested that the GBO should provide a summary of the status of biological diversity and an analysis of the steps being undertaken by the global community to ensure that biodiversity is conserved and used sustainably. The first edition of the Global Biodiversity Outlook was published in 2001 and work is currently underway for its third edition (Global Biodiversity Outlook 3). The GBO notes the importance of mainstreaming biodiversity conservation concerns across sectors, in particular also to address the increasing significance of climate change as a driver of biodiversity loss, and of maintaining biological diversity for both mitigation and adaptation measures in times of global environmental change. The conclusions of the GBO, along with the findings of the Millennium Ecosystem Assessment mean a reorientation in policy needs for the Convention on Biological Diversity and for global biodiversity conservation actors generally.

Let me now briefly turn to the IUCN Red List of Threatened Species which is widely recognised as the most comprehensive global approach for evaluating the conservation status of plant and animal species. From its small beginning more than four decades ago, the IUCN Red List has grown in size and complexity, and now plays an increasingly prominent role in informing policies and guiding conservation action. While the conservation status of certain groups such as of birds, mammals and amphibians is well-known, assessments of most of the taxa pertaining to the world of plants are very much lagging behind. The 1997 IUCN Red List of Threatened Plants includes 34'000 species, the vast majority of which however has not been evaluated

against the revised 2001 IUCN Red List Categories and Criteria and most of these species are therefore not included in the latest Red List publications. The 2007 IUCN Global Red List comprises 12'043 plants of which 8'447 have been listed as threatened. Considering a gobal total of some 350'000 plant species, the urgent need to have a more targeted assessment focus on this component of biodiversity goes without saying.

As mentioned earlier, the list of environmental assessment and status reports is hugely long, and to conclude this general overview, I would like to point out just three more from this plethora of publications that policy and decision-makers are spoilt for choice: EarthWatch's State of the World series reports, WWF's Living Planet Report, and FAO's Global Forest Resources Assessments. And they always reach the same daunting conclusions: loss of biodiversity is not slowing, and ecosystems continue to degrade.

I would like now to turn to the Global Strategy for Plant Conservation which was approved by the Conference of the Parties to the Convention on Biological Diversity (CBD) in 2002. It was a response from the CBD Parties to one, but particular issue of biodiversity conservation – plant diversity. Initially met with reservations as "too narrowly" focusing on plants, it is now regarded as a very effective CBD decision. More importantly, its genesis was not from the CBD Parties but from the botanic garden community.

So what is the Global Strategy for Plant Conservation (GSPC)? First and foremost, it is a successful example of an evolving partnership for plant conservation. It provides a strategic framework for plant conservation action from global to local levels. It connects governmental and non-governmental partners, and science institutions and policy-making authorities alike. The GSPC was developed through a multi-stakeholder consultation process and includes 16 outcome-oriented targets to be met by 2010. These targets are being regarded as trend-setting in the development of outcome-oriented objectives, and this model is now taken up by other programmes of work of the CBD.

More than any other initiative, the Global Strategy for Plant Conservation has been acknowledged to have stimulated the engagement of the global plant conservation community in the work of the CBD. Parties are encouraged to develop national and regional responses to the GSPC and nominate GSPC national focal points to promote implementation and monitoring. As shown on this slide, examples of countries that have successfully developed their own strategies following

the model of the GSPC are the United Kingdom, China and South Africa, and there are many more.

In the same vein, a number of botanic gardens and related national and regional networks have developed strategies and projects in response to the GSPC. For example, Oxford Botanic Gardens have ensured that the GSPC is incorporated into teaching in all years of the Biological Sciences degree course at Oxford University. The GSPC itself has become the syllabus for a course module in plant conservation. Every visitor to the garden is given a guide to the GSPC explaining the 16 targets. Missouri Botanical Garden focuses its work on 7 the 16 GSPC targets including taxonomic research and activities related to the establishment of inventories, conservation status assessments, identification of centers of plant diversity and endemism to inform conservation priority setting, and work with local communities to develop models for sustainable use of plants, raise awareness and build capacity. Here is another example of how the GSPC has brought attention on the plight of the status of plant diversity to the forefront of wider conservation efforts. The North American Botanic Garden Strategy for Plant Conservation is a comprehensive continent-wide strategy including botanic garden associations in the US, Canada and Mexico. Its establishment led to improved awareness of the GSPC beyond the actual botanic garden community, e.g. among other governmental and non-governmental conservation organizations, universities and research centers. Practical horticulture in support of the conservation of the flora of Britain and Ireland is the objective of the Target 8 Project led by the regional botanic garden network (PlantNetwork). This project aims to grow the threatened plants of Britain and Ireland ex situ and to link them to conservation activities in situ through building horticultural expertise and knowledge in propagating and cultivating the native flora.

Six years have passed since the adoption of the GSPC by the CBD Parties in 2002. A review of the progress in the implementation of the GSPC was carried out in 2008 under the chairmanship of the Global Partnership for Plant Conservation – a voluntary initiative bringing together international, regional and national organizations to contribute to the implementation of the GSPC. The review states that while progress has been made towards achieving a number of targets including GSPC target 8 – ex situ conservation, the urgency of safeguarding plant diversity worldwide remains very high. In particular, the denvelopment and implementation of recovery and reintroduction

programmes as part of GSPC target 8 still shows little progress, and more in-depth consideration needs to be given to the impacts of climate change on plants and ecosystems. Important challenges also remain for those GSPC targets pertaining to the sustainable use of plant genetic resources.

Botanic Gardens Conservation International (BGCI) has been associated with the Global Strategy for Plant Conservation from the beginning. BGCI supported its development, adoption and implementation, and also provides the secretariat to the Global Partnership for Plant Conservation mentioned earlier. Assisting countries and botanic gardens and related networks in developing their responses to the GSPC is at the heart of BGCI's endeavour to foster plant conservation. BGCI works at various levels of intervention which I would like to illustrate with examples in the following slides:

Development of resources and tools that contribute to building capacity and enhance knowledge in the field of plant conservation: These include for instance to explain multilateral environment agreements and policies of special relevance to botanic gardens; I would like to mention BGCI's CBD and CITES manuals for botanic gardens. Another important area for BGCI in support of plant conservation is to contribute to global conservation assessments using the IUCN Red List Categories and Criteria – let me highlight here the examples of the Red List of Oaks and the Red List of Magnolias published two years ago; other taxa we are currently working on to establish their conservation status are maples and rhododendrons. BGCI is also addressing pressing environmental issues like global climate change and its impacts on the world of plants; and we are in the process of setting up a global information service related to the links between climate change, plants and ecosystems. Monitoring progress in the implementation of GSPC target 8 using BGCI's PlantSearch database is an important activity for BGCI to identify major gaps in ex situ conservation. It is therefore essential that botanic gardens around the world facilitate the update of this global database on a regular basis. The difficulty of obtaining information on ex situ conservation that Dr. Priya Davidar just mentioned in her presentation from India illustrates well those challenges.

BGCI is also implementing a number of practical conservation programmes in collaboration with botanic gardens and other conservation partners. These include species-specific ex- and in situ conservation projects focusing on threatened taxa, for instance

Aquilaria crassna (Thymelaeaceae) in Cambodia or *Bretschneidera sinensis* (Bretschneideraceae) in China. Engaging local communities in integrated programmes that link conservation and activities for improved livelihoods are becoming a more and more essential part of BGCI's work programme.

I would like to draw my presentation to a close. To summarize what I have been trying to discuss and illustrate in this presentation about the challenge in linking science and conservation policy, I would like to highlight the following points:

Despite a plethora of scientific reports on the state of our biological heritage, we still have limited data, tools and technologies, especially in developing countries, for a number of scientific fields. There is a lack of applied resources to undertake taxonomical research; there are still very few conservation status assessments for many taxa – the world of plants is grossly under-represented. We need to better understand species, for example reproductive biology, and we need to gain more expertise in conservation techniques such as seed conservation. Developing alternative management responses to global climate change will become increasingly critical. Then, we need to think also much more about the language we use to communicate our scientific findings. Scientists and policy-makers talk past each other in their own jargons and this is compounded by the diversity of various existing languages. Information dissemination and distribution is not one and the same thing, we need to better guide the reader and produce target audience-oriented policy guidance using appropriate styles and jargons. So, interpreting the evidence base to formulate policies which can be effective and which are understood by everyone is also a key role and niche for botanic gardens and I think we have to aspire to that in a much more firm manner.

BGCI has set out its strategy in responding to these challenges in its Five Year Plan 2007 – 2012. More emphasis on recovery and restoration programmes, a continued commitment to supporting ex situ conservation as a precautionary approach in the face of global climate change, a focus on conservation activities using plants of economic importance (medicinal and nutritional plants), and promoting science-policy interfaces for plant conservation by participating in or facilitating various policy fora and events designed for different target audiences.

I would like to conclude my presentation with some "intriguing" questions. First of all: Are we focussing conservation

efforts on the right priorities? For example, should we focus on crop wild relatives or can we afford also to put our efforts into conserving rare species (with equally uncommon names…) like Bretschneidera sinensis –which may not have an immediately apparent critical role in the functioning of the ecosystem within which it occurs? In other words, can we practice triage on endangered species to achieve quick and viable wins? Is putting values on ecosystem services for human well-being, the "economic argument" helpful or not in advancing the conservation agenda? Are policy makers interested in Red Lists and other biodiversity status assessments? If not, how can we promote their value? What priority can we achieve from the science base for future policy development? Well, I do not have ready-made answers to these questions. Certainly, however, policy and decision-makers are looking for simple explanations of complex issues. The challenge is to de-mystify our work so that the policy process can better understand the meaning of the scientific evidence.

Loss of biodiversity continues to be a major issue facing human societies despite the efforts undertaken through international treaties, rules and regulations and intergovernmental bodies. Science and policy will need to be better connected in these fora. More importantly, north-south and south-south capacity building and knowledge transfer need to be accelerated. Science alone will not solve problems. There is also a significant role for society and its choices as far as the type of the environment and biodiversity it wants is concerned.

So, conservation scientists need to work on several fronts. We need to build an excellent conservation biology base. We need to develop new science at the interface with other disciplines. And we need to better understand the role of science-policy interfaces in delivering the results of science to society. Therefore, science and conservation policy are two sides of the same coin. Thank you!

Q & A

Person 1

Q: You remind us that policy-makers and scientists are actually talking in different languages. I cannot agree more with that. But unfortunately, here most people are not policy-makers but scientists and students. So this message may not reach out to policy-makers in China. I have a question which is not specifically for you and which is in my mind for some time: In China, I do not see a good connection between scientific

education and the perspective of what you can practically do later using what you have learned in ecology and environmental science. E. g. there are little opportunities for scientific consulting work. The government does not pay a high priority to that. However, when I was a student in the Netherlands, I saw my friends transferring very quickly from their scientific studies to work in the public sector as well as in non-governmental organizations and associations. This question is for all the people here and also for Director Chen Jin, how can we develop a more robust scientific education that prepares us for the kind of career in environmental sciences and conservation in which we can have a real impact on the society?

A1: I believe you are in person actually an example of this kind of experts we need in the future. You mentioned that you have been studying in the Netherlands. I think one of the important dimensions to be well-prepared for work when coming out of university is to encourage the government to promote such exchanges, so that students from China can go abroad and study in other countries as well. This will forge ultimately a broader perspective and prepare better for a practical job following the years at university.

A2: I think universities are playing a key role in improving this situation. The research institutes need to pay attention to that, and the directors and professors should guide scientific research with a practical orientation. In so doing, students will not concentrate only on very specialized scientific questions but also think about practical solutions for big environmental challenges. I think XTBG is trying to work very hard in this direction.

Person 2

Q: I guess agriculture is a driving force for species extinction. Conservation of crop wild relatives is important in this context. If you look around XTBG, or on your drive from Jinghong to XTBG you can see land degradation everywhere as a result of agriculture. So what is the role of a botanic garden, a repository of species or should it argue with politics?

A: It is probably not an “either or” question. We need an approach that deploys a certain degree of pragmatism. At the same time, we also cannot do everything and so we need to focus conservation efforts on activities of specific interest to and research expertise of the individual garden; coordination among the gardens therefore becomes very important to build work complementarity. Making research findings available in the language that policy and decision-makers understand remains vital for every research domain the garden is

working on.

Person 3

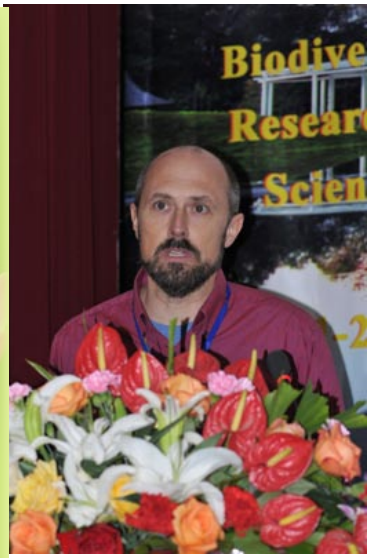
Q: An important question is what the government is doing for young people?

A: I think that most governments respond to what the people ask for. So it is the responsibility of each individual to put forth what the government should do and I am sure most governments are sensitive to listen to these requests. One of the ways such issues or ideas can be addressed is in NGOs associated with global issues and working together to get the government's attention to what needs to be done. To engage in either NGOs or other types of civil society institutions is a very good way for young people to draw attention to their concerns.

Thank you.

Seven pillars of biodiversity (we are not alone)

January 2, 2009



Prof. Dr. Chuck Cannon
Xishuangbanna Tropical Botanical Garden, CAS

Thank you very much. I am very happy to be here at the 50 anniversary of XTBG. I am very happy to be here on faculty and I would like to congratulate XTBG on 50 years of excellent work. I think the garden is in very good condition and it's a very good resource for the Chinese people and the Southeast Asia in general. I think it's a good tribute to longstanding commitment by establishing a research here at such a special place. I just want to congratulate on so much success.

Since we are talking about the dissemination of knowledge and information, I'd also like to bring up that there is a ATBC, Asia- Pacific meeting in Chiang Mai next month. This is website I've just actually got this off the web this morning. So the deadline has been extended so you can still register in the early bird registration.

Another thing I would like to mention is, the original idea for this talk is Dissemination of scientific knowledge in the purpose of biodiversity conservation, so I really was thinking about how to get the ideas about how our currently data of science and technology, and

what we think is very valuable, how we transmit that to the general public for the purpose of biodiversity conservation. I've been thinking a lot about this in different aspects. So I hadn't really thought much about genomics and that's a lecture I'm going to give in Chiang Mai. So I'm actually giving a much more complete lecture on genomics conservation next month, in Chiang Mai. Because John Kress mentioned, and also Richard did as well, so I will just talk a little bit information here about what I'm currently doing. But these are the topics I would like to talk about today. I am calling this The Second Modern Synthesis, the Conservation Endgame, and then the Seven Pillars of Biodiversity.

As an educator, I mean I am still a faculty in Texas Tech University. I taught there for 6 years and I often talk to the class with hundreds of graduates that are not majors. A lot of them don't have a very strong background in Biology, so I was really talking to the tough audience of the time. I was struggling with getting the message of excitement across. I think it is very important to get across the message that we are living in a very exiting time. It's a very exiting time to be a scientist. There are amazing breakthroughs on so many fronts that we are really gaining a holistic view on biology and ecosystems in general. It was just impossible in ten years ago. I mean we are now routinely doing things that were virtually impossible 5 years ago. I saw comments in publication a single lab can now do the work of basically an entire genome center used to do ten years ago and probably more than that. So we are at a really tiny time when there is a lot of convergence of different ideas. I'd like to propose this idea that there is a second 'modern synthesis' is coming up, mixed up with E.O.Wilson's idea of 'consilience' that we are going to see the convergence of a lot of intercounter knowledge and technology that will come together.

What is the first modern synthesis? Just a quickly introduce. I think it is important to remember when we talk about the theory of evolution that Darwin and Wallace, they did not know anything about genetics. When they proposed the theory of natural selection, they were completely ignorant of genetics. They were looking at organisms. They were trying to understand major patterns. They had never heard of Mendel. So their breakthrough is even more remarkable for that reason. As an educator also, I often found that you get much better response from the undergraduates and particularly from young people if you show Charles Darwin as a young man and you point out the fact that he made his major breakthroughs and insights when he was a young man. He voyaged around the world on the Beagle when he was in his twenties and he made his own mental breakthroughs when he was still

quite young. So as the general(are you talking about Mao?) back there has mentioned that it's the young people that are important and you are the one that going to make the major breakthroughs. That's the graduate in the back of the room there, the ones that really will contribute to the future of conservation. We always see Charles Darwin as an older man. I think it is very important to remember that he was young when he made his major breakthroughs. I'd also like to bring up that it is his birthday. On Internet you have a very nice background about some of his work on parasitic plants and things. This 200 years seem like a long time but it is not really that long ago. The publication of The Origin Of Species is great work published 150 years ago. I would really like to express my gratitude to Mr. Darwin because without him I would not have a job today.

