出國報告（出國類別：其他）

第十屆韓國國立標本館年會

服務機關：林業試驗所森林保護組
姓名職稱：徐嘉君 助理研究員
派赴國家：韓國
出國期間：**102/11/05-102/11/08**
報告日期：**103/1/21**

摘要

有鑑於氣候暖化所導致的極端氣候事件頻仍，韓國國立標本館於本年度擴大舉辦的十周年紀念年會中，將氣候變遷作為主題，邀請各國專家討論標本館及植物園在未來東亞區域的氣候暖化條件下，能扮演甚麼樣的角色及如何因應，台灣與韓國皆屬東亞區域，擁有許多相似物種及生態環境，雙方面的研究有許多足以借鏡之處，且東亞生態系在地球暖化情境下所受到的衝擊亦有許多共通之處，可說是命運共同體，本次本人受韓方邀請，參與本次年會，分享彼此之研究經驗，研討會成果亦有助於本所轄下植物園及標本館經營管理之參考。

目次

壹、參訪目的

就在 2013 年 9 月，聯合國政府間氣候變遷小組（IPCC）於斯德哥爾摩發佈最新版的氣候變遷評估報告(AR5)，顯示過去 30 年是地球近一千來以來最熱的 30 年，總結全球一千多位科學家的研究報告，幾乎可以確定人類活動就是造成氣候暖化的元兇，而全球氣候變遷將劇烈衝擊生態系，尤其對某些脆弱生態系中的生物多樣性與物種組成帶來劇烈的衝擊，有鑑於此，韓國國立樹木園(Korea National Arboretum) ，為韓國主管森林生態系健康及生物多樣性的主導機關，於其擴大舉辦的 「第 10 屆國立標本館年會」(International symposium of the anniversary of Korea national herbarium)，特別將會議主題為「植物園在東亞地區氣候變遷所扮演的腳色 Role of the Arboretum and Botanical Garden against Climate Change of the East Asia」，職近年來負責執行與氣候變遷主題相關的科技計畫，研究重點為氣候暖化對森林生態系、以及對附生植物的衝擊，並發表多篇相關論文，於是本所植物園組長邱文良博士向主辦單位、韓國國立樹木園推薦本人參與此次研討會，經書信往返，對方同意邀請本人並上台口頭報告，此次會議之食宿及國際交通費均由韓國方面全額負擔。

貳、行程摘要與工作記要

本人於 11 月 4 日午後降落首爾機場，經過一個多小時的車程，終於抵達位於首爾市區東南方、漢江東區的 Olympic parktel 飯店，當天晚餐時間由主辦單位的介紹參加的學者們並互相引薦，當天認識了國際植物園保護聯盟(Botanic Gardens Conservation International, BGCI)的秘書長 Sara Oldfield 女士、來自中國科學院華南植物園的黃宏文所長、中國昆明植物所種子庫的杜燕工程師，以及俄羅斯遠東植物園長 Krestov Pavel V.博士，於餐會中自我介紹並相談甚歡。

第二天上午在奧林匹克大廳進行研討會的開幕典禮以及重要來賓致詞之後，研討會分別於三個場地同時舉行，主要場地奧林匹克廳(Olympic hall)的報告主題是東亞區域的氣候變遷與生物多樣性(Climate change and biodiversity of the East Asia)，當天下午本人亦於本場地進行報告，內容為近年來職所從事的研究: 利用台灣山蘇模擬氣候變遷所造成的影響及其適應機制(Adaptation of a

widespread epiphytic fern to simulated climate-change conditions)，由於此種蕨類廣泛分佈於東亞及東南亞區域，所以會場亦有許多人感到興趣並且提問。