The first modern synthesis was when darwinian ideas about natural selection was brought together with Mendelian genetics. So a lot of the theoretic work was done by Fisher, Dobzhansky and many others and they brought together genetics revolution and createed the first modern synthesis that contribute so much to our understanding about evolution and how things were.

I'd really like to propose that there is a second modern synthesis on its way. It is primarily due to this DNA sequencing technology. It is not an 'incremental' change. This is not a small movement, small increase about ? but a huge leap forward. You probably can read that table. I'd like to say that these are the technologies that we have right now and this table continues on to upcoming technologies and some of these are quite amazing. They said they will release their machine next year and it is the third generation of sequencers that will make things more faster and cheaper as well. So I think the second modern synthesis were really going to learn more about human genomics in particular because that is the focus of most genomic biology. But real genomic biology in general we will learn more in the next few years than we previous known in the past hundreds. This shows you a little bit time map of genomic biology's evolution. You can see here in this 1999, 10 years ago, this was when they sequence the first human chromosome. Just 10 years ago. Then a few years later they published first draft of the human genome. This was 8 years ago. Things are really progressing very rapidly so now, 2008, we have publications of the first diploide human genomes. We now have, I think a handful of human genomes that have been completed. There are a thousand of human genomic projects under way that will be completed soon. The number of genomes our there that are completed is rapidly rapidly increasing.

A lot of these have also got to depend on bioinformatics. It will bring together all the different databases, information sources, and a lot of work will look like this. I started out as a field biologist. I went to Borneo, I lived in the forest for quite a bit. I love the rainforest but for the next few years unfortunately I am not so exited about it. It is not the way things will work for many of the people are doing a lot of work that will push things forward. Bioinformatics is going to be a major challenge. It will be where a lot of contribution is made to the future of this work where it goes. It is quite amazing what they are able to do. On my good days, I am an OK programmer. I can do all right when I am writing programmes. So when I was getting into this data, I would write something and try to analyse a few million reads. I would set it up in the afternoon and go home and come back in the morning, perhaps the analysis was done. So I was actually looking around for other software that might be able to do it. There is package that actually came out from the human genome project called the “mummer”. The mummer package is free. You can download it, store in your computer, and set it up and do something, get a cup of coffee, and you will get answers later this afternoon. When I sat back down, it was done. So I was very humbled by this programme can run millions of reads against hundreds of millions of base pairs and line them all. It’s a very powerful programme and I’ve been using it as a basis for a lot of stuff I’ve been doing. The bioinformatics capacity is quite amazing. So in the second modern synthesis, we will move past the rather categorical concepts of ‘genes’ and ‘species’ and really begin to understand how these regulatory pathways are working together, deep genomic diversity as it relates from the individual and up to populations and species and so forth. I think it will be quite different from the previous breakthroughs because it will be those large groups and collaborative researchers who are going to make these breakthroughs. These are the people from the Michael Smith Cancer Genome Center that are doing the sequencing for my group. You can see in the text a large number of people run this center. They are actually producing a lot of data and most of the people are bioinformatics people as well. There will be large groups of collaborating people making this contribution.

Just to get into the genomics a little bit, this is a kind of stuff I added since yesterday. Just to go into a little bit detail about what the available next-gen sequencing technologies are. The most common right now is something called 454 parallel sequencing. People like it most because these sequences are rather long in relation to the other technologies. The sequences are coming in fragments of 4 or 5 hundred base pairs. They are relatively short but they are still not that short compare

to the traditional solar reads. It's also quite expensive and does not generate that much data. The other two technologies we have been focusing on Illumina platform from Solexa. This table is not very accurate and it is another sign of how quickly things are changing. It says it produces reads of 25 bp long, which was last year. They are actually up to 50 now with the paired-in technology that assists a great deal on the assembly of the genome. This technology is available. A lot of machines are running at the center here in Shenzhen, as one of the biggest clusters of machines in the world. They are running, I am not sure, 24 hours a day. Another technologies here is called Solid from ABI and that's the thing developed in Beijing Institute of Genomics. They are going to be a cluster of ABI in Asia, so this will be a major center. They've got machine there, and offered to sequence things for my group as well. We are hopefully sending them samples. There is an additional layer of complexity in analyzing the data from the Solid machine, which makes it a little bit difficult. But it produces 2 Gb of data in a single run. This is a very large amount of data. The human genome is about 300 Megabytes, so they can easily sequence a human genome in a single reaction. The major problem is the size of the reads. They are very short, less than a hundred bp long. But just to kind of give you an idea of what this means really, these are just some basic numbers. When we talk about computers we are talking about 32 bit addressing, 64 bit addressing. You might have heard these terms before. Most of the computers we are using are 32 bit and this refers to how many addresses they can make for a piece of memory on the chip. That's why most 32-bit machines can only go up to 4 Gb a run. This is the number of addresses a 32-bit machine can have in its memory. So a 32-bit machine can only have about 4 billion addresses. A 64-bit machine as you can see, now has much greater capacity. That size of computer, that type of architecture in the memory of the computer can now hold a very huge number of addresses. When you think about the DNA sequence, you think 36 bp is a very short piece of DNA sequence. But when you think about the number of possible sequences that you can have in such a short fragment of DNA, it's rather huge. It's larger than the architecture on the 64-bit computer. So within a stretch of 36 bp, you can actually have more information than a 64-bit computer can store on its memory. So you can actually map 256 64-bit architect chips onto just the information of 36 bp sequence. There is a great deal of specificity in such a short fragment of DNA. When you think about the size of the genome that are out there. The poplar genome is about 480 MB. The chestnut genome is about 800 Mb. You can fit over a million completely unique genomes within the space of a 36 bp sequence. Even though they

are very short reads, there's extremely high specificity. Even though it seems that you are getting very tiny pieces of information, they are very complex and have very high information context. so I really think 36 bp is really plenty of information.

Basic concepts about what we are doing? We are not doing'genome' projects. My aim is not to construct a physical map of these genomes. We are looking for genomic diversity, and that does not require a physical map. That's not the goal of the projects. We need to free our minds of an assembly-based approach. That has been the limitation for these micro-arrays, focusing on the assembly. Myself had kind of got caught up by assembly of these things. It is very difficult. You don't have a reference genome. So the reason this technology is so powerful with humans is that we have the human genome that we know the sequence of. You sequence the human genome, then you can align it against the reference genome. But for tropical trees, we do not have the reference genome so we had to do what was called de novo assembly.

So it's two pathways we are pursuing in my lab. This is the data pipeline we have constructed. This is all free software. These are programmes that I've written. This is free software you can download from the Internet to analyze your data. You can do the reference assembly, you can do the de novo assembly, using a series of programmes that become available to create contigs and then you can align it. You can go to this data pipeline and get your markers discovery. I am sure it is difficult when you have de novo organisms and you do not have a reference genome for. But even with these limitations, right now we have the majority of the chloroplast and mitochondrial genomes for these four species in over 1 million base pairs of the nuclear sequence. So it is possible to do this without a reference and to come up with a lot of information. It is actually one of the agonies. I do not know where to go yet. There are so much possibility for this data. There are so many things you can do with it from phylogeography to functional genomics that I have not be able to bit off a piece to really chew on yet.

This is just an example of what the data looks like when you aligned it. All of these little reads are lined up. This looks very repetitive but actually it's highly unique. This little sequence here has a lot of 'T's and 'A's and 'GC's around and these are all the same. But they are very specific. It is very unlikely you will randomly get that sequence even though it is very short. It is actually quit accurate. You can really assemble these things using such short reads. In the past months I really made my own step away from assembly why am wasting my time trying to assemble these

things? I really want to use assembly-free analysis because I am not trying to read the genome. I am just trying to get the information out of the genome. I am going to forget about try to put them back together. We are pursuing two interesting options now, using virtual hybridization against the known DNA microarrays that are out there and deep mining of complex k-mers. You can actually go and download affymetrix and microarrays off the Internet right now. There are 20 plant species that have been there, Rice, Soya Bean, *Arabidopsis*, *etc*. You can download these arrays that been designed to determine gene expression. These are all functional genes that you can use. So you can download these things and hybridize virtually against your data. I've done this for 4 of the Ramin individuals. These are the 4individuals that are Sum, peninsular of Malaysia, and you can see the sum went quit different than the Pah. This is the correlation in the frequency of these pro-sequence data for these different individuals. You can see these individuals are very highly related and the red dots here versus the black dots. The red dots are ones that are unique to the Ramin Genome. So there are 200 and something pro-sequences that are unique to the Ramin Genome in the one that been so far. So That gives you 250 low site that are each 25 bp long and unique to that genome of that species. It's a very powerful finger printer or signature. We expanded a little bit so we also have three species in the chestnut subfamily, *Chrysolepis chrysophylla*, *Lithocarpus havilandii* and *Lithocarpus turbinatus*. I also similated the sequencing of Arabidopsis, Poplar and Rice genome. So you can actually similate the sequencing reaction for these three known gemones as well, and compare the data that you get.

You can see the correlations of these pro-sequences on the X- axis. You have this sum individual against all of the other individuals. See the by the time when you get up to rice against this Ramin individual, there is very little correlation in frequency of these pro-sequences in the genome. So this is a very powerful way of distinguishing these different organisms. If you actually step back and say, OK this just takes the entire complex. 25-mers in the data. Every unique stretch of 25 bp in that genomic data, and begin to think about hundreds of millions of these in the data. I screened it down to 40million or so. This is again 2 Ramin individuals of the same species aligned against each other. You can see this is just one bunch of those 40 million; about 1 million 25-mers and there are a number of things quite different. We are talking about the frequency of these 25mers. So this individual has some 25mers that is much more frequent than the individuals of the same species. These will be very powerful tools when distinguishing the tiniest things.

Even at individual level, this kind of genomic data will be very powerful. In response to what John said about the budge that has been spent on the bar-coding. I am not criticizing bar-coding. I just want to point out the fact that there are a lot of opportunities out here because of this new technology. We can look at the budget. If we are just thinking about the available technologies we can start isolating DNA today and sending them to the genomic centers. Just given that budget, we can get 2X coverage of an average genome of a tropical plant. we can probably do about 10,000 species. If we get a third of the money for bioinformatics and computers, we still get about 6,000 species. We can do it today. What could we do about the genomic data? To find out more about that you have to come to Chiang Mai because I am stepping out of the genomic discussion right now and get back to what I am really going to talk about.

We are kind of returning to that idea the assimilation of information. 2009 is a very exiting time to be a scientist. It's also an extreme challenging time. We are obviously reaching some kind of major change in the world. It is very obvious to everyone, global climate change, the end of 'peak' oil, a lot of natural resources are seriously depleted, global population is quickly reaching seven billion! I just got this off Internet a couple of days ago. That's what they estimate the number of the people in the world is 6,750,166,706. We are rapidly reaching the conservation endgame. Paul Ehrlich predicted the global hunger will cause'The Population Bomb'. This did not happen because agriculture actually produce more food than he predicted but I think his argument is still very valuable and it might not be food. It will be other natural resources in different part of the world, such as energy and water. This is going to be an issue everywhere. E.O. Wilson also described the challenges to life, as we know it in his book 'The Future of Life'.

So what is an endgame? In chess, there is a different set of strategy. So you are reaching the end of the game. You have roughly equal number of pieces, equal ability of the players, and it will often last a very long time if you have a different set of strategy. I think we are now kind of at the conservation endgame. We are reaching the limits of natural resources. We have seen many different slides about the 10%, best situation 20% natural forest left. So we are very rapidly reaching the endgame. So really can we hope to reach a draw? Unfortunately, we are not evenly matched I think. Natural resource is the black chess and human population is quickly increasing, so the endgame is actually not balanced. As we are approaching this endgame, we need to develop new strategies, maybe radically different ideas about

how we can teach people, how we can send our conservation message out. We have to recognize that we are at the disadvantage here. Human development is a current whether we are going to control it. We also need to be realistic about our goals.

When are thinking about the conservation, we have to think the pieces on the map. This is a project that I have been involved in Indonesia, in Sulawesi, trying to map out the conservation priorities in Sulawesi. We took all the available data, the bio data, the environmental data, the geological data and put them altogether and came up with this map here. We are trying to pinpoint where the most important pieces are on this chessboard if you want to think it that way, and where to focus our strategy. This kind of thinking is very bible. There are a lot of organizations doing this kind of study. I think they are very important. But I think there is also another on earth in 1971 how many hectares those people are using per hectare that are occupied. If you are in the purple region, you are using a lot more earth than you actually occupied. So this is 2001. It is saying now we are reaching 120% of capacity of earth productivity. We are consuming more than the earth if producing. We are living on credit basically and we have seen recently in the US what this can do with the economy. The idea of living on credit in the natural resource basis is even more dangerous and more fragile. This is a very important point to make that we are living beyond our needs. If you look at the map of where the consumption is happening, this evaluates the size of the country, the level of consumption that is going on in that country. You can see it is really imbalanced between where the biodiversity is, where the wealth of natural resources are, and where the wealth in terms of economy and finances are, there is a major imbalance. Look at the size of Japan, look at North America, look at Brazil on the other hand, and many of the countries in Africa, where a lot of the biodiversity is. So you can see there is a major imbalance here between the wealthy countries in term of the economies and wealthy countries in terms of biodiversity. We have to think about that when we are thinking about the conservation endgame. There is a communication crisis. We have enormous amount of information. I told my undergraduates that when I was a undergraduate, we knew a small fraction of biology than we have known now. What they had taught me was relatively small subside of what we know now. So it is actually a much bigger challenge as a biology professor to teach biology, particularly in a general way to undergraduates, to non-majors, because we know so much more biology now than we did. So what do we teach? That's actually a major problem. How do we communicate this idea to

the general public? It is even more challenging when you think about the urbanization of the world's population. This is an interesting map showing you the travel time from any location on earth to a major urban city. It's actually getting lighter and lighter. You see here the scale bar, how many days it takes to reach a major urban city from any location on earth. The world is definitely shrinking. It is not just a figure of speech. We are rapidly connecting all the dots. You can almost see on dark spots in North America. There is no place in the US where is more than a few hours away from a city. So it is a very small world. A lot of the people are living in city. We are reaching a major tipping point that more than half of the world's population lives in the city that happened in the past few years. Most of the people do not come in contact with the natural world. How are we going to communicate the importance of nature to humanity that has had very little experience with nature? That is a major challenge in getting our message across as conservations and importance of biodiversity. If you walk outside, there are a lot of kids playing in the garden. But the garden is actually a very carefully medically controlled in relation to our true willingness. So how do we communicate with these people? E.O. Wilson put the idea of 'biophilia' forward but since we are becoming more and more urbanized, the concept of 'biophilia' is going to have less power. I think we need some kind of iconography, some way expressing these connections and the importance of biodiversity to the general public. Just show you some draft about how to get these across and it's in working progress.

Thinking about the tree of life. I think it is a very powerful symbol and something that gained recently so we have been able to understand the historical relationships among all the species and life. Somebody presents some problems when you use it as an icon because it implies directionality and lineages. If you teach in the US, it is also a very controversial notion that we are related to primates, we all connected in the history of life. It seems like the most non-controversial issue to me. They just hooked around. But as we are becoming increasingly urbanized, people have very little experience with the natural world. This idea of natural selection being an controversy still has a lot of weight. So I would like to introduce the idea of sever pillars of biodiversity. Thinking about the major lineages and how they relate to one another, in a very simple sense, microbes, plants, fungi, invertebrates, vertebrates, Our wealth, our health, and everything that in our lives are maintained by countless other living things. Let's kind of walk through these seven pillars. Micros, they are the earliest one of life, the simplest design,

with a single circular genome which is a single chromosome. They are also very vital because they contribute chloroplast and mitochondria to the rest of lives. Our cells depend upon mitochondria and plant cells capture sunlight using chloroplast. These things are originally microbes. So you can modify the seven pillars of life by having the vertebrates, invertebrates and fungi resting on microbes. Then everything we do, is depending on microbes. You can also have some kind of inter-connections of microbes into these different ranges of life.

So plants. The capture solar energy, turn it into sugar, fiber, fuel, and wood, so they are very important resources that we use. All ecosystems are structured upon them. Natural productivity comes primarily from plants. The grass family contributes most to our food and energy. So they are very critical for ecosystems everywhere. Then you can modify the structure again a little bit, and put plants at the base. But you still have a interface of microbes and you have this big interconnection between the mitochondria and the chloroplast between plants and microbes. So all of these things are very interconnected.

So fungi. Maybe you can think of it as the 'Internet' of the natural world. You might see it everywhere. In the soil they connect many different organisms. Some of the largest organisms on earth are fungi. In the soil a single clone can cover counties in Wisconsin. They are very good at recycle, re-using, and reducing. They can come in quite shocking color sometimes. So you can modify this a little bit as well. Fungi often form association with plants, so they have some kind of connection to plants. They also run parasity on different organisms. Fungi do not interrupt other organisms in a whole bunch. They do not have any kind of spore dispersal mechanism or very few. They do not really do much about seed dispersal things acted with other organisms.

SO invertebrates. This is the most diverse clade of life. They interact with every kind of organisms in every ecosystem. They provide very central pollination services. So insects, the most diverse and most important in ecosystems. I also would like to bring up spiders. I become fascinated with spiders in the last couple of years since living in the garden. It can be a very good indicator of habitat quality and condition because they are predators on a invertebrate level. They are the top predators many times and often hunt in different ways. We have web-building spiders for sampling flies and that kind of invertebrates; we have jumping spiders that are running around and hunting. This is actually a spider that looks like an ant. There are a number of ant-mimics that are jumping spiders. See its front legs have kind of turned into antenna-mimics. I thinks spiders are

a very neglected group. It can be very informative about habitat condition. So you can modify this a little bit more. Invertebrates encounter much larger and you can have interactions here between invertebrates and plants because there is pollination going on. They provide central foods to a lot of invertebrate species. It is good to remember there is increasing diverse speciation between plants are invertebrates occur.

So vertebrates. We are kind of late comers in the history of life when we about ecosystem. We provide really few direct services except those are domesticated. So the vertebrates are fit here. We do provide some seed dispersal services and things to plants. While they do provide a lot of services to us. We made a little bit modification so this is an ever more complex situation where there are a lot of interconnection between those pillars. It is no longer the idea that pillars are next to each other but they are inter-linked, inter-locked. The width of indicates diversity, the height indicate productivity. I am sure you have noticed I have been talking about 7 pillars but I only talked about five. I am talking about the natural situation so we have these 5 major pillars, they are very intertwined, and interdependent. They developed over hundreds of millions of year of evolution, then we have this very dramatic event that occurred to things on earth, humans evolved. So here we are somewhere on this vertebrate pillar and we began to very rapidly expand. Now we totally dominate earth. We wrapped ourselves around very pillar and invaded every little space on this pillar of life. Most 'wildlife' has undergone a recent and dramatic reduction in population size and ecological dominance. So humans have become a very important part of the ecosystems worldwide.

How did humans manage to do this? We created these artificially controlled ecosystems based upon agriculture and domestication. So now we have a very directional ecosystem. All these microbes, plants, invertebrates are all kind of bound together by human activity. We create crops, we create fields, we provide fertilizers, we put a lot of artificial inputs of the ecosystem so forth we create this artificial pillar of agriculture.

When we first began to develop, we had a few human populations coming out and quickly we took over more and more of this. For one thing, agriculture dose increase the productivity normally. We can usually get more biomass out of the region using agriculture than natural systems do. So we kind of dominate these regions more and more, and fragmented natural areas quite a bit.

The seventh pillar to me, will be biodiversity itself. If we can teach people

that we are truly not alone, we are only a species that aligns many other species, we are actually integrated into nature. We have microbes living in our cells; we have bacteria in our blood; we have many different organisms that living with us, upon us and associated with us. We are definitely not alone.

You might have noticed as I am going through this there is a kind of fillings nature of natural systems inside this network of human dominance. We can think of humans as a strangling fig. If we are a small seed germinated on top of this pillar of life, we grow down and we wrapped more and more around the rest of the natural world. Will we kill our host? That's a very fundamental question. Thinking about human as a strangling fig can be a powerful way for people who may not have a understanding of prey and predator relationship, what invertebrates and fungi are. It might be a compelling vital way to present them. We can actually add more and more details into this. You can present data and ecosystem in a more stick mathematical way based upon this kind of symbolism. You can actually use it to instruct people about the brilliance of ecosystem and the human relationship to it.

I would like to end it with a few questions. Thinking about people as a strangling fig on the tree of life, could we possibly stand without it and do we want to? We are not alone in this world. We have nature within us. We rely on nature for everything. We must not forget that we are not alone.

That's it.

Q&A

Person 1

Q: Thanks for this fantastic talk. Is there some relation between the DNA barcoding and genome sequencing and which one is cheaper?

A: You do not really have to go to Chiang Mai to listen to the talk. We are going to post a summary of the genomic work that we have done, how we use the data, and how the data can be potentially used.

I think the answer depends on the objective of your data. I think the DNA barcode will be very for things that designed for it. But I think we can get beyond the idea of simply sampling the forest. We are facing such a crisis of environment and we cannot wait. We are waiting for the genomic technology to benefit the tropical biology and it will be too late. In a decade, we will finally have the technology but we will have nothing to study. It is still a wise decision to go ahead and invest. It may

take you a couple of years to get a good answer. But what you will get is so much more powerful than a single barcode. You will be able to look at functional genes and many aspects of genome evolution. I think adopting this technology is available now. It is actually going to get cheaper. You can use the budget that John mentioned to sequence on a order of 10,000 species. It is just the problem of handling the data. But I think it is capable. Once you get to the point, in a day you are done. You give me the data, in a few days I will get to the point. Developing these pipelines is the problem but once they are in place. As for the machines, I am talking to people of Beijing Institute of Genomics. They are very interested with what I am doing. They are using SOLiD, which is actually a different machine producing different kind of data so it is another level of difficulty for analysis. But I think this will all be cracked by someone. So I think it is worth investment. We are going to send more samples to resequence. We have examples from chestnut family and all the major branches in that clade. We will be able to do a lot. In response to what John said about sequencing technology, if you look at what people use as genome type platforms, for humans, for domesticate animals, PCR sequencing has nothing to do with it. It is like you create a database, get your markers, put them on chip and then you screen your DNA against that chip. There is no PCR, no sequencing reaction. It is a DNA strand hybridization reaction. It is much more simple and sensitive. Then you can go to the field and screw a little bit fluid from that leave into this thing, and they will identify for you.

SESSION THREE

January 2, 2009

Bringing scientific institutions into action

14:00-17:30 Friday, 2 January 2009

Chairman:
Dr. Peter W. Jackson
National Botanic Gardens of Ireland

14:00 – 14:45: Turning challenges into opportunities: need for supporting empirical and applied research agenda for achieving an adaptive management regime for biodiversity conservation and sustaining ecosystem services
Mr. Hasan Moinuddin
GMS Environment Operations Center, Thailand

14:45-15:30 Conservation on Yunnan golden monkey
Prof. Long Yongcheng
The Nature Conservancy China, China

15:30-16:00 Coffee Break and Poster

16:00-16:45 Perspectives of botanical gardens' contribution to biodiversity conservation
Prof. Dr. CHEN Jin
Xishuangbanna Tropical Botanical Garden, Chinese Academy of Sciences, China

16:45-17:30 Tropical seed conservation and ecosystem services: a research perspective
Dr. Hugh W. Pritchard
Royal Botanic Gardens, Kew, UK

Turning challenges into opportunities: need for supporting empirical and applied research agenda for achieving an adaptive management regime for biodiversity conservation and sustaining ecosystem services

Mr. Hasan Moinuddin
GMS Environment Operations Center, Thailand

I would ask the first speak Dr. Hasan Moinuddin from the Greater Mekong Subregion environment operation center in Thailand to make his presentation on: turning challenges into opportunities: need for supporting empirical and applied research agenda for achieving an adaptive management regime for biodiversity conservation and sustaining ecosystem services.

Thank you very much! Good afternoon! I hope you'll not have any questions after the lunch. So that was very strategy decision to put this because my presentation will be different from all the curricula you have seen for the last one and a half days. And I think that while we were looking at high tech and advancement in knowledge as we go along, I would like perhaps bring you a little back to the Stone Age. And that is to deal with human beings and the nature of decision-making etc. Now, the title here is a little bit too populate, be very long, but what I am trying to say is the XTBG has played a role in this program and I would like to look at that role and also see whether future perhaps should be.

Before we begin, just a quick introduction or information: what is a GMS, the Greater Mekong Subregion? A program that six counties in Asia, including China, which two provinces in China are part of the Greater

Mekong Subregion. The others are Cambodia, Laos, Vietnam, Myanmar, and Thailand. Now they meet every three years in the summit, it is called the GMS summit or heads of state. The last summit took place in the March 2008 in Phnom Penh. And before that, there was the second summit that took place in 2005 in Kunming. They have GMS ministers' meetings that are basically meeting of finance ministers, because finance ministers are actually driving the GMS investment. The Asian Develop Bank only acts as secretary and facilitator. And we have about 11 major sectors in the Greater Mekong Subregion are going on. If you look here, you have an enrollment. There is a working group on the enrollment. Just give you an idea: it is an informal integration of institutions that work together. And most of the programs that RDB implemented about probably 12 to 13 billion dollars investment of which the Asian Development Bank only has a third of that. The second GMS summit, here is a picture of that, indoors, as well as the first Environment Ministers' Meeting which was held 2005. They are indoors.

The Biodiversity Conservation Corridors Initiative, we use abbreviation BCI. Yesterday I saw Prof Kress, I think, put out also BCI but that is supposed to be island somewhere. But this one is not in island, may be an island were sinking. Launched into 2006, stages have been equaled to the second environment ministers' meeting in 2008. And we are working to scaling up by Biodiversity Conservation Corridors Initiative activity by 2011. Basically, what is the approach by Biodiversity Conservation Corridors Initiative? So we know that protected areas are there. And there is a huge move to actually establish as many protected areas as possible. Sometimes the target was flag as at least 10 to 12% of the total land area of the world, even more, if possible.

Currently, as you may have heard even yesterday Dr. Chiu Sein as well, you know, there is very little land available on the production. What we saw in our discussion of the design was that protected areas are islands sitting around and they are getting more and more intricate into enclosure or even cut of or even be deserted in some countries. We saw that the connectivity, the basic ideas-defragment. You connect either through a linear corridor or a stepping-stone corridor, or through a sustainable landscape, which have a various variety or diverse land-use options. Now the corridor obviously will be protected area, but then you need to buffer them with isolation, and then you need to create something here, so continuous strips of land etc or stepping-stones on larger landscapes.

More importantly what are the sub-

borders of the program are first of all improve livelihoods. We think there is no conservation possible without the human dimension. We have to take development; specially life will be expected consideration or also take into account. Then we have optimum land-use. Most of the land that is currently available in the Greater Mekong Subregion still hasn't resolve the issues of land continue and land excise. You will have varieties of management regimes and this is important to actually give proper land analysis and land-use right to many of the biologists, for example, there are over 70 or 80 million right now within the Greater Mekong Subregion. Restoration is a very important part of it, as I said connectivity is important. So that restoration that make for the ecosystem productivity and hence capacity of a sustainable development. Capacity needs to be built also at the local level and the provincial level as well as the nation level. And finally there is no implementation without financing in the long term. Our program is a ten year program, so we are going a little bit infinite.

Now what we started with, as I said, is trans-boundary areas, we are looking at trans-boundary areas. Here is Vietnam and Laos. This is called the central land map. You get border land map here. Here is the tri-border forest area between Laos, Cambodia and Vietnam. Here is the Cardamom Mountains. This is basically bordering on the part of Thailand on this side. Here is the Western Forestry Complex. Dr. Chiu Sein yesterday said well the large primate mammals basically still exist here, which is true. This is a connectivity we are talking about Concorca in the south and Western Forestry Complex in the north. Here is Xishuangbanna and you are looking at the northern part of Laos here. As well as we are looking at northern part of Vietnam from this side. We are given have been the gain read been discovered, so to say, as well as the donkey's slap doors, south china monkey. Now these are some of the pilot sites we have. I'll just skip this and go strike to the targets.

Now the conventional biodiversity actually has a target of 2015 which talks about protected areas, protected area sustain and integrate wider landscapes. They of course use seascapes from marine areas. Now if I look at the 2009 target of the BCI, what you see here are these pinkish type of lines are corridors of economic development. The Greater Mekong Subregion countries have decided that they would like to have connectivity along these zones, and connectivity is through these economical corridors, which also means that they cut right through large landscapes of high biodiversity areas. These high biodiversity areas basically

have been assessed on the basis of many studies and services and literature that is there in biodiversity. What we actually mean to say is how we can mitigate the impacts of corridor development as well as economical development along these corridors. This one actually comes from Kunming right down to Bangkok here. There is another southern corridor.

By 2009, at least five biodiversity corridor pilot sites established, poverty reduction measures and restoration is undertaken and ecosystem service payment mechanisms have been developed. This is our target. Currently we have yard, we have got draft corridor designs zoning and demarcation that have been proposed. Here we are. We have 9 important measures that been undertaken. We have ecosystem restoration that has been initiated in some of the site. We have payments for ecosystem services under studied.

Now currently we designed the Xishuangbanna biodiversity corridor. We look at the economical corridor as I just have explained. This is our tri-corridor from Kunming down. It goes to Jinghong, and then it is now been collected with this highway that goes on to the Laos border and move on. We look at this area and we first said that what are the protected areas that you can find. And most of the protected areas basically were the national nature reserves; for example, these are national nature reserves here. You have another nature reserve, which has a more of a provincial level. You also have some provincial nature reserves and you have smaller nature reserve like Mengsong so long and so far. Here although we thought this should be a national nature reserve, this was not a national nature reserve. This is the Mengsong forest area. I am going to talk about a little bit later about that.

What we learned was we together with the help of scientists from XTBG and from other parts of China we look at what is the connectivity, where are we going to see whether corridors are possible, feasible and so on. So these are some of the potential corridor areas that we are undertaken at that time when I mapped and just made some of the basis for discussion. And finally when the project started we had this corridor area that was chosen and this corridor area you know very well that you always think this line of opposition so you thought this was the shortest possible distance and see what we can do here. This is of course different elevations and two different nature reserves under two different institutions one the YEPB or EPB, Environment Protection Bureau and the other on the Xishuangbanna Nature Reserve Bureau.

Now in the corridor which goes between Mangao and Nabanhe. You see Nabanhe here. You get Mangao here. There are about 40 villages that are in targeted, and this in theory of which we are currently looking at probably 15 or 16, something like that, within the first phase. Total area of this corridor is 15446ha. If you look at satellite map, it's about a year of a half or you see you have Mangao here, you have Nabanhe here. You see a slight, sort of you know, curbing snake-like from nation going to most of the slopes, steep slopes and high regions where forest is still existing. What we do know that there are deers and other mammals etc. that are still around and they move along. The other corridor that is in the south, here we can see in this part. This is Shangyng, and that's Mengla, and then here is the connectivity. We found that there was not much inhabitants here, but all these areas is robber. This all sounded by robbers under stage. This was the only really green area that connecting these two. And there is a large, highway of course going down to the south till the Laos border. So we found that this is very important to have a food productions status there. We got them and take them out and they moved out. And these are the current status that will be expectation some time under protected strategies of corridor linking the two here. Now these are some basic status, you know, a number of functions, religious, house wards, population, the sizing factors of these corridors Shangyng-Mengla and Nabanhe - Mangao.

And this is a sort of structure you may look very complex, but you have a project manage officer here then is prefecture guide's group with high leaders that are been moved to. In this box, there are a lot of people there. You see Prof. CHEN Jin's name here. You have Hu Shaoyun who is the EPB director. And XTBG is one of the organizations, here, with the others like EPB and VH and so on and so far. Right, there are some other cooperation agencies also Agriculture Forest Bureau and so on which are participating in this program.

What we do know currently is that on the poverty alleviation the villages of all in funds have been set up. So they have pilots in 6 villages. The villages have received the money in their own accounts. They have distributed the money. As proposed, they have got it back. Some of them have actually have got into a second cycle of the credit lending etc. The main reason is that it is important to give the local people an option to improve their livelihoods on restoration savings have been prepared for restoration, different kinds of savings on the areas to be disturbed. They have gone into feared. They have disturbed.