本場次還有華南植物園的黃宏文所長介紹稀有植物的域外保存；俄羅斯的 Pavel 博士以宏觀的角度報告東亞的季風及颱風，對俄羅斯的遠東區域所造成的影響及植群變化，此外來自北海道森林綜合研究所的田中信行博士，職過去亦有在台灣大學與其有一面之緣，他所做的研究是利用棲位模式預測日本的主要森林樹種在氣候變遷條件下的分布變化，以及利用過去的氣象資料來加以佐證。此外，韓國國立樹木園的研究員報告的，有關氣候變遷對稀有植物的威脅及保育策略，內容中也提及與職所研究的台灣喜普鞋蘭、十分相近的物種日本喜普鞋蘭，在當地的保育措施，感覺收穫頗豐。

研討會的第二天(11 月 6 日)移師韓國國立樹木園舉行，韓國國立樹木園位於首爾東北方 30 公里左右的郊區，車程約 1 小時左右，所以一大清早所有的與會學者就搭乘主辦單位的交通車前往，國立樹木園也是管理光陵林(Gawangneung forest)的主管機關，光陵林是聯合國教科文組織 UNESCO 所公告的生物圈保留區(biosphere researve)，從 15 世紀始便因為是太祖的陵墓所在地而被保護著，未曾受過人為開墾破壞，光陵林的面積總共有 25000 公頃，組成主要是韓國的原生針闊葉樹林，森林裡也分布許多稀有植物，包含筆者所研究的台灣喜普鞋蘭姊妹種: 日本喜普鞋蘭，此外，樹木園的部分亦引進許多具有園藝及經濟價值的溫帶樹種。

本日的報告內容以種子庫的經營管理為主，主辦單位邀請了來自英國 KEW、美國數個大學以及中國西雙版納的種子庫管理人員進行心得交流，此外平行場地亦有多場精彩演講，由日本學者報告分子生物學於保育及育種上的應用，很高興本人在這裡遇到神交已久的東京首都大學的角川洋子教授，主動進行攀談之後，角川教授並十分熱情的邀請共同合作研究。

國立標本館中庭亦展示許多壁報，內容來由來自韓國各大學及研究機構的研究人員，許多研究極有參考價值，例如植物園玻璃溫室內的溫度監控及植物展示配置，筆者亦發現由國立慶熙大學的研究生所做的包含台灣喜普鞋蘭，所有東亞區域的喜普鞋蘭種系發生學研究，十分具有參考價值。

週四進行最後一天的議程，上午的演講內容偏重於分子生物學於保育學上的應用，下午的議程首先由參加的幾個國家代表簽屬備忘錄，承諾未來會在因應氣候變遷的威脅下，加強各國的研究交流與合作，接著由西伯利亞的 Irkutsk 大學植物園園長 Kuzevanov 博士進行閉幕演講，並結束整個研討會，其後與會學者由樹木園的解說人員帶領下，在光陵林中健行 2 小時，健行結束後參加設於標本館廣場隆重的閉幕晚宴，隔日大部分的與會者乘坐專車參加主辦單位所安排的南北韓非軍事區(DMZ)的會後旅遊行程，不過筆者因另有行程安排於本日返國。

參、心得及建議

本次參訪的主要目的為通過參與國際研討會，加強與鄰近東亞各國的森林研究人員的交流，並尋求合作研究機會，此外透過各國研究人員的報告內容，了解目前的研究趨勢及重要研究成果，並透過與會發言，增加台灣森林研究的國際能見度。

本次參訪，發現分布於台灣的物種資訊，在建立東亞植物的研究版圖上，佔有很重要的地位，如 BGCI 的秘書長 Sara Oldfield 便希望筆者提供有關台灣特有種樺木科(Betulaceae)植物的基礎資訊，以供 BGCI 目前評估樺木科植物在全世界的保育狀態。此外東京首都大學的角川洋子教授，長期研究廣泛分布於東亞及東南亞地區的鳥巢蕨山蘇，收集了包含日本、韓國以及馬來西亞沙巴的材料，卻獨獨缺乏位於此物種分布中心點的台灣，由此可見台灣的物種在連結亞洲區域植物種系版圖的重要性。