Which areas be connectivity, what the villagers need to do in order to protect those areas which will be restored etc. If you look at one of the pictures, basically is talking about determine farmland improvement area. Here. So farmland is not actually excluded. It is part of the restoration area. If you are wanting, you also have diversity with agro-forestry. Village-guards have been trained, security could be ensured. They are been hired by the villagers. They have been given certain contract to work.

Now what is we are seen as one of the major achievements is that Mengsong, as I said, Mengsong forest area has been looked at in terms of fit-ability. It is fit-able to declare there is a nature reserve. Basic information, report to government officials, conservation workshop, side-visit of the vice governor, you see, our on-sun heroes, most of them are being on-sun heroes sitting here. Instructions are given to foreign bureau by the governors' office for future planning. Conservation as well as I know is part of Bulong nature reserve. If you look at the next one, this is not exactly the map of Bulong nature reserve, but this was the targeted area that one was studying. I don't know how to read Chinese, but I am guessing. All these are robots. If you think it is different, let me know. OK, good! So when did it happen, it happened in the last two years. So just before the years we were there in 2005 or maybe earlier. So we could see when you looked at land-use changes in Xishuangbanna basically immediately after 2003, 2004 after 2009 has been a rapid extension of rural plantation, which obviously is not bad. If there anybody said that was bad. We have some problems with that maybe want more focus on that.

OK, emerging issues and challenges I meant to highlight a few of these vulnerability and risks to food security and biodiversity from the potential climate change impact is coming. And it is not just potential climate changing impact. The main issues when you have monoculture you also increase vulnerability, of the people to market vulnerability, of the pricing, and of that me say academics that comes out and so on and so far. So it needs to be also taken into consideration what kind of land-use they are having on their farms. Establishing policy regulation framework, recognizing concept of biodiversity corridors is one of the major challenges. Securing financial resources for the up-scaling investment activities of the biodiversity corridors is another challenge. And then I have another slide on challenges. Competing land-uses, as I said, competing land-uses actions, monoculture, cash crop expansion versus diversify and forestry and agro-biodiversity models. We have model on agriculture. I think what

we are trying to do is to integrate agriculture with forestry. Without to bring, however, biodiversity move out into the corridors and see how it reports. Absence of producing policy framework that gives incentives and disincentives, absence of regulation framework for establishing the corridors, creating forest databases through land model, social safeguard and net cash engross. Very important social save guard right now because of a downtime of very high GDP growth rate in China. You are currently having liberties coming back to their origins. We are thinking maybe there is an estimate of half a million re-back and also they will be going back to rural areas or to hand around in urban areas. The government is trying to put it in the public central investment program.

But our opportunities that we are talking about which is turning the challenges into opportunities. One would be, if the last one you look at the last one: linking founding for up-scaling to enhancing rural land opportunities, social safeguard go back from forest sector and carbon sequestrate. The first one is enhancing carbon sequestration potential and deforestation of avoidance under REDD. REDD means reducing emissions from deforestation and land degradation. Addressing food security in climate change risks and vulnerability of local communities through diversity certification and agro-forestry, then undertaking trans-boundary initiatives between Laos, Myanmar, Vietnam and finally the employed environment sector approach.

OK, the up scaling of such corridor initiatives would contain No.1, net cash flow to households. We have to provide something for improving livelihoods using village laboratory funds that we get initiated. If they are successful, we hope that this would be the major we are decentralizing directly let cash flows to the people who are on the crown. No2, land-use intonations are very important. Very few people had actually indulged intonation after doing the protected area borders. They have just set down and set down, that is enough. I don't think that is enough. Buffering the protected areas within the corridors, propagating diverse 19 options and sustainable forest management are really important. Yesterday you heard about volumes. There is a lot, lot of forest, but there is less volume of yields. And I think it's the same forest management rule along way to create that. Cash-based deforestation avoidance under reduction of dimensions that is red; cash-based forest restoration with long; rotation indigenous species for carbon sequestration and again cash-based plantations, fast growing species for house-wards cash through and promoting forwardly just wood processing.

You see what we are looking at is that these are exciting times not because of high-tech development and knowledge, but also exciting times because we are also grow. So 2009 this year will be the watermark of trying to figure out whether we can survive financial. But in these times we are also asked to look innovatively in the challenges and the challenges are, this is the right time to invest, right time to invest in renewable energy, right time to invest in biodiversity conservation through certain other techniques that are there, or certain other frameworks that are there. And this also the right time to say: well, look at Robert, we just looked down in this singer, you see the prices how they are. Many of the farmers are basically dig out rice together and put everything under robber, what are you going to eat tomorrow? We are the robber and team prices are basically collapse. Of course, that will come aback after 6 month, 8 month, 1 year, 2 years, but then you have the cycle going up and down. So this is the right time to propagate. Rushing is always propagating.

OK, up-scaling of the BCI as I said, really had been looking at this in the last one and a half years. And this area, this area is promising because about a tentative estimate is about 80% of forest cover. It's still intact. And we need to see whether we can do something about it. So this has now been declared as a nature reserve. So the question would be can we do something at the Myanmar border, can we do something at the Laos border. This is one of Dr. CHEN Jin's proposals in 2005. When you connect Xishuangbanna with Laos and you connect Vietnam, across to Laos, and then we can see some corridor possibilities along these areas.

OK, now I go to the future role and expectations. I did not cite anything from the British Society or any other international. I am just stating a selection from the Chinese academy of Sciences 9 transitions that were declared by the president and Prof. Lu on the 21st of November 2008. These are not all on line. I just take a few which I thought, you know, a better select, just to be my arguments. No.1, change in research mode from an isolated, free exploration to innovation activities concerning sustainable development; No.2, change from conventional practice of laying stress only on research papers and awards to also give importance to innovative contributions of research work to practice and development trends; No.3, stressing innovation and technology transfer; No.6, converging from a system mainly compose of research institutes according to academic decisions to a massive grade composed of both research institutes and innovation customs.

SESSION THREE

January 2, 2009

Now we can not ask straight away how much of that has been down because that just we're among the half of this declaration has happened, and all the transitions will take a long time to happen. But my question is: what is XTBG doing in that framework? Because XTBG is one of the major pioneer institutions. The key questions that are very importantly is yes. XTBG is a pioneering biodiversity research in the serial, and XTBG has an excellent database and has a very good reputation now build up over the years. Can XTBG link as pioneering diversity research to economic research and provide a plat form for policy makers to understand dollars and RMB in the context of ecosystem services? You see, ministry or finance, develop planners, policy makers, politicians, they know money. I also know money. Now if you talk about biodiversity, oh, my goodness, this is a rare, this is a demon, this is…..Ur, beg your pardon, what did you say? To go researchers and professors and stuff who are working on implementation of activity. Can XTBG play a policy and implementation role, turning challenges into opportunities? Currently I know in the BCI program that Dr. CHEN Jin and others have been instrumental in getting in the Bulong nature reserve established. The Bulong nature reserve is actually like *dokesho* if you ever heard of that story rushing against windmills and see these windmills are demons, you know, big evil forces that we must fight them. And this one man on a horse with a little lance and try to fight against the windmills. Here what we say is on the personal level because there is a personal communication and acceptance and there is a person on the governor's side, the prefecture who is willing , understanding and listening that things are happened, that the management decision that are be taken. But is this institutionalized? It is not institutionalize. CAS has a great standing in China. Can CAS see whether the prefecture and prevention levels and these roles been institutionalized? Do we have a commission here in XTBG because of its major role be played yet, can play this role on a continuous bases. Currently what we see is a lot of personal conflicts, here and there. I don't like this, I mean this, we are not there anymore. So that is what I am saying, we are back to the stone-age, you know. So whatever scientific advancement we do, whatever knowledge we have, we may go around with our mobile phones, getting a little bit of the sap and looking at the genome here. Out there, we are back in the Stone Age. So we have to do a focus; we have to do understanding; we have to do accept ion; we have grow these institutionalized manner. And that is what the XTBG opportunities are: turning challenges into opportunities.

And I thank you very much. I hope I am in time.

Thank you very much for that speech. Any questions anyone would like to put?

Q & A

Person 1

Q: Nature reserves, the question: how do you assess the capacity of the tree species in occurrence of carbon sequestration?

A: There are a few research programs ongoing that are looking at forest ecosystem types. The forest ecosystem, each forest ecosystem type, whether is a dry forest or is evergreen forest etc or deciduous forest, has a particular carbon sequestration potential even all the gross and land and deforestation, etc. We are looking at mature evergreen forest about 7T (tones) per ha-1yr-1 of carbon sequestration. And we are looking at plantations, new plantations of sequestration potential about 10T per ha-1yr-1. What happened here is that already some researches in Xishuangbanna has taken place on one or two our selected forest ecosystems. And I am going to look at that in our next BCI design up-scaling document and try to present that. Under the reduction of a mission from deforestation and land degradation, one of the major conditionality is the lunch market. What is the current status of the forest and how much carbon sequestration is there, and what is the conditionality, what are we bringing in terms of conditionality. So I think in the up-scaling that will be part of the research that we will do continuous research and at the same time we will look at the existing information that we have, and look at the design of the indigenous species. In Thailand we know that the framework approach has been used in Chiangmai, which has a lot of number of species that are putting there. But the department of national parks and forest department in Thailand have used much less number of species and yet have created a very good comeback of that kind of forests under the JUPI program in the last ten years. Now the question is not whether there is 100% sequestration, 50% sequestration. I think the question is that if you have plenty, in normally ends up to an average to 10T ha-1yr-1. Because it is growing and it absorbs much larger quantities. If there is a mature forest, that the forest ecosystem defines exactly what is the range of carbon sequestration. So I think you do not choose the species because of carbon sequestration. You choose the species because of forest ecosystem compatibility. What is compatible in the next door, and that is where we go in terms of framework.

Person 2

Q: Different country has the different situation. For example in China, the project is facilitated by the local institute like XTBG, and some other country like Cambodia which is facilitated by the international NGOs. So whether any judgment so what kind of approach is much more success in the long-term perspective.

A: OK, I lost my presentation here where the monkeys are present here. But I can say that, let's look at country-by-country and just be let grave very grave, you see. In Thailand, the entire implementation is down by the government agencies. There are no NGOs at all. And they are doing quite a good job. In Vietnam, there is collaboration between prevention governments' implementation and the WWF. But that was also ended in Phase 1, because it is been prepared for up-scaling in phase 2. In Cambodia, because of the institutional, structure was there. After the civil war finished the international NGOs were able to get decorations of protected areas. Now they are sitting in there like territory position holders in there. But that is changing dramatically. In the second phase, the prevention governments are going to takeover. So that is the stages we are moving into because each country has a different. In Laos, it's completely different. The national government is in charge. The prevention government are implementing, WWF assisting. In China, let's comes back to Yunnan, the government is implementing; the XTBG is assisting and giving technique advice and is part of the implementation team. However, in the BCI up-scaling, XTBG basically will probably provide research services and technique advice and we are not being on the mainstream implementation. Implementation has to be taken out. So phase-wise we have planned this way.

Person 3

Q: You mentioned money and everybody cares that. What are going to do with the farmers? You have to give some incentives that means probably if you gain some money from ecosystem services …how much money you save per hectare or spent ...

A: Yeah, very important question. I think one of the reasons why we have testing the village revolving funds at village level is when we went out the implementation and all our expanding from XTBG are here. You can find out that one of the questions resided is should be account whether the money should be given the involving fund should back we at the township? Because that is larger, you know, organization units that have government control. And all the villagers, as I know, we don't like that. We don't want to do that. So we decided that these funds must be operated and controlled by the villagers. That is our conduit. We

use that conduit in Vietnam. We use that conduit in Thailand. We use the same mechanism here to first get start their own fund, let them get expedience now when come in but ecosystem service maybe come in. Our suggestion always would be never put it into a centralized regional, provincial, prefecture never fund, never. All this go directly to either the villagers or the community based organizations, associations that are working in other countries that are doing this kind of similar work. Give them the money directly; let them account for it, even if there is a linkage of low percent percentiles. In this more important for them to understand gross through level democracy and dealing with this under decentralized level. We have learned this experience from many other Southeast Asian and substation countries. So that will be our way forward. In the example from Laos, which has already a similar system where this sent are being account. It is the operatives of hydropower have agreed to put the revenue that they will generate from which percentiles will go for BES. We may put it into a big fund. We still wonder to know how it's going to work. I personally feel that's under right base. So that would be my long answer to your short question.

Person 4

Q: I want to know do you have some expectations of the future of the corridors. Let's say when it takes 50 years, how we look at the corridors?

A: Well, I am not sure how they look like. But the program has a 2015 target. And the 2015 target for the program, if as we are proceeding to Phase 2 and Phase 3, and we know that the Environment Ministers' meeting in Phnom Penh has already asked us to prepare for the investment framework. The 2015 target is that every corridor that will working on from the year 2006-2007 will have some connectivity reestablished between the protected areas. This is one. Whether the stepping-stones are related to linear forest, whatever it's possible. No. 2 we'll have sustainable use options there, of land-use. Sustainable use means that the monoculture will be with other diversity fighting in forms of land-use. We do not question that robbery is important. Robbery is very important. Coffee is important; tea is important; all these are very important. But our question is a balance. The balance is important because even taking our vegetation cover from one area obviously create landslip. And that landslip needs to road maize land costs. Those are costs that I externalize. Nobody actually thinks about that. But we have to get the government to understand that they are certain vulnerable areas where robber has to go, where forest cover have

to comeback. And that's the issue. So by 2015 at least, we will have listed the 3rd most important parties, then livelihood will back. There is a livelihood coming out of this activity. There is a connection between people were living there and the protected environment not because they are under force or they are under some big police, but they understand that there is valuable income coming out of that forest. Be it a romantic, be it senses, be it oils, be it NTFPs, or be it entertainment. So this is our vision for 2015. 2050, if the climate change continues as it supposed to, then I am very pessimistic here.

large mammals are actually moving north to south. And what needs to be done to restore these areas, to continue and enhance that movement. In China, they have down some surveys of what kind of mammals and others are moving in the corridor. They have not yet put any monitor system because there is no large-scale distraction. The distraction of forest grows very slowly, and it just goes, you know, meter by meter. So we need to perhaps find out what kind of monitoring will be putting in place once biodiversity corridors are established in regular framework, I think, in China. But in other countries there is some monitoring.

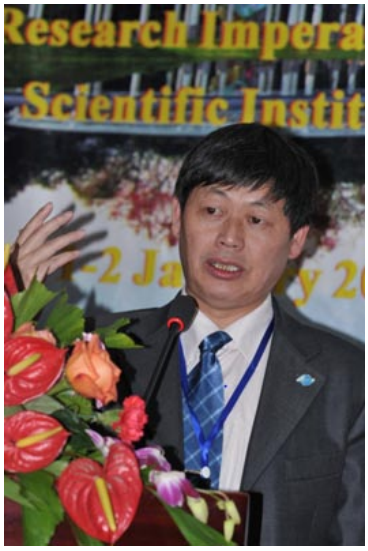
Closing remarks

Chairman: Could I finish with, are you aware this: biodiversity is currently already using the corridors for movement between these important areas, and have got mechanisms and base to monitor to what extents this would be to have important and justified their existence.

Answers:

Yes, in different countries it is different, at different stages. I think give you one example from Thailand as I said, which is connecting Western Parts of Campracham. They have done a very detailed analysis and survey of which mammals, which

Conservation on Yunnan golden monkey



Prof. Long Yongcheng
The Nature Conservancy - China

First of all, I would like to thank for Prof. Chen Jin's invitation to such a meeting. I really appreciate this opportunity to enjoy so many nice presentations. It might take me 1 month to digest the questions that raised in this meeting.

I think XTBG is really amazing to me in two ways. The first one is in such a remote town such a great gathering with so many talents here to present their findings and propose some of the insights. The second one is that so many botany students just stay here and listen to my talk on monkeys. So it's really the first time for me.

So, my presentation will have three parts. The first one is about the species. Then I will tell you the history about the survey in the past and the third part will be what we are doing so far.

So, at the first part for this species, what I can say is that they are beautiful creature, great creation of the god. Here the god is actually the nature. This is the concept proposed by a Dutch philosopher, Baruch de Spinoza, about three and half centuries ago.

So, this is the monkey, with a face and red lips. It's a really humanlike animal. And you see this is a soldier of The Flying Tiger. And I think many of you must be very familiar with the Flying Tiger, which is famous during the 2nd world war. So when look at the mouth and the teeth, you can see that the monkey is really very human like creature. Almost no difference! And I should also mention that this monkey is the biggest monkey in the world. Some of the males can be over 50 kilograms, but I just say 40 kilograms. From this photo, you can see how huge the male is. The female is usually about 10 to 15 kg. But the male you can see here, if you put Yaomin and his wife sit together, that might be the same contrast. Most of the primates are found in tropical area because they don't have fat under the skin, and that's why they can hardly bear the cold. These monkeys are very special and they are always associated with snow mountains. So sometimes they can go up to 5000 meters above see level. Actually, I did have a chance to take photos on the monkeys while I was standing at the elevation about 4750 meter.

This is so unusual. That's a unique adaptation, which we know very little so far even after a study that have lasted for over two decades. It is very hard to see the monkeys in wild. Sometimes, it will take us about 3 months for only one glimpse of the monkeys. Here you see the fir forests are their main habitats. When I first travel to US in Oregon in 1991 I saw so many fir forests in the area and said, 'We should bring some golden monkeys here'. But actually, all the creatures are created by the god (the nature) and you can find that they always have certain ecological function in that ecosystem, which makes sure zero waste in the system. So if you bring something to somewhere as the artificial modification, then you can hardly avoid such mistakes because we are human beings, not god—the nature.

Lichen is their main diet. In this world, very few mammals use lichen as their main diet. So this is very creative and unique ecology niche. This species is very different from any other kinds of primate species as far as we know. Unlike the all the other flower and coniferous plants, the lichen doesn't have the one-year cycles.

These monkeys spend a lot of time on the ground. Sometimes the momkeys will bring the baby on the ground to search for food and so the kids will be able to learn the skills. Based on my observation in 1998, the monkeys spent about 20% of their time on the ground. Actually I do have a bias to give such a result because: 1) you can see the monkeys in a distant if they are on the tree crowns; 2) you can only see them in a very close distance when they are on the ground.

The basic unit for the monkey's society is the one male unit (OMU). One male usually have 3 or 4 wives. In this picture, the male has four wives. Maybe that's why the male is so tired, and its status may keep for about 5-10 years and then another one in that group would take his place. The competition for mates is very fierce. That's why the males become bigger and bigger, and the average weight is 40 kg.

So now, I will talk about the surveys and history in the past. First record about the species is taken by a French missionary in 1871. He wrote in his report in 1871, Dec. 26, 'Oh, I heard somebody said that there is a huge black monkey with a long tail in the northwest Yunnan'. But later, in 1895, in a real survey searching for the living specimen, Biet and Soulie were successful to get 7 specimens and brought them to French. Biet was another French missionary who then served as the bishop in northwest Yunnan's Deqing County.

The first Chinese scientist who found this species is Professor Peng from Kunmin Institute of Zoology. In 1962, he collected 8 hides in a shop in Deqing County. His finding confirmed the existence of this species.

Another thing I should mention is that Biet and Soulie found it in 1895. But in the literature, you can always find it was 1890. It was wrong because everybody just cited each other. Actually, only in last year,when I had a chance to read the original publication in 1898 in French, I noticed that the date was 1895, a five-year difference.

The field survey in China was performed by Professor Li Zixiang, Ma Shilai and Wang Yingqiang from Kunming Institute of Zoology in this site. It was in 1980 that for the first time human knew about the monkey in the wild. Then Professor Bai Shouchang from Kunming Institute of Zoology performed a field survey to search for all the populations in the wild. By he just collected some stories from the local communities. The real search for all the populations is done by me. This is really a long process. Initiated this in 1987, it took me almost ten years to find all the populations. The data was published in 1994 and 1996. Recently somebody mentioned a new observation of Vietnam golden monkey found in the boarder between China and Vietnam, which is a new population. I think we should just announce to the world when we've found all of them.

No.1 in this map shows the place where they recorded the monkey for the first time. I changed the location just one month ago because according to the literature, the monkeys are called by the local people "ZHICHA". Only the local people there call this monkey in that

way. But recently, when I carefully study the first publication in 1898, I found this site. All the 7 specimens came from the three sites nearby. So only one month ago, I changed that.

No.2 is just one-day walk from Deqing. It is the place where the Chinese scientist first saw the monkeys in wild. From this site, Chinese scientists collected 3 specimens and they are still stored in Kunming Institute of Zoology. But the population is extinct already. At that time, this is the only site where the survey team actually saw the monkey.

These circles (on the graph) are drawn based on the interview with local communities done by Professor Bai Shouchang. In fact, they didn't have coordinates. I just put that like this based on the original map and their position related to the rivers. Bai claimed the monkey then has 11 groups with 800 individuals in total.

This is my survey results published in 1994. This is the first time to give coordinates and size for each of the 20 populations.

This is the map for the monkey's geographical distribution and population published in 1996 also by me. I integrated the 20 populations into 13 ones though actually some of the integration are right and some are not.

During the survey done in 2005, 5 local management authorities were involved and this is the results.

Here I would like to raise one question: Why in such a large area, more than 10 thousand square kilometers, the total population of the monkey is so little while this area within the Yunnan Baima Snow mountain National Nature Reserve, which is less than 3 thousand square kilometers, we can see that almost over 60%-70% of the total population of the species? While within the nature reserve, the monkeys here in this area about 100 square kilometers are more than those found in all the rest of the reserve. Why? I think the reason for this phenomenon is the protection for the monkeys is in place in the reserve, especially in this site. This also means there is no much real protection for the monkey species in other places.

Now we've found three groups of the monkey have been extinct. For an instance, this is the 1st site where our Chinese scientists saw the monkeys. The specimen are still there, but the monkey population has vanished. Three groups are still outside the nature reserve. You see, the monkeys do not know the boundary of the nature reserve. They just live where the diet is.

As I mentioned, hunting is still the main

threat to the monkeys, otherwise we will not have the situation that this place with such high population while other places so few. Habitat loss poses another chief threat in the long run because we have so many people, even in northwest Yunnan.

This is some data published on "Molecular Ecology" in 2007. We found three gene-pools for the monkey species range-widely. You can see this is the one outside the nature reserves and it is also the most endangered gene-pool.

Also the needs of the HR(Human Resource) and financial resource for the local management are desperate. For an instance, Baima Snow Mountain National Nature Reserve has only 7 staff, and they are supposed to take care of an area almost 3000 square kilometers. That's impossible.

I took this photo just last year. It shows sometimes we have no tents or shelters to stay. The working condition is very poor. At the moment we are trying to promote the tourism in that area, and perhaps this is the only way for us to sustain the monkey populations found in that area.

Now I should mention what we are doing for this species for the conservation. First one is that we are trying to build and sustain the partnership for the monkey species range-wide conservation action. Fortunately, we got the half a million US dollars fund and then got all the partners to be involved in the action. We have mobilized some scientists (both domestic and overseas), and all kinds of authorities, including SFA (State Forest Administration), Yunnan forestry department, Tibet forestry department, and all the local management authorities in the area to be involved in the action. From this photo, you can see these guys are from the Tibet Forestry Bureau. I tried to bring all of them together and sat down for the discussion on the species conservation issues. This photo shows the 2nd meeting of the Yunnan sunb-nose monkey project steering meeting, and we also have the 3rd and 4th meetings for the project.

We also have a local ranger training of the management authorities, and then they could know how to do the management, how to survey, and how to take care of the animals. It's very important to get support from local communities.

We initiated the "hunters to protectors" project, and we establish the hunter conservation association in the area. This guy is over 80 years old and he used to be the best hunter in the village and had already killed over 100 Yunnan golden monkeys in the past. However, he is now teaching his son to be a good

protector.

We also initiated the conservation biology study on the monkeys. Now a international study center is going to be established soon. Yunnan provincial government has taken this into the agenda and so far 50 million Chinese Yuan has been in place already. I do believe in near future it will attract the eyeballs of the world.

This is a picture from the discovery channel. We are trying to formulate the China Golden Monkey Conservation Action Plan, not just Yunnan golden monkey, but also other two species of the golden monkey genus. The action will cover 7 provnices, including Yunnan, Sichuan, Shaanxi, Gansu, Hubei, Guizhou and Tibet. So we have done a lot of discussions with local management authorities and local rangers about this action. Now we are trying to persuade State Forestry Administration to formulate such action plan. Chinese government has set aside a lot of money for the action already and just wait for the action plan for the guidance.

We are also trying to set up a GIS-based Info Management System. The 50*50 meter grid system has been set up for whole Laojun Mountain Area, which is about 7,000 square kilometers. All the detailed information for each of this grids could be easily look up from the system. That's a really kind of the application of the concept that Richard mentioned yesterday.

The last thing we did is try to promote the public awareness and get support from society. This is a book published for the public appreciation. This is the assistant secretary of the Department of States of US. She came all the way from US to see the monkeys in the field with me. This is Yunnan's two top officials held this monkey photo in last year's NPC. So we are expecting such conservation action will soon get quite some support from Chinese government. That's what I want to say.

Thanks.

Q & A

Person 1

Q1: The monkeys only eat the lichens? Not fruits?

A: The main diet of the monkey is lichen, because it is such a universal food in that area and you can find lichens everywhere. Of course they would like to taste fruits with no much sugar. They usually prefer the food that is bitter in tasty. As you know, fruit is only available seasonally while the lichen can be found all year around. Just like the people in South China, we have rice everyday,

but we also have cucumbers or pumpkins for certain seasons.

Q2. What is the relationship between this monkey species and the golden monkeys in Guizhou, Hubei, and other provinces?

A: They are from the same genus, the genus of golden monkeys. We call them golden monkeys because the first species in this genus is Sichuan golden monkey with really golden hair and it looks real golden in color. So this monkey genus is named as golden monkey genus. When we found the other 3 species in this genus and found they are not golden in color, it is noo late since the genus name is used already. That's why we keep on calling them golden monkey. Vietnam golden monkey, Guizhou golden monkey, Sichuan golden monkey and Yunnan golden monkey are the four species in the genus. The Vietnam golden monkey usually lives lower than 1,000m asl., the Guizhou golden monkey lives between 1,000 to 2,000m asl., the Sichuan golden monkey,2,000-3,000m asl., and this Yunnan golden monkey, 3,000-5,000m asl.

Person2

Q: It is a very interesting report. You just mentioned one way to protect Yunnan golden monkey, which is turning the hunter to protector. I am wondering that what approaches you took to realize the changes.

A: That's a good question. It really took a long time. I had to contact the local hunters to search for the monkeys during the long process for searching the monkey populations, and then many of the local hunters are my friends already. Usually, they are the best and most prestigious hunters in the region. After such two decades, we established very good relationship, very intimate. Also, they became the true lovers of the monkeys during the process. We also established the Hunter Conservation Association in the local area, and kept them under the management of local forestry bureau. Now they stop hunting and become protectors to work for the local forestry bureau.

Person 3

Q: About the hunting, is there a market for it or just local consumption?

A: Mainly local consumption, but in the past some part of the monkey is believed to have medicinal effect, and one monkey can be exchanged for over 100 kilogram of rice. That is a really value to them. Sometimes I talk with my friends: "If you go into a jungle and see $1,000, will you take that? You might not in the public but how about in the forest and nobody knows? It is the same for the hunters.

Person 4

Q1: What is the main difference between the male and female Yunnan golden monkey? You mentioned that the male monkey are usually very big, but apart from the color, the size, are there also some other differences?
Q2: What is the sex ratio of the golden monkey?

A: To me, the sex ratio is just like human, around one to one. But there is fierce competition among the males because one male usually has 3 or 4 or 5 or even 8 mates. The females always tend to choose the biggest one. If I were monkey, perhaps I would have no chance to gain any mates!

The hair is different. I will show you, look at this picture, this is the male, this is the female. That's obvious.

Person 5

Q: It almost takes you 20 years to accomplish the change from hunters to protectors. As you survey in forest, did you see the hunters kill the monkey? What did you do?

A: I only have one chance to see the hunter kill the monkey. He was an old man when I first met him in 1988, he was killing a female. I didn't hire him as my assistant. I just persuaded him and told him how valuable these monkeys were. He then felt really regret and promised not to kill a monkey again. Sometimes you have to be patient because such hunting practice has lasted for thousand years in the areas.

Perspectives of botanical gardens' contribution to biodiversity conservation

Prof. Dr. CHEN Jin
Xishuangbanna Tropical Botanical Garden, CAS

Good afternoon everyone, after two days of excellent presentations and discussions about the botanic gardens' role in the biodiversity conservation, I wish my presentation is still available to our audience. As one of the research institute, we need to discuss how the botanic gardens make contribution to the biodiversity conservation.

I think most of the people here know the definition of botanic garden. They are institutions holding documented collections of living plants for the purposes of scientific research, conservation, display and education. Theoretically, botanic gardens have better materials, which can make contributions to the biodiversity conservation. As research institutes, botanic gardens generate knowledge on conservation or plant science, ecology, horticulture that relevant to conservation, provide material for research and conservation programs, carry out ex-situ conservation for endangered species, involve into local/ regional biodiversity in-situ conservation program and public education. Those are the functions that a botanic garden can play. Actually, botanic gardens (BGs) can really go through these channels towards conservation and BGs really take very unique partition to provide implement to conservation.

Here is a more comprehensive list

of ways that Botanic gardens can implement the CBD by Wyse Jackson & Sutherland in 2000

1. Contributing to national biodiversity strategies and sustainable development (Article 6)
2. Undertaking work in plant taxonomy systematics, floristics, inventories, monitoring, and surveys (Article 7)
3. Contributing through the development, designation, care and management of protected areas, habitat restoration or re-creation and wild plant population research, recovery or management (Article 8)
4. Developing and maintaining germplasm collections including seed banks, field genebanks, tissue collections in culture, individual species recovery programmes, and databanks (Article 9)
5. Identifying and developing economically important species in commercial horticulture, forestry and agriculture, and in bioprospecting (Article 10)
6. Undertaking research in many relevant field, such as taxonomy, ecology, biochemistry, ethnobotany, education, horticulture, plant anatomy, biogeography and providing training opportunities and courses in conservation and related disciplines, often available to national and international trainees (Article 12)
7. Providing public education and developing environmental awareness, including programmes to promote public understanding of biodiversity, its importance and loss. Many botanic gardens play important roles in school and university teaching (Article 13)
8. Developing the capacity of partner institutions for biodiversity conservation through collecting fees, research support, equipment, information, training, shared specimens. As well as providing access to their vast conservation resource of stored and managed biodiversity (Article 15)
9. Making information on their collections and the results of their research widely available through published and unpublished literature and accessible databases. Many botanic gardens share data on their collections (Article 17)
10. Cooperating in technical and scientific areas, including joint research and staff exchanges (Article 18)

One the one hand, we often heard some kind of discussion about for example the collection in crisis. This passage is from universities that suffer from financial difficulties or do not know how to make use of the collections. Because the collections in the universities or the herbaria are not well used and they have to maintain them. This is the idea that proposed by some scientists.

There are actually a lot of discussions, including one meeting I attended in Paris called the Buffon International Symposium, which is a collection of

people from natural history museums and a couple of botanic gardens. We met together to discuss how the natural history institutes can play a much more important role in the future conservation or knowledge generation programme.

That is a paper published in *Nature* for the botanic gardens. Probably comparing to those natural history research institutes, botanic gardens are in much better situation, noticed a couple of years ago by *Nature* using the title *Gardens in Full Bloom*. Everything is good for the gardens. They get good finance, have good skills on preserving rare plants, which may provide relevant material for molecular researches.

This talk comes from Mike Maunder. He was supposed to attend our symposium but he has another appointment. He mentioned that the botanic gardens are rather skillful in running educational programmes and garden design to attract the public. In Mike's paper, he used a picture took in China, which is the Fairy Lake Botanical Garden. So, botanical gardens are in blossom, great. But if we talk about botanical gardens' contribution to the conservation, probably the role needs to be re-examined. For example, botanical gardens have been considered to play the role as a conservation center. That is coming either from conservation communities or from scientific communities, or common public. A couple years ago I went to Bogor. The Bogor botanic garden made a clear statement to make Bogor a conservation center or something like that. That is the kind of things that we can discuss here. If you talk about the ex situ conservation, we might ask how many native species, especially those with accurate record from wild and how many endangered species have been maintained inside the botanical garden, and how much effort has been put into reintroduction program.