本次會議的主辦單位，韓國國立樹木園，表現令人感到十分亮眼，主辦單位邀請上百位來自世界各地的專家學者，可以想見會前的接洽聯繫工作必定繁瑣至極，主辦單位不但大手筆的支付所有邀請學者的交通費與食宿，接送住宿亦安排得十分周到，此外會議流程隆重卻不失流暢，參加的韓國本地學者與學生都能與外國學者達到良好的互動與交流，諸如研討會即時口譯的細節也都十分完美，使得語言不成為本地研究人員溝通的障礙，並於研討會開幕及閉幕晚宴帶入許多傳統表演，使外籍人士能更深入了解韓國的文化，由於主辦單位全體工作人員的積極投入，使得本次國際會議辦得十分完美，值得台灣的學術機關仿效。

肆、圖片說明

圖 1 、韓國國立標本館起建於 2000 年，於 2003 年完工，建坪為 3849 平方米，為韓國第一棟也是最大的木造建築，外觀由日本落葉松的壓縮層板黏合而成，目前收集有 11 萬份以上的植物、昆蟲、真菌、岩石等等標本，此外還包含設備完善的種子庫。(照片來源: 研討會主辦單位)

圖 2 、BGCI 的秘書長 Oldfield 女士，也是本次國際研討會的籌備委員之一。(照片來源: 研討會主辦單位)

圖 3、本人於奧林匹克演講廳報告有關台灣本土性蕨類在氣候變遷下的適應機制。(照片來源: 研討會主辦單位)

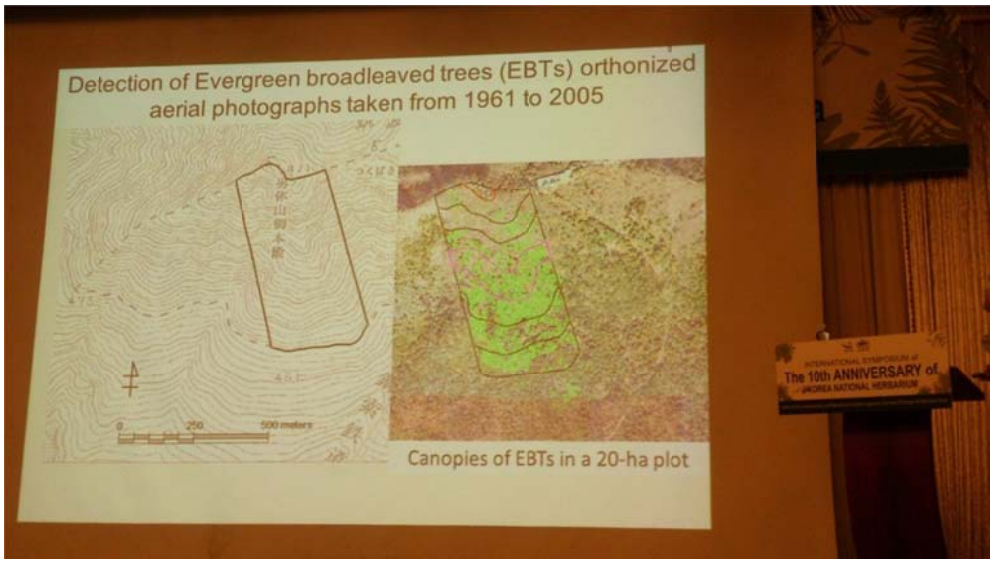


圖 4、田中博士利用空照圖比較不同年代某個山頭闊葉樹跟針葉樹冠面積的比例，來探討氣候暖化的影響。(照片來源: 徐嘉君)

圖 5 、研討會議程結束後，當晚於奧林匹克大廳所舉辦的歡迎晚宴(左圖)及傳統太鼓表演(右圖)。(照片來源: 研討會主辦單位)

圖 6 、國立樹木園的研討會舉辦會場。(照片來源: 研討會主辦單位)

圖７、於會議廳中庭內所進行的研究壁報展示。(照片來源: 研討會主辦單位)

圖８、與會各國代表共同簽屬合作備忘錄。(照片來源: 研討會主辦單位)