Another thing we would like to ask is how many botanical gardens are really involved into local or regional *in-situ* conservation program. How many habitats have been saved? Which national or local conservation regulation established with the facilitation of BGs?

We provide material to research and conservation programs. People often argue about botanical gardens profitable or non-profitable organization since we charge for some kind of service, also we get very good price for entrance fee. So it always makes people confused, especially when comparing to some other commercial-based theme park. Then, to enhance public awareness through educational program, we can ask those gardens, whether the major purpose of visitors to the garden is to

be educated or some other purposes. So are those educational programs we conducted really functional? A lot of questions remain unanswered and let's discuss one by one.

First, are those BGs knowledge generating center for conservation? Those are the publications in SCI, which is the Science Citation Index, not the stupid Chinese idea(laugh). From 2005-2008, we published 179 papers. We calculated the papers into categories. So for plant science, 35.2%; ecology,19.6%; environmental science 11.7%; forestry, 7.3%; biodiversity and conservation, 6.1%, not very high.

If you think XTBG might be a special case, let's look at a much more famous one, Missouri Garden. They have much more publication during the same period: plant science, 75.7%; evolutionary biology, 13.4%; chemistry, medicinal, 10.1%; ecology, 6.6%; pharmacology and pharmacy, 6.3%; biodiversity and conservation, 2.4%.

You may doubt using the category of SCI has some kind of bias. We noticed for ecology, we got roughly one searching generally belongs to the SCI category. If you have a different pool, it is easy to get a different ratio. But we can look at one famous organization, Wildlife Conservation Society (WCS), which is both a conservation agency and research institute. They got a much higher number of publications, more than 570: ecology, which is very related to conservation, 40.0%; zoology, 23.8%; environmental science, 14.7%; as for biodiversity and conservation with the same category and same definition, they got 14.6%, which means comparing with those pure conservation based research institutes probably botanical gardens are not directly towards the core part of the theory.

So my first conclusion is that most, or many research botanical gardens generate knowledge that is relevant to conservation, but not directly towards, or be the major force for the core knowledge of conservation. This is my first judgment.

Nowadays we are talking more and more about the role of botanical gardens in *Ex-situ* conservation. This is an academician from the Institute of Botany, CAS. He mention that botanical garden has many roles but probably is the only organization that could carry out native plant species ex-situ conservation. Prof. Barthlott has also mentioned several times that in European BGs, α-diversity of the total species number of the plants in each botanical garden is extremely high. They are often small in size, only 700 ha or so, while holding maybe more than 10,000 species. However,

the ß-diversity is extremely poor. They noticed some species are just transplanted from one garden to the other. So in terms of the value for genetic diversity, it is not as rich as the collection of specimen.

OK, let's look into China's case. We have packed all the database from the 8 major botanical gardens in China, including XTBG, South China BG, Wuhan BG, which are the 3 major botanical gardens belong to CAS. The other 5 are Beijing BG (CAS), Fairy Lake BG (now belongs to the government but also correspondent with CAS), Nanjing BG, Guiling BG, Tulufan BG(CAS).

So we believe these 8 botanical gardens hold at least 80% of the total specimen number in the whole China. We have very accurate data for the total specimen number, which is 39796, including taxa under species, which belong 409 family and 3914 genus. It is very surprising to look at the species duplication in botanical gardens. We can notice that 93% of the plants have been maintained in one single botanical garden. Very few duplicates. I guess this is mainly due to the widespread distribution of these 8 gardens in different geographic region. So technically they just collect the plants near their gardens. I believe this is very different comparing to the gardens in Europe or North America.

We just mentioned that 39796 species in the garden are preserved in the eight BGs, but how many are native species? The data pool we are using is of total 28851 specie. 64.6 % are China's native species; 55% of China's native plants in genus; 83% of China's native plants in family. So more or less 50% of the 40,000 species maintained in these 8 botanical gardens are China's native plants.

However, if we look into the endemic and endangered plants, the situation is very different. Whole China's endemic plants in genus are 243. Only 42% totally 102 endemic genus has been preserved in the eight gardens. Whole red-book listed plants include 392 species and 204 (52%) species have been collected in the eight BGs. Among a total of 3471 IUCN listed species, only 594 (17.1%) have been collected.

If you look at where the plants are from and how the botanical gardens collect those plants, you will notice most collecting concentrate on a few provinces. So the botanical gardens should collect more plants in those untouched provinces such as Qinghai. Not only in China, this is a study also carried out by Mike Maunder. They noticed that in many botanical gardens the frequency of the commercial sources is very positive correlated with the frequency of palm collection in botanical gardens, which means either to be on

the market, or to be maintained in the garden. So it is not that selective. Then my second conclusion would be that although quite high proportion of native plant species have been collected in China's BGs, systemic accession collection policy still need to be implemented such as where to collect, how to duplicate, especially for those endemic and endangered species.

Involving into In-situ conservation, I will talk a little bit into the XTBG case. You might recognize this picture showed this morning that suggests the land use change in Xishuangbanna from 1976- 2003. XTBG, together with some other scholars proposed and established the protected area in Xishuangbanna. Those five dark red area(in the figure) are protected. If you compare this map with here, you will recognize that most green color still exists inside the protected area. So what you mean is more or less half of the forests outside the protected area are simply gone. Yesterday I argued with my colleagues. Even there are a lot of problems with the protected areas; still it is a very effective way to save forests. So this is a very powerful evidence to demonstrate that.

This is a story about BCI that we have already discussed. XTBG has been involved in this project. This is developed by Prof. Ma and other of my colleagues to develop a corridor. We also discussed a lot of mechanisms to coordinate with the local conservation agencies such as Xishuangbanna National Nature Reserve Administration Bureau and other Bureaus. We have an annual meeting to exchange information. The paper about 20ha plot is now available in the lobby the hotel, which is one of the cooperative programme between XTBG and the nature reserve.

We are also involved to biodiversity impact assessment lead by Prof. Cao. This programme is try to get very quantitative data in the appearance of the degradation of the forest diversity. This regulation has been promoted by State Forestry Agency to wider usage, not only in Yunnan province but also in other provinces.

We also work very hard to try to establish ecosystem service mechanism. We got the proxy from the Xishuangbanna government; some of my colleagues also published a paper on it. Actually two days ago I discussed with the governor whether we can use this as an example to really do something for that. We already helped the Xishuangbanna government to get information about the permission to charge extra money from the electricity power station for the ecological compensation.

This is a piece of so-called Chinese red title document, which is very powerful. This idea is proposed by Prof. Zhu Hua, who is here. Although the exact boundary need to be determined, because I am trying to build a bigger area. Nevertheless, if this protected area is dashed in, the protect area in Xishuangbanna will increase from 14% to 19%. This is 115431ha in size. So that should be very good for the conservation in this region. It is not SCI, but it is important.

So BGs, especially those BGs located at plant species rich area, should and have a great potential to, by joining local in-situ conservation program, make significant contribution to conservation. That is the message I would like to convey here.

For the public engagement, I also take XTBG for example. I noticed that one of my colleagues also gave this example from Edinburgh BG. According to the interviews or questionnaires, majority of visitors do not come to their garden, nor to most botanic gardens, with the specific aim of learning, but to find peace and tranquility, to eat, to read a newspaper, to relax, for recreation, to play games, to be with their family or to escape from their families. There is one thing we want to ask ourselves. We took XTBG as a conservation center, a research institute. We provide material and information to conservation but, what is common public's point of view? We want to do a serious research trying to understand botanical gardens' image in public. There is a wild elephant valley park that we are going to compare with XTBG. We designed a 5-points measurement, 1=very disagree, 2 = disagree, 3 = no comments, 4 =agree, 5 = very agree. This survey is conducted by my student and this is unpublished data. We are happy with the data because the public strongly supports that XTBG as a research institute, a place for germplasm preservation, and a place to enhance public environment awareness. While they do not so agree with it as a place for entertainment. So it is not a place for fun, seriously. But still, we enjoy high reputation. So this is kind of statistics. If there is no significance, the answer is poor. If you compare XTBG with the wild elephant valley, you can notice a lot of statement have significant difference. Only for "a place for entertainment", there is not significant difference. So for the public, XTBG is place that does serious conservation, education and knowledge generating, which is great.

Traditional environmental education and interpretive programs only provide knowledge, without attitudes and behavior improvement. So in this learner-centered training program, people have the opportunities for self-

discovery, participation and sensory involvement that probably can make some difference. So we invited the students from the nearby school and did a series of research on that. They are assigned a couple of things such as searching plants' label, taking photographs, painting on the ground, and lots of other competitions. They also stay here overnight, having parties and dancing.

Another questionnaire we designed including testing for knowledge, methods and attitude. For knowledge, people can choose between agree and disagree; for methods, we use Yes or No; for attitude, we have 5-points. So the questionnaire has been prepared and has three forms, one for immediately before; one for immediately after, and one for four months later. This is a summary of the result. We have noticed that in the result of Kruskal-Wallis test, there is no difference in Knowledge, method, but significant difference in attitude. This means training programme is really worth for changing attitude, especially for long periods.

This is a picture display with a lot of pictures. We want to know What kind of picture is more attractive to the audience. We categorized those pictures into three types, negative and objective, abstract, positive and objective. Five pictures are selected for each type. The reactions from people are also categorized into three types, no-interfered observation, no person stop or no person pass, and time for watch. Here is the result. The negative and objective ones are significantly higher than those two both in the no person stop or no person pass, and time for watch. The conclusion we can draw here is that picture shows negative phenomenon actually is more attractive, or more influential to keep people stay longer period for watching.

So the thing I would like to emphasize here is that most BGs have some kinds of EDUCATION program, but the most difficulty part is to evaluate the effectiveness. Serious researches are needed for new theory and new practice.

In conclusion, the present blossoming situation for many BGs worldwide comparing to many other NHIs, probably due to the recognition of the scientific value of its living collections, as well as BGs' continually concern to public's needs. It is a long way to go for BGs, to make full use of their resources, and to play a vital and non-substituted role in biodiversity conservation.

Thank you!

Q&A

Person 1

Q: It is such an exciting presentation that I could hardly keep myself silent. You raised a very important issue to us that whether botanical gardens are equal to conservation centres. I think the answer should be yes! Firstly, botanical gardens should be the biodiversity conservation research center. Over 100 papers are published on this topic from BGs every year. Secondly, I think this is very good articulation in certain ways like knowledge transferring, gaining public support and society's recognition on the conservation issues. Thirdly, BGs can really play a key role in both ex-situ and in-situ conservation. Fourthly, BGs ensure the sustainable conservation come true because we can generate income. It is hard to raise fund in other ways but this is really much simplified process. XTBG also plays a key role as you listed here to provide technical support for the governments' administration management for all the other protected areas. So lastly, combining all these points together you can make BGs equal to conservation centers. Now my question is, as a decision maker for XTBG, what is your mission for this garden?

A: Tomorrow morning I will to the committee our mission, situation, and some kind of dream for the future. One is the most beautiful garden; one is the regional conservation leader; one is the international recognized research institute; one is national germplasm conservation place. That is our dream.

Person 2

Q1: Zoos and botanical gardens have been completely separated for some reason. But if your aim is conservation, might not make sense to combine aspects of botanical gardens together with animals.

A1: Actually a couple of years ago some people also suggested that, because kids like animals more than plants. When you hold expertise on ecology and plants, you need expertise on zoology to keep the animals.

Q2: But much of your scientific research has involved plant- animal interaction.

A2: Yes. We tried to hold a small group of people major in animal science. But it is difficult.

Person 3

Q1: I am kind of surprised that negative & objective images are the most attractive. Did you do any follow up interview about why they stopped?

A1: Actually the research includes 2 parts. One is observation, one is interview. After letting them watching all the pictures, we gave them an interview. We showed them all the pictures and asked which pictures they still remembered. The data from that part, is

very agreed to that one. It is continuously support negative & objective pictures.

Person 4

Q: As Dr. Gratzfeld mentioned in his lecture that a scientist speaks a different language from policy makers. I think local people also speak another language, their own language. As a scientist, and the director of XTBG, what do you think about the relationship between the three groups? What roles the local people play?

A: Firstly, I think the people here should try to get over these difficulties in language boundary. For the government officials, we need to make friends with them. For the local people, I mentioned the tour guides here a couple of times. They will get married, have kids, and stay inside the village. But they learned a lot from the garden, such as the green philosophy and beauty of the plants. That is also one part of the influence. Last year, we cooperated with local TV station to develop a special TV program. Each episode is 15min shoot. By all the Chinese and the Dai and the Aka languages. The title is *Stories from Tropical Rainforest*. We try to invite local people as movie stars to show their knowledge, beauty of their culture, trying to influence the local people.

Tropical seed conservation and ecosystem services: a research perspective

Dr. Hugh W. Pritchard
Royal Botanic Gardens, Kew, UK

Thank you very much. Firstly I would like to say congratulations to all stuff in XTBG on the anniversary on behalf of the director of the Kew, Professor Stephen D. Hopper, who also sent his apologies for not being able to attend this meeting. So the topic today is Tropical seed conservation and ecosystem services. What I want to do is to cover three broad areas. Firstly to try to impress on you the importance of seeds for the ecosystem services; and the value of preserving seeds *in situ*, does not mean conserve that one species. Secondly to address the challenges particularly in seeds storage around tropical oilseeds and around recalcitrant seeds in relation to similar work and support in targets 3&8 of GSPC and then finally to reach your attention what I describe in ecosystem's failure between the distribution of seeds and the distribution of plant species. So in terms of what you're interested in seeds, particularly good value of money in terms of seed conservation or plant conservation and sustainable use. Firstly seeds are often desiccation tolerant; they germinate in

wide environment conditions quite often; they are produced in large numbers annually and which is species dependent; they persist in the environment and therefore they could store the genetic memories. They represent the genetic diversity not just the parents, but the group of sampling strategy of that population or that individual species. At the bottom the three traits of seeds, in terms of Provisioning service, various in dispersal mechanisms, including mammals, they serve as a food source, vitamin source, chemical source and the medicines.

Primarily seeds support the provisioning-side of ecosystem services and I will come to two examples of science around new crops (oil seeds) and tree seeds in terms of conservation problems. Of course seeds can generate plants and plant support all aspects of the ecosystem services, supporting and regulating in terms of nutrient cycling and also climate regulation. Also the human will be in fact associated with the cultural services of ecosystem for plants and beautiful landscape, beautiful gardens as XTBG. so biodiversity I think is one of the key aspect in ecosystem services and what I mean by the biodiversity is the number of species, the relative abundance of species and composition and interactions and we should reflect the main means of reproduction in plants via seeds.

So there are lots of good reasons for appreciating plants and seeds as a part of ecosystem services. I'd like to give some examples and I would come to the reliance on plant diversity. Plant or crops medicine globally, 80% of our plant based food intake comes from just 12 species from crops and 8 of those are cereals like grains, and 4 are tubers. But we actually know there are probably more than 30,000 species of plants are edible plants. In addition, in terms of medicinal species, 70% of the world's population is dependent on traditional medicines as primary health care. Just in China alone, there are more than 5000 species in traditional Chinese medicine. So that also supports traditional provisioning science of the ecosystem services. Another example is our reliance serving as local people from non-woody forest products. The total extraction of non-woody forest products is around 7 million dollars a year based on the FAO in 2005 and 4 and a quarter million tones is extracted as food, the majority of that is as oilseeds and nuts.

You'll be familiar also with the potential of seeds in regulating and supporting services in ecosystem with the expectation to rebuild natural capital. A very interesting read if you haven't looked at that yet is to the book by

Storm Cunningham called *reWealth* where he emphasizes the constant redevelopment of the environment in some of the regions for 2 trillion dollars, not only to revitalize economies, rebuild communities but to restore structures, replenish natural resources, also to repair damaged land and recover the natural capital. To achieve the latter part we talk about broadcast sowing or seeds.

So in terms of our interests in ecosystem services, what they provide are seed production, dispersal, survival and germination or enable plants to continue to provide ecosystem services. What we particularly concern is the threat of loss of ecosystem services, the driving towards considering conservation options and that loss for the most part is human-driven and the direct or indirect impact here would be climate change. It was summarized very clearly in 2006 the rejected increase in temperature over last 20 years or so would expect to those impact. The impacts will be get past to 2 degree increase by 2100. We will see in developing countries and the tropical countries an above average increase of temperature and a decrease in yield of crops in their production. Secondly in terms of spectrum species existence, about 2°C increase will cause 40~45% percent of species facing extinction.

But the more direct human activities called deforestation by burning contributes 20% to gas emission in terms of CO^2. Between 1960s and 1990s, we reduce the world forest by one fifth. It is reported 25 countries lost for all forests and 29 of the countries lost 90% forest cover and we continue to deforest at around 100,000 km2 per year.

So we need to consider our conservation options for species in the natural environment. We prefer to conserve them *in situ*, but the pressure of human population to our research makes it more and more difficult. However the global average for protected areas is 12% of lands. I think it is 16% in China with the target of around 19%. On the other hand, as scientists, we do reliance on *ex situ* conservation to preserve species. There are various means of banking ex situ. We can try in *vitro/cryo*-banking of meristems, began *vitro/cryo*-banking of choral material, such as somatic embryos, tissue culture cells. We can bank pollen. We can bank DNA. But all these methods have limitations in terms of a limited sample size or limited genetic diversity and indeed sampling stored DNA will not regenerate whole plant either. As for *ex situ* conservation, the seed banking and the review that was mentioned this morning reviewed that there are more than 5 million PGR accessions across the world and 90%

of these are actually seed-based. So seed banking is the first method for ex situ conservation.

I've been forced to be involved in a global project that was conceived in 1992 and finally became more certain from 1996. It is called Millennium Seed Bank Project but it is managed by U.K. Lottery government. We secured 75 million funds for about 15 years from 1996 to 2010 from the UK lottery, or we would say the lottery losers which we have the money from, and also from corporate and private sponsors. In the first phase of the project, we conserved U.K. flora. As there are only 14,000 species in U.K. flora and with around 600 species already conserved, so we have 800 species to conserve in 3 years which is what we essentially did. So we now have 90% of bankable flora from U.K. conserved. We also built the Wellcome Trust Millennium Building, the housed of millennium seed bank.

Now Phase II of the project, we have to say is far more challenging. We started with the target of collecting 10% of the world's plants based on the estimated 242,000 species in the mid 1990s. It is 24,000 species to conserve in ten years. We have passed 20.000 species and we will this year achieve this target within 2009. I'm willing to put it as well. The project also involved training and platitude research so we have been involved in the building of network across the world with 120 partner institutes in more than 50 countries. Now the main seed conservation partner countries are 18 and they range from the USA, Mexico and Chili to African countries and then in this part of the world all capable states in Australia and also China, particularly we are working with the Kunming Institute of Botany. You see here the Germ Bank of Wild Species in Kunming I was pleased to attend the opening in October 2008 and we have a 10-year agreement with KIB assigned by Mr. Crane to help KIB conserve up to 4000 species by 2008 to 2010.

So there have been several collaborations and the main objective is to help conserve seeds for 200 years. You'll be right to ask do we have the seeds in the bank that are 200 years old and the answer is No. Our understanding of seeds is based on empirical studies that unable to develop models. So we were a few years ago offered some seeds that have been found in a wallet of a Dutch merchant on a ship, but were boarded by British pirates here. So these are pirates in English Channel. But the ship had stopped in the Cape and the seeds we found have come from the Cape flora and we found 3 of the collections actually germinated, *Lipparia*, *Acaria* and the *Leucospermum*. As you see

here we can carbon date the seeds to make sure indeed they were more than 200 yeas old. In general seed banking is not just for a few seeds to survive, dry and storage but to enable the majority of seeds to survive for 200 years. In the way of going back is to collect the seeds that the point of natural dispersal then to dry the seeds at 50℃ and 50% humidity to 3~7% moisture content, which is quite dry, then to clean the dry seeds and to check the purity using X-ray from all directions. Then the dry seeds are cleaned to transfer to containers. So the seeds stay dry and we see here various jars perfect for this particular purpose. Then the jars are transferred to cold storage among 20 centigrade. This is our particular storage place. Then the seeds can germinate. We do 10,000 germination tests a year.

The collections in terms of genetic representation come from usually more than 50 individuals. There are more than 30,000 seeds but it only costs 2500 pounds the species. That seems like rigidly an expensive insurance policy for plant conservation. Just to get a few from the study, I found it particularly helpful that this year *The economics of ecosystem & biodiversity* reported on their studies on the cost of conserving the lands. Their studies have caused a lot of interesting cost falling on the climate change. The study has been developed by economists and you see some interesting value here about the economic value of ecosystem services for 30 trillion dollars around. To preserve the tropical rain forests we cost between 1 dollar and 28 dollars per hectare per year, depending on the forest. To conserve a whole floristic region, such as the Cape would at the start of costing 500 million U.S. dollars and then along going cost 24 million dollars. And to conserve and make sure of 2000 network (18% of biomass) for 25 EU countries would be about 6 billion euros per year.

In terms of summarizing our conservation tools, there are large scales of global conservation efforts under way to dry-store tens of thousands of species with orthodox seeds. But given there are more than 300,000 species that estimated as higher plants, there it a lot more work to do and we have a draft outline budget for 2010~2025 to help conserve maybe another 45,000 species with collaboration around the world. As all species can be banked in our bank then how to storage them in a way we would like them to. These are the challenges and we are moving forward. They related tropical oil seeds in the dry state and they relate to recalcitrant seeds in the content of GSPC.

Tropical oilseeds we mentioned this morning particularly is *Jatropha curcas.*

Jatropha curcas is in a large genus with 170 species, which has been found in Latin American up to Mexico, and it contains seeds with 40% of oil. There are so of the region with 2000 hectares associated with BP(British Petrol) around the world. So in a commercialized project of *Jatropha*, they particularly grow in marginal lands. Secondly I would like you to remember another species *Allanblackia floribunda* in tropical Africa. 7% oil in seeds and 55% saturated so unlike *Jatropha curcas*, which has 25%, saturated, but we have two species with high proportions of saturated fats compared to many of the species. What this means is that their physical properties and join temperatures are very odd also compare species which have a higher level of unsaturated fats.

We're very interested in looking at the physical stability of oilseeds. We do that by generating thermal fingerprints. This is the system we use, a differential scanning calorimetric and allows this to look at the physical transformation in seeds when we cool them 10℃/ min to around -100℃, and rewarm them to 40℃ and we can compare the reference sample which contains no seed. The thermal fingerprint we get, dependent on the direction which you go at the bottom we cool it and you get two troughs and they are printing invents and they are in the lipid of an orchid. We used 100,000 seeds to get a lipid content graph. I don't know what the saturated fat content but you see the lipid freeze in different temperatures. When at the top we start to rewarm you have a greater cooperativity between the fats. If you start at around -30℃ of the species and they finish at around -5℃ . Fascinatingly, we observed comparing storage in the dry state where is no water in the seeds, at temperature of 20℃,5℃and -18℃, that storage -18℃ was worse than storage 5℃. I've been speculating in those in 1993 and this is due to a problem with an intermediate physical transformation in these lipids so storing seeds when their RNA are partly fluid, and partly solid state with not necessarily constitutes to the longevity.

Now a much more eloquent explanation for these problems have been provided by Crane in the US. The study is looking at the main oil structure in *Cuphea.* Actually they looked at 26 species. I just have 5 here stored at -18℃ . This is dry seed. Those seeds from the species *C. parsonia* have 60~80% of short chain saturate fats, C12 and C14. So they cannot tolerant cold storage. The two species at the top have much lower level of these saturated fats. What they find was that when you look at the scanning of electronic microscope images upper

in the figure, if you are not prepared to handle the seeds in terms of post storage and the germination test, you get massive destructions. They have crystallized fat at the top. At the bottom of this image, you pre-heat the seeds carefully and you have a greater opportunity of recovery the biodiversity. The effect of -18℃ is a decreasing germination fell by 32~74% which is a major drop. If you handle the seeds probably post storage you would recover some of the biodiversity but not all. So you see here the fingerprints for 4 of the species and they have very high melting temperature. The main peak is 25℃ and the lowest species, *C. glossostoma* is around -23℃. There is a series of melts from that to 25℃. What Crane and his colleagues have found was if you heat the dry seeds for an hour to 45℃ to melt all the fat, you can recover about 77%of the germinations. You don't recover all of these. So we have a problem with dry oil seeds been stored in -18℃. If we don't handle them properly they would lose biodiversity. If we handle them properly, we can recover some of them but not totally.

So one of the imperatives for future research work should be to screen the oil composition and content in tropical material to produce thermal fingerprints which will only take 30 minutes to generate and to assess storage traits. Concerning to recalcitrant seeds and the GSPC, I have explained earlier how orthodox seeds resoponse to the dry condition such as 3~7% moistry content. Now here are the seeds of 10 tropical African dryland trees. I want you to see the coconut germinate against moist content, and you'll see that out of ten there are seven horizontal lines so as moist content reduced, germination is retained for most part then we can transfer to -18~-20℃. We have 3 lines here signified by the blue arrows, *Vitellaria parodoxa*, *S. cuminii*, and *T. emetica*. We show the practical recalcitrant seeds response we dry 40% moist content of these seeds showed high moisture then you reduce them around 20~25% moisture. It turns out that the recalcitrant seed have a very strong association with habitant. Reported recalcitrant species increase significantly as we go from the deserts very few of them, through to the moist forest in the temperate or the tropical. But in the tropical forest the worst case of senario, is 47% of tropical moist species will be desiccation sensitive. With the estimation of more than 300,000 higher plant species producing in seeds and probably more than 50% of the world's plant species are in tropical forests, it means that we had at least 75000 species to have the recalcitrant seeds. It turns out that the majority of recalcitrant seeds been identified so far are 'trees'. They are dominant species of temperate and

tropical forests. So in Southesat Asia, dipterocarp are recalcitrant. There are 2 examples here. I have mentioned *Trichilia emetica*, and *Vitellaria paradoxa* is from dryland in Africa. There are dryland recalcitrant seed species.

We've looked at this association further by choosing the target family, which are sufficient seed biology. This is the *Seminum Palmarum*. We have been studying this species in the last 5 years with a very simple test using silica gel to dry a limited number of seeds to low moist content, then check the gel there after. You can see from the graph here that there is a very strong association between seeds with desiccation sensitivity and species distribution in wet habitats. There are 0.85 probability of coming cross desiccation sensitive seeds. So we started to develop a predict of desiccation sensitivity in species we haven't screened. This supports the GSPC target 3 which is on models of protocols for plant conservation. We take the recalcitrant seeds further using the datasets of a hundred palm trees from Panama. What we looked at is seed mass, because our hypothesis is the larger the seeds, the further they dispersed because they dry more slowly. On the other hand, rapid germination are facilitated by thin seed coat. So you look at the seed coat ratio in terms of the moisture ration and coverage to the whole seed. What we find is that if you take here, a seed coat ratio 0.2(20% coat weight to the seed), and we take the largest seed, then we have a probability of 0.5. This is published on Annals of Botany in 2006 and there is open access so you can reach this from home.

So we've made some progress towards models to predict protocols and contravention options for a wide range of species. That is on the target 3, but on the target 8 we have a group of seeds biologists failed. The key target is 60 % threatened species in accessible ex situ collections. Many seed bank project will extract DNA and it will be achieved in a number of countries, preferably in the country of origin. Our collections are duplicated. 10 % are in recovery and restoration programmes. But in a sub-text to that target, they face current threatened species collections could be increased with additional resources with technology development and with transferred especially for species with recalcitrant seeds and majority of the seed biologists have not see this statement.

What we've been trying to do is dealing with both orthodox and recalcitrant species. What we need to do is to dry the material to a moist content which enables us to transfer the seeds without

ice formation that means drying to around 20%. We have to do that with thin seed coat. If you dry slowly they will lose vitality so we have to dry it rapidly. We can do that in a flow there or we can do that chemically. I will show you the limitation of the two approaches. When we get to 10% moist content, there is only partial ice formation and when it is still cold, we can not store at -20℃ because in time there will be ice formation. We have to transfer to liquid nitrogen. So the basic means is to transfer samples to use a kind of freezer, place the sample directly in liquid nitrogen, and then leave the samples to -196℃. This kind of the approach we worked for zygotic and somatic embryos, embryonic axes, meristems and shoot tips as well. The example here is the embryo of the palm where rapidly air-dried in a flow cytometry and we cut the embryo with liquid nitrogen in vitro on the tissue culture region that worked for a number of species. Another target we found to this type of approach particularly in south China would be Fagaceae when looking at that now with Kunming Institutes of Botany.

This second method is to chemically dehydrate and so we germinated a tropical recalcitrant species, a legume, *Parkia speciosa* and we pre-treated the meristem. Without the meristem we pre-treated the trehalose and encapsulated that meristem in alginate beads. That bead will be loaded in PVS2. It is high concentration therefore the solution is toxic. So we have to expose the sample to this chemical desiccant for a limited period of time. For a targeted speciosa meristem beads, 60 minutes is enough to reduce the moist content of the sample to 17% moist content and then we can transfer to liquid nitrogen with 60% survival. So this enables us to start to address the target 8 of GSPC in terms of the recalcitrant seed conservation but we don't yet have generic cryo-conservation method for tropical recalcitrant seeds. I think it would help greatly when the GSPC reckoned the recalcitrant seeds which is listed from the subtext to one of the main targets.

Briefly in the end, system's failure. Here is the eco-regions of the world in terms of plant species. There are 10,000 species or more in the orange and red areas and not so much green of plant diversity now across the tropics. This is the distribution of seed bilogists and we got this disconnection between the people who're doing seeds science globally and where the seeds science problems are. We'd look at the ingredient detail and think about the opportunity of getting new species for sustainable development into the seed trade and the main body to do that in terms of establishing quality control is International Seeds Association

founded in 1924 and it published standard seed testing procedures from vegetables to trees. There are more than 170 countries so it is the truly global network. Within that network, there are 17 committees and these committees are carrying out management on seeds storage. There are 228 places, 228 seeds and 73% of those seeds are taken up by European or North American scientists and quite often agricultural based. So if we dare to look at what we are doing in terms of generating rules, this is a collection stated in 2007, which goes over all the established rule development. Then for germination testing, there are 837 species only in the recommendations for germination. That 311 species for radical species storage; maybe 50 of plant species are dominant of northern latitudes forests. So less than a thousand of species with trade regulation for seed quality testing out of 30,000 species that are available normally and more than 3000 species of higher plants in the world. So we are not reaching out to find diversity so we have a system failure and for some reason I think we are going to bring more utilized species to the market in a sustainable way. We have to generate a tropical seed biology with tropical youngsters. We need to involve a lot of researches to find the way to get involved in international policy committees.

Four take home messages from the last 40minutes: seeds enable plants to continue to provide ecosystem services; seed bank is very cost effective insurance policy for the preservation of many species; seed conservation research should focus on tropical oilseeds and recalcitrant seeds in the very near future; and seed science needs to attracts more students from tropics so that they can influence future policies as I mentioned this morning and we need to influence future policies so that we can have greater levels of conservation and sustainable use of plants from this region.

Thank you.

Q & A

Person 1

Q: I'm thinking about the healthy species and the endangered species. For healthy species, they produce large amount of seed especially invasive species. But for endangered species, some of them even have difficulties to produce seeds. Their seeds are not sustainable to the environment. Do you have some explanations for why endangered species have few seeds and very difficult to germinate?

A: I would suggest that there's an association between the endangerment and survival of seeds. I don't think so in terms of seed banking. I agree with

you in terms of seed collections. As I mentioned we are trying to gather 30,000 seeds, we have 97% of the UK bank of flora while there are 3% we don't have. Species endangered are irregularly flowering and generate or yield very few seeds. So we continue to try collecting those endangered species. But there is no reason why these endangered species cannot be long-term conserved in seed banks as long as endangered species are not recalcitrant seeds in which case we have to think about for a while.

Person 2

Q: I agree with you about the recalcitrant seeds in the tropics and how important it is. I'm just thinking about my own experience in the day coming about how long seedlings can persist in the natural environment and they are heavily suppress and can proceed for a decade and you're talking about building facilities in the country of origin where the seeds are coming from. I'm thinking about exploring the possibility of using the seedlings as the stage of some kind of insurance policy perhaps.

A: There are various approaches that you can take and certainly to maintain the seedlings should be one. I think for this problem, you should be thinking about building the most appropriate methods possible in order to in store and preserve that species. Some of the methods I mentioned such as cryo-preservation are translatable into conservation for lower plants, and also for preserving animal as well.

January 2, 2009

Closing Remarks

Hosted by Dr. CHEN Jin

Prof. Peter. W. Jackson
Prof. Sir Peter Crane

FINAL SESSION

January 2, 2009

CHEN Jin: So again, Good afternoon, everyone. Most people enjoyed the nice presentations this afternoon, meanwhile we get a little tired. So let's quickly move to the closing session. First, I would like to invite Professor Peter. W. Jackson to give us some conclusive message.