圖 9 、光陵林的導覽健行。(照片來源: 研討會主辦單位)

附件一、邀請函

The Role of Arboretum and Botanical Garden against the Climate Change in East Asia

Seoul, Republic of Korea, 5-8 November 2013

INVITATION LETTER

August 5, 2013

Dear Dr. Rebecca Chia-Chun Hsu

On behalf of the organizing committee, I am pleased to invite you to the 10th Anniversary Symposium of Korea National Herbarium, to be held on 5th to 8th November 2013 in Seoul, Republic of Korea. This international symposium is to be hosted by Korea National Arboretum (KNA) with support from the Ministry of Korea Forest Service.

It has been ten years since the establishment of the very first national herbarium in Korea. It started with only few thousand plant and insect specimens in 2003. The collection has now increased to more than 790,000 specimens including plants, insects, fungi, lichens and etc. We also provide Korea's biodiversity information to the public with the biggest biodiversity database in the country. The Korea National Herbarium has become a leading figure of biodiversity collection in the country, and I am very proud of this great achievement.

Upon the 10th anniversary it is time for Korea National Arboretum to look beyond and go further. The climate change is not an unusual phenomenon any more. It happens everywhere, and many living organisms are threatened as we all know only too well. This symposium would be a good opportunity to discuss what we can do in order to protect and conserve such threatened species.

In this regard, the themes consist of five categories: Climate change and biodiversity of East Asia, plant conservation and seed bank, biodiversity informatics, role of natural historical collection in taxonomy, East Asian plant diversity and conservation.

Researchers and representatives from various institutes are invited to present their papers and attend this symposium to share their experience and insight on the themes above. For details concerning the presentations and other lodging information, you will be informed on the symposium website, http://isknh.org.

We sincerely invite you to join us in this event. With your support and participation, I believe the 10th Anniversary Symposium of Korea National Herbarium will enjoy great success.

Your expenses for air tickets, hotels and etc. will be paid by Korea National Arboretum.

Looking forward to your participation.

Shin, Joon Hwan

General-director, Ph.D.
Korea National Arboretum

附件二、研討會議程表

Tuesday, 05 November, 2013 — Olympic Parktel

08:30~09:30	Registration
09:30~10:00	**Opening Remark** — **Olympia Hall (1F)**
Plenary Lectures	**Opening Plenary** ***Moderator: Joon-Hwan Shin (Korea National Arboretum)***
10:00~10:30	**Korean Peninsula as a cradle, bridge, refugium and melting pot of plants** Woo-Seok Kong (Kyung Hee University)
10:30~11:00	**Safeguarding and restoring plant diversity in a rapidly changing world** Sara Oldfield (Botanical Gardens Conservation International)
11:00~11:30	**ASEAN Center for Biodiversity's efforts for the research, policy and partnerships for ASEAN biodiversity conservation** Roberto V. Oliva (ASEAN Center for Biodiversity)
11:30~13:00	LUNCH provided by ISKNH
S1	**Climate Change and Biodiversity of the East Asia** — **Olympia Hall (1F)** ***Moderator: Ho-Sang Kang (Seoul National University)***
13:00~13:30	**Distribution limits of Korean plants in northern Asia: Climatic controls and history** Pavel Krestov V. (Botanical Garden- Institute, Far Eastern Branch, Russian Academy of Sciences)
13:30~14:00	**Prediction and detection of climate change impact on plants species distributions in Japan** Tanaka Nobuyuki (Forestry and Forest Products Research Institute)
14:00~14:30	***Ex situ* cultivated flora of China** Huang Hongwen (South China Botanical Garden; East Asian Botanical Garden Network)
14:30~15:00	**Climate change and biodiversity researches in Mongolia** Nyam-Osor Batkhuu (National University of Mongolia)
15:00~15:20	BREAK
S1	***Moderator: Woo-Seok Kong (Kyung Hee University)***
15:20~15:50	**Adaptation of a widespread epiphytic fern to simulated climate-change conditions** Rebecca Chia-Chun Hsu (Taiwan Forestry Research Institute)
15:50~16:20	**Response to global climate change from study on biodiversity in China and regional cooperation in Northeast Asia** Yong Huan Jin (Institute of Applied Ecology, Chinese Academy of Sciences)
16:20~16:50	**Conservation project of the threatened plants by climate change and the plan of Northeast Asia cooperation** Seung-Hwan Oh (Korea National Arboretum)
16:50~17:40	Session Discussion
17:40~18:30	BREAK
S2	**Biodiversity Informatics** — **Seoul Hall (2F)** ***Moderator: Jeong-heui Lim (National Science Museum)***
13:00~13:30	**Korean Biodiversity Information Facility: Biological diversity information flow in worldwide, its activity and the role to GBIF** Hyung-Seon Park (Korea Institute of Science and Technology Information)