Peter W. Jackson:
Thank you very much. It's a great honor for me to have been asked to make some closing remarks in what has been a fascinating, very stimulating, and useful conference for all of the attendants. I would begin by saying how much we appreciate not only this great hospitality here, but also how much we've learnt from watching the welcome going on in this garden in such an important and remarkable way, building on the achievements of the last 50 years onto a very bright future for what is fairly one of the world's leading botanic gardens with remarkable leadership. Certainly, the garden can be very pride for what have been achieved and in something which all of those who are collaborating with the garden will be looking forward to working very closely. I had the opportunity to visit the garden in 2004 when I worked with a number of colleagues in China to help and develop a national program agenda for botanic garden and conservation here in this garden, held by XTBG. That was really by the initiative of the establishment of the global strategy for plant conservation. That is really worth looking at again for many people because we talked about the need to link science with biodiversity policy development. That is one very tangible example of where the botanical community wrote its concerns to the international table and thought real change and real development by engaging with the policy makers at the highest possible levels. The conventional biological diversity had never before had an initiative comment from sectors other than the government sectors. It shows the engagement by scientists can have a real impact and can really change the global policy theme. I think that is something which we, which is often overlooked by scientists working in our institutions. We can engage and make a real difference and sent our own agenda for what needs to happen globally. I think most of you know, and have been mentioned the global strategy for plant conservation has 16 targets to be achieved by 2010. In 2008, which is last year, the assessment ran forward to see what progresses have been made in the achievement of those targets. And all these 16 targets, I've been making some assessments also, it's clear that of the 16 good progresses in achieving the targets have been made in 5 of the targets. There has been moderate progress in five more, and only limited

progress in six targets. So it shows that over the last year of the GSPC, there is a huge amount of work to continue on and set the theme for building on the success of the global strategy for plant conservation beyond the year 2010.

Secondly, great progress has been made in the targets that have been failed into by botanic gardens. For example, target 1, on developing a preliminary checklist to the world's flower. It is predicted that as much as 90 percent of that checklist may be available by 2010. Good progress has also been made, for example, on target 8 ---on ex situ conservation, certainly an extend to which present species are maintained by the botanic gardens has probably doubled in the period between 2002 and the current time. Target 3---on developing of models with protocols for plant conservation as sustainable use, I believe very good progress has been made in that part too. When you look at conferences like this, which clearly are contributing to the achievement of this particular target, it is also a major step forward has been affected the botanical community. It's now recognized through the global partnership for plant conservation as being part of the biodiversity conventions coordination mechanism for the global strategy for plant conservation. It is the first time that known governmental sector has been recognized and given such a role. That is something we have to recognize and something, which I believe. The power we have has been recognized through a conference such as this. I think you all know that we are coming to the end of global strategy of plant conservation in 2010. But there is now a new face proposed which is in the planning stages. However, despite the successes of the strategy, one of the failures is the fact there is very limited mainstreaming of plant conservation concern and action into national economic and national development policies. Too often plant conservation and biodiversity conservation in general has been seen, has been paid a much more secondary concern considered against the economic development. Despite the fact that we recognize now, that the sustainable development is and will be possible if we have good biodiversity conservation. This is the message that has been stated again and again throughout the conferences. We also discussed the fact that climate change is an issue which will impact greatly on biodiversity conservation. But that is still only recognized by the global community as a minor component of most national climate change strategies. When you look at individual strategies to achieve climate change adaptation and mitigation, most of them fairly mention biodiversity conservation. This is something that has to change.

This is clear in the discussion last two days. The botanic gardens and other scientific institutions have to be in the forefront of insuring that biodiversity conservation is brought into the discussions on climate change increasingly. Because unless we have biodiversity conservation considered, then we will not be able to adapt successfully to the elaborated consequences of final change. The paper that was presented during the conference have been really very stimulating. They described the whole theories of new technological advances in researching recent years. For example, the growth and use of molecular data to inform and guide conservation practices, they provided examples of new technologies such as barcoding, remote sensing, sequencing technologies, new advances in informatics. They also pointed out the growths of conservation biology as a major discipline supporting the conservation biodiversity worldwide. That really is so important because in the past so much biodiversity conservation we played will not necessarily remove the cause, or understand the cause of decline of species of ecosystems. It is clear from many of the presentations that we have inadequate capacity for science in so many institutions. That's why it's particularly encouraging to see such a wonderful and growing community of students, postgraduate students in institutions such as this. Because students will be those who will take forwards so much of the work in biodiversity conservation through institution like this in years forward. Some of the key research priorities that seems to me to be suggested during the meeting were put into categories. It's clear that we need to continue our work in taxonomy and in particular also to get better understanding on the start of sub-species in the wild. For some groups, for animal groups, we have good knowledge; for invertebrates, we have really poor knowledge; for plants, we have very limited knowledge as well. Clearly, the need for research in ecological management and restoration ecology and species re-category, this break is needed. Because we have to move on from the position where biodiversity conservation in the wild was largely function of protected areas when we recognized that protected areas come on to extreme, external pressures. Indeed, as a result of climate change, we also have been in great pressures. So that much more direct management of species and ecosystem would likely be necessary in the future. That management has to be based on the best scientific research, results and data.

We need to undertake new research on climate change. We need to understand better the tolerances and resilient of the ecosystems and plants to climate

change. Indeed we really still do not know what are the drivers of lost species or ecosystems as a result of climate change. It is generally a very complex factors, mixtures, competition, changes in temperature and moisture, nurture staffers, lost pollinators, the impact of ingredient in population variability. So we need much greater research to explore those sorts of factors. We just heard we need greater research on ex situ conservation, developing technologies, up scaling the work and also insuring that we are more effective in broadening the space for ex situ conservation.

Very little has been mentioned in the conference also on the need for research on invasive alien species. But I think this is an area that would also need to be top priority for our scientific institutions, help not only to predict a monitor the spread of invasive aliens which threaten so much on biodiversity conservation, but also to research and develop practical methods to control and insure that we can actually remove those species worldwide. It's clear also that there are excellent research programs going on in botanical institutions and scientific institutions around the world. But sometime I am concerned that the cross party in multidisciplinary research has not yet been pushing in face.

I think we also have to take a flexible approach to our research programs and be responsive to develop such programs in relation to emerging issues. The emerging issues are of course climate change, which has emerged in recent years, and biofuels, another emerging area, and the impact of biofuel on biodiversity. Another emerging issue we heard too is threat to food security. All of these areas need research. We also need to promote the sustainable use of resources for human needs. Innovations can support sustainable development and direct some of our research.

I was also impressed in the discussion by recognition of the needs for us to be effective in communicating in science in languages that is appropriate to the receiving audiences. The way we communicate to policy makers will be different to the way we communicate with children. It is clear that if we engage with the policy makers, we can change those policies and we can have a very significant impact as it happened with global strategy for plant conservation. Equally, I believe we have to move increasingly in terms of communicating with public from education about the environment to education for the environment to insure that our education efforts and communication efforts are moving forward with particular messages that we believe, with the necessary for

biodiversity conservation based on the best available scientific information.

Communicating and bringing children closer to nature is a particular challenge. I recently with my young son and some of his friends setting down and did some basic research. I asked him and his friends to tell me the names of as many Pokemon characters as they could. This Pokemon for those of you who don't know are Japanese cartoon characters that are very popular among the youngsters in Europe. I was amazed to find they were able to list almost 200 of this Pokemon characters. Then I asked them to list as many native plant species as they could, and after 12 they stopped. They could name 12 different native trees and other plant species. This to me illustrated the disconnect between young people and the environment, and the fact the environment is not something they engage with in the way that is promoting a lot and learning knowledge of nature. This is the challenge we will face in communicating what is a basic scientific message in the way that is appropriate for young people.

One of the things I want to just say to finish with is that the global strategy for plant conservation has been very effective in promoting the idea of measurable targets, and then using these as means to measure the success in achieving our ambitions. I believe for all of our scientific institutions, we should try to set ourselves these measurable targets not only to guide ourselves, but also to provide a way of explaining to policymakers to the general public what we are trying to do, what we are trying to achieve. In my institution, one of our measurable targets that we have adopted for the National Botanic Garden of Ireland is that between now and 2050, there will be zero distinction of plants in the country as a result of our efforts.

Finally, I think one of the great messages from this meeting for me has been the value of partnerships and the need for developing partnerships at all level, both dimensionally, crosscutting, multidisciplinary partnerships that have been demonstrated through many of the presentations, but also partnerships which operate at local and regional level too, because through these partnerships, we will be able to set real goals and work together to achieve them.

It's been a fascinating conference for me and I hope that some of my takeoff messages that I have just shared with you will resonate with some of the key issues that have emerged from the conference. But for each one of us, I'm sure we have a whole series of different ideas with the stimulators and our

works to take forwards in our work in biodiversity conservation when we return home. Thank you very much.

CHEN Jin: Now let's invite Professor Peter Crane to give the summary restatement.

Peter Crane:
Well I think you are happy not for some profound restatement but short one. So I will endeavor to do that. I think we had a fantastic conference. Peter. W. Jackson was just giving a very eloquent summary and I want to try to repeat all of that with very brief comments. I think as Professor CHEN Jin said, we still have a long way to go in the botanical garden community to realize for potential in terms of contributing to the conservation of plant diversity. As one of my former mentors used to say that there is much more we can do to be more vivid. I think it's also true to say, on the whole, botanic gardens and organizations like us are losing the war. But on the other hand, I think we are waiting for some significant battles. Those successes what we need to build on toward the future have even greater defense. I think that as we heard this afternoon from Professor CHEN Jin, public education is an area where botanic gardens really still need to do a huge amount of work. Compared to the museums on the one hand, as John Kress pointed out, we may avoid scientific terms of getting a crossed message that we are not just a part, we are engaged in the science behind the seeds. But compared with the museums, our approach to public education is still extreme primitive. Museums spend the more amounts of time and care thinking about how they interact with the public and we don't yet. That is probably constrained to the organisms and habitats we deal with. You can't just raise the garden and start planting things again, in a particular way to get across particular message. When you do a museum exhibit, you put up your performance. So that's the constraint. But in general, we are not doing a good job on public education and I thank you for bringing up that because I thought long about this and when I was the director of the Kew and I looked around the world to see whose wonderful ideas I could copy. I couldn't find any from the educational side. I think between us, we have to be better.

I think it is also true to say that one of the most important things to recognize about botanical garden community is that they are populated by many different kinds of institutions. Those institutions have the interest in plant diversity. But they're different because they have very different governmental arrangements. They have very different financial arrangements. They have

very different kinds of leadership and very different kinds of history and tradition. Those things combined adults to organizations with very different perspectives of views on the world. So I think the all the one can really ask for is in the context of all those conditions in which individual botanical gardens operate that they strive to be, as effective as they can be, to have the impacts they can have within the constraints of their system on conservation of plant diversity. I think we see here, XTBG, a garden that's made extraordinary progress as a result of great vision, great leadership and great work by all the people engaged in this enterprise. Professor CHEN Jin raised some very important questions about how botanic gardens should judge their success. I think this is a key area. When I ever go to the US institutions, I try to ask what do you regard success. The success is very different again depending on what are the government, the finance, the leadership and the history fields. But one general point is very clear and that is what you define a success will determine what the institution produces. If you are emphasize high impact papers, then you are going to get high impact papers. So the question I think is how to develop a balance for success within these different kinds of organizations. The time spent on policy development, and the time spent engaging with the local community is as valuable in its way as that paper published in the NATURE or in SCIENCE. I think that is the real challenge. But the institutional rewards system will determine what the individuals in the institution produce, therefore as a whole what the institution is known for. That's the implement not only to moving an institution in new directions and making a larger impact, it is also an implement to collaboration on publishing. Because very often, publishing collaboration is not valued and the question is how we establish through the governments and leadership in organization.

I think we can say that the world is very complicated, and the botanic institutions are also complicated. They do what they can within the constraints as they can. But it is important that we do what we can quickly, because as we have seen in many examples in this conference. The world is changing before our eyes. We don't have luxury lots of time. In that regard, we may just want general point. That's something that I often say to people around me, the perfect is always the enemy of good. In many cases, we can move ahead and produce good outcome or good products, but we instead step back and say that we want a perfect product. Peter. W. Jackson spoke about global strategy for plant conservation. We will run into the discussion that took place around the target number 1--- which is to build a global working

list of all the world's plant species. I can remember in that discussion, people said: no, no, no, we got have complete work of flora. Well of course, we wish we could have a complete list of flora, but we would never make progress with the complete work of flora in that time. So setting sensible targets, good targets, not necessarily perfect targets is very important. I think it is worthy to mention the IUCN red list in this context to the perfect of being the enemy to good. The IUCN itself operated within many difficult constraints. It has to have an defensive system to the constraints. That's why only 12, 000 IUCN plant species assessments were got through. We can and we could do a very much better job in getting a good series of preliminary red list assessments very quickly, not for 12,000 species, but for 120,000 species in the very short time indeed if the community decided that it wanted to do it and did under its own way without having to deal with the complexity as the IUCN system. They very often have large backup of this red list assessments that they're trying to get through their own system. So I think in some areas where we still have to seize the initiative to get the focus and get the job done.

On behalf of all of us, as I said in the beginning, I think those of us come form the outside come to this garden with great humility, with great admiration for what is able to achieve and we thank you most sincerely for wonderful and remarkable conference and your wonderful and generous hospitality. I think we should always express our thanks to the professor CHEN Jin and the staff. Thanks to the excellent arrangement. We've been extraordinary well looked after. It's been memorable conference. I think there's no doubt, what's so ever, we will all remembering where we were on the January 1st, 2009. Thank you again for hosting this marvelous meeting.

CHEN Jin: Thanks to Peter for your excellent summary and nice words. So, finally, as the organizer of this symposium, I'd like to say thanks to all of you for your contribution, and all the presentations in this meeting, so are the hosts of presentation on raising questions, joining the discussion. Thank you. Also I want to take this opportunity to say thanks to my colleagues: HU Huabin, FANG Chunyan and couple of others for your excellent job. So now I announce that the 2nd Xishuanbanna symposium is closed!

LIST OF POSTERS

#	Title	Presenter
1	Carbon sequestration potential of the stands under the grain for green project in Yunnan Province, China	Chen Xiangang, Zhang Xiaoquan, Zhang Yiping, Wan Chengbin
2	Biodiversity backup systems and invasive pollinators: do honeybees count?	David W. Roubik, Enrique Moreno, Liu Fanglin
3	Phylogenetics and diversity of seed dormancy	Jerry M. Baskin, Carol C. Baskin
4	Climatic control of plant species richness along elevation gradients in Longitudinal Range-Gorge Region	Liu Yang, Zhang Yiping, He Daming, Cao Min, Zhu Hua
5	How does the fragmented forest influence the abundance dynamics of beetles group (Coleoptera) in a changing land-use system	Meng Lingzeng, Konrad Martin, Gerhard Langenberger, Chen Jin
6	Soil seed bank research in China: present status, progresses and challenges	Shen Youxin, Zhao Chunyan
7	Environmental controls over ecosystem photosynthesis of tropical rain forest in Southwest China	Song Qinghai, Zhang Yiping, Yu Guirui, Zhao Shuangju, Yang Zhen, Tan Zhenghong
8	Seed size, more than nutrient or tannin content, affects seed caching behavior of a common genus of old world rodents	Wang Bo, Chen Jin
9	Comparison of spatial-temporal distribution characteristics of water temperatures between Lancang River and Mekong River	Zhang Yiping, Gao Fu, He Daming, Li Shaojuan
10	Annual variation in carbon flux and relationships between carbon flux and impact factors in a tropical seasonal rain forest of Xishuangbanna, SW China	Zhang Yiping, Sha Liqing, Yu Guirui, Song Qinghai, Tang Jianwei
11	Characteristics of carbon source/sink effect and its causes of a tropical seasonal rain forest in Xishuangbanna, Yunnan, SW China	Zhang Yiping, Tan Zhenghong, Sha Liqing
12	The influence of soil temperatures and soil moisture to soil respiration in different tropical forests of Xishuangbanna Southwest China	Zhou Wenjun
13	Functional analysis of an Arabidopsis transcription factor WRKY25 in heat stress	Li Shujia, Fu Qiantang, Huang Weidong, Yu Diqiu