Tuesday, 05 November, 2013 — Olympic Parktel

13:30~14:00	**An open access biodiversity database for the Hindu Kush-Himalayan region** Nakul Chettri (International Centre for Integrated Mountain Development)
14:00~14:30	**Practical use and database quality control of the Korea National Biospecies Information System** Sang-Yong Kim (Korea National Arboretum)
14:30~15:00	**The Asean clearing-house mechanism (Asean-CHM): Benefits of data sharing for biodiversity conservation** Lilibeth de la Rosa Cabebe (ASEAN Center for Biodiversity)
15:00~15:20	BREAK
S2	***Moderator: Hyung-Seon Park*** ***(Korea Institute of Science and Technology Information)***
15:20~15:50	**Genome sequencing of *Panax ginseng* and novel de novo assembly method to obtain complete cp and nrDNA sequences for study of plant diversity** Tae-Jin Yang (Seoul National University)
15:50~16:20	**The current of genomic data analysis in various plants by NGS** Ahn Kung (Theragen Etex Bio Institute)
16:20~16:50	**Considerations for research regarding scientific investigation and effective publishing on traditional knowledge utilized in the local communities of Korea** Mi-Jang Song (Jeonju University)
16:50~17:40	Session Discussion
17:40~18:30	BREAK
18:30~20:30	**Welcome reception** — **Olympia Hall (1F)**

Wednesday, 06 November, 2013 Korea National Arboretum

08:30~09:00	Registration
S3	**Role of Natural Historical Collection in Taxonomy** **Audio-Visual Hall (2F)** ***Moderator: Joo-Hwan Kim (Gachon University)***
09:00~09:30	**Past, present, and future of Korea National Herbarium** You-Mi Lee (Korea National Herbarium, Korea National Arboretum)
09:30~10:00	**An introduction of the Herbarium of Institute of Botany, Chinese Academy of Sciences** Xian-Chun Zhang (Chinese National Herbarium, Institute of Botany, Chinese Academy of Sciences)
10:00~10:30	**The database of herbarium and flora of Mongolia** Oyuntsetseg Batlai (National University of Mongolia)
10:30~10:50	BREAK
S3	***Moderator: Young-Woon Lim (Seoul National University)***
10:50~11:20	**Molecular identification of insects: Application of DNA barcoding to Dipteran and Hemipteran insects** Seung-Hwan Lee (Seoul National University)
11:20~11:50	**Sequencing all mushrooms and associated taxa from the Tsukuba Botanical Garden, Japan: Merging all data from fruit body survey and metagenomic analyses** Kentaro Hosaka (National Museum of Nature and Science)
11:50~12:20	**Research and commercialization of Cordyceps** Jae-Mo Sung (Kangwon National University, and Cordyceps Research Institute, Mushtech Co.)
12:20~14:00	LUNCH provided by ISKNH and poster session (P)
S3	***Moderator: Seung-Chul Kim (Sungkyunkwan University)***
14:00~14:30	**Host species, fruiting body structure, and substrate dependency of microbial communities in Antarctic lichens** Soon-Gyu Hong (Korea Polar Research Institute)
14:30~15:00	**Insect species diversity and insect collection** Hirowatari Toshiya (Kyushu University)
15:00~15:30	**The role of the modern herbarium in studying the systematics of orchids: The largest family of plants on earth** Kenneth Michael Cameron (University of Wiscosin)
15:30~15:50	BREAK
S3	***Moderator: Bong-Kyu Byun (Hannam University)***
15:50~16:20	**Insect and plant collections are essential for evolutionary research on Lepidoptera** Erik J. van Nieukerken (Naturalis Biodiversity Center)
16:20~16:50	**World Flora Online project** Libing Zhang (Missouri Botanical Garden)
16:50~17:20	**The Global *Carex* Group: Revising the classification of the temperate zone's largest angiosperm genus, and training the next generation of sedge systematists** Andrew H. Hipp (The Morton Arboretum)
17:20~18:00	Session Discussion

Wednesday, 06 November, 2013 Korea National Arboretum

S4	East Asian Plant Diversity Conservation 2013 (EAPDC 2013)	Special Exhibition Room (1F)
14:00~14:30	**Opening of the EAPDC 2013** **Symposium opening Greeting from the President, The Korean Society of Plant Taxonomists** Jae-Hong Pak (Kyungpook National University)	
S4 (O)	***Moderator: Hyo-Sig Won (Daegu University)***	
14:30~15:00	**Mesozoic and Miocene fossil woods from Korea and their palaeoclimatic implications** Kyung-Sik Kim (Chunbuk National University)	
15:00~15:15	**Orbicules in the phylogenetic context: A case study of Lamiaceae** Hye-Kyong Moon (Kyung Hee University)	
15:15~15:30	**Phylogeny and biogeography of intercontinental disjunct genus *Symplocarpus* (Araceae): New insight from additional cpDNA markers** Joon-Seon Lee (Sungkyunkwan University)	
15:30~15:45	**New GIS-based approach for comparative phylogeography of Japanese deciduous broad-leaved tree species** Takaya Iwasaki (The University of Tokyo)	

* EAPDC 2013 is an international symposium held by the Korean Society of Plant Taxonomists.

Thursday, 07 November, 2013 Korea National Arboretum

08:30~09:00	Registration	
S4	**East Asian Plant Diversity Conservation 2013 (EAPDC 2013)** ***Moderator: Sang-Hoon Oh (Daejeon University)***	**Special Exhibition Room (1F)**
09:00~09:30	**A phylogenomic study of chloroplast genomes in Magnoliaceae** Sangtae kim (Sungshin Women's University)	
09:30~10:00	**Map based analyses of adaptive evolution and speciation in ferns** Yoko Yatabe-Kakugawa (Makino Herbarium of Tokyo Metropolitan University)	
10:00~10:30	**DNA barcode of plant: a core barcode with some alternatives** Shiliang Zhou (State Key Lavoratory of Systematic and Evolutionary Botany, Chinese Academy of Sciences)	
10:30~10:50	BREAK	
S4	***Moderator: Next meeting organizing committee***	
10:50~11:20	**DNA barcoding and community phylogenetics in forest plots, Cambodia** Hironori Toyama (Kyushu University)	
11:20~11:50	**Molecular phylogeny of Liliales** Joo-Hwan Kim (Gachon University)	
11:50~13:00	Session Discussion	
13:00~14:00	LUNCH provided by ISKNH and poster session (P)	
S5	**Plant Conservation and Seed Bank** ***Moderator: Kyu-Suk Kang (Seoul National University)***	**Audio-Visual Hall (2F)**
09:00~09:30	**Biobanking of plants – Achievements and challenges** Hugh W. Pritchard (Royal Botanical Garden, Kew)	
09:30~10:00	**Challenges of *ex situ* seed banking with climate change** Jeffrey L. Walck (Middle Tennessee State University)	
10:00~10:30	**An important base for conserving wild plant resources in China** Du Yan (Kunming Institute of Botany, Chinese Academy of Sciences)	
10:30~10:50	BREAK	
S5	***Moderator: Ki-Sun Kim (Seoul National University)***	
10:50~11:20	**Conservation and management of tropical seeds in Indonesia** Upik Rosalina Wasrin (Sang Hyang Seri)	
11:20~11:50	**Preservation and management of seeds in KSVS** Eun-Hee Soh (Korea Seed and Variety Service)	
11:50~12:20	**Role of Genebank on plant genetic resources conservation** Sok-Young Lee (National Agro-biodiversity Center, National Academy of Agricultural Science, RDA)	
12:20~13:00	Session Discussion	
13:00~14:00	LUNCH provided by ISKNH and poster session (P)	

Thursday, 07 November, 2013 Korea National Arboretum

Plenary Lecture	**Closing Plenary** ***Moderator: You-Mi Lee (Korea National Arboretum)***	**Audio-Visual Hall (2F)**
14:00~14:40	**Botanic gardens and arboreta as ecological resources for sustainable dvelopment** Victor Kuzevanov (Botanic Garden of Irkutsk State University)	
14:40~14:50	**Closing Remark**	**Audio-Visual Hall (2F)**
14:50~17:00	Excursion in Gwangneung Forest	
17:00~19:00	**The 10th Anniversary Ceremony of Korea National Herbarium**	

附件三、合作備忘錄內容

LETTER OF INTENT

FOR THE BIODIVERSITY CONSERVATION NETWORK OF EAST ASIA

Between

The Botanical Garden-Institute, Far Eastern Branch, Russian Academy of Sciences,
The Forestry and Forest Products Research Institute,
Institute of Applied Ecology, Chinese Academy of Sciences,
National University of Mongolia,
Taiwan Forestry Research Institute,
Botanic Garden of Irkutsk State University of Russia,
South China Botanical Garden
And
Korea National Arboretum

The Botanical Garden-Institute, Far Eastern Branch, Russian Academy of Sciences, The Forestry and Forest Products Research Institute, Institute of Applied Ecology, Chinese Academy of Sciences, National University of Mongolia, Taiwan Forestry Research Institute, Botanic Garden of Irkutsk State University, South China Botanical Garden And Korea National Arboretum (hereinafter, "the Participants") will:

acknowledge that the East Asian region represents almost all biogeographical regions of subtropical and temperate, as well as cold temperate forests, including species diversity and habitat heterogeneity;

bear in mind that climate change is among the greatest challenges facing the world today;

express concern that in East Asia, the species and their habitats are dramatically degraded by high population density and rapid economic growth;

focus on decentralized cooperation in areas related to biodiversity, climate change and management

Consider:

The Sides will implement the letter and the spirit of the 1973 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), the 1992 Convention on Biological Diversity (CBD), and the national laws and regulations of the Sides concerning

biodiversity, including laws on access to and the transfer of plant genetic resources

Resolve:

First Provision-On the object

The current Agreement addressed scientific cooperation on the following topics:

I. Biodiversity conservation by researches on biological changes of species in response to climate change
II. Data collection and taxonomic study of plant diversity in East Asia
III. Controlling non-native invasive species by partnerships for invasive species management

Second provision – on Activities

Activities will include *inter alia* seminars, exchanges of human resources, field trips and cooperation between participants.

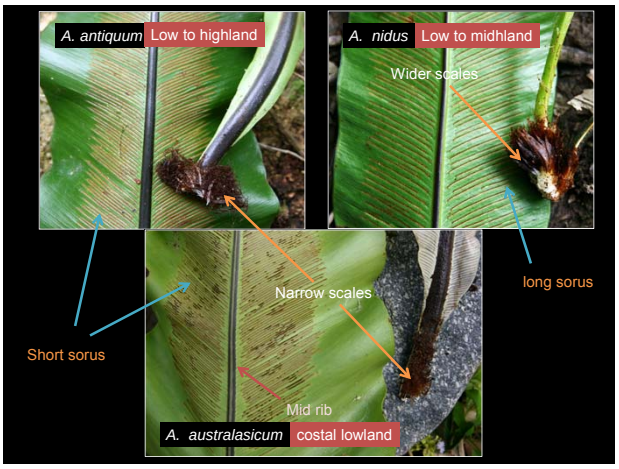
Signatories below take this document as a proof of their agreement and commitment, and sigh it for it to unfold its legal effects.

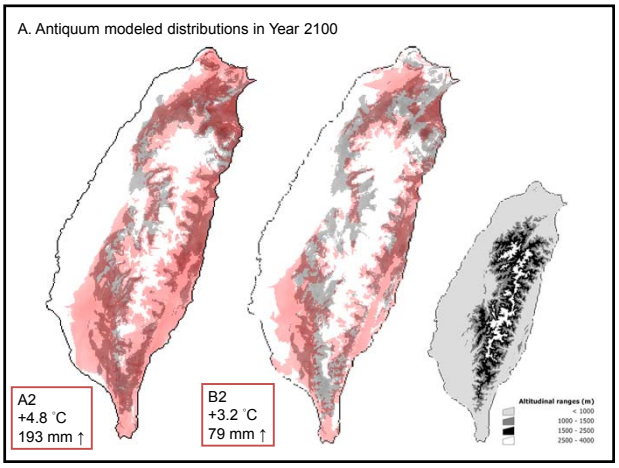
附件四、簡報檔

Adaptation to simulated climate change of a widespread epiphytic fern *Asplenium antiquum*

Rebecca C.-C. Hsu

INTERNATIONAL SYMPOSIUM of
100th ANNIVERSARY of KOREA NATIONAL HERBARIUM

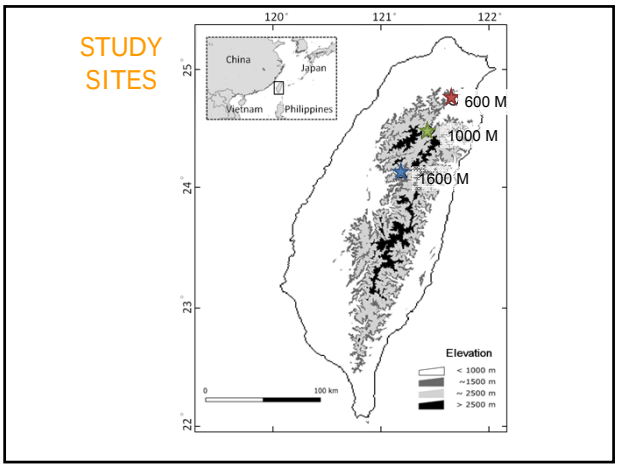




RESEARCH QUESTIONS

- To evaluate *A. antiquum* sensitivity to manipulated climate-change conditions using Reciprocal transplant experiments
- To understand if altitudinally separated populations of *A. antiquum* are adapted to their local environment.

STUDY SITES



JUVENILES CULTIVATION

TRANSPLANTATION EXPERIMENT


WILD JUVENILES


Fog sensor
Mini OFS

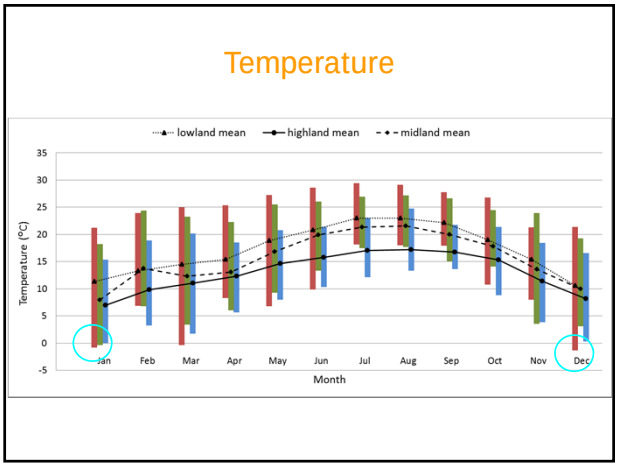

MONTHLY MEASUREMENT


MICROCLIMATE MONITORING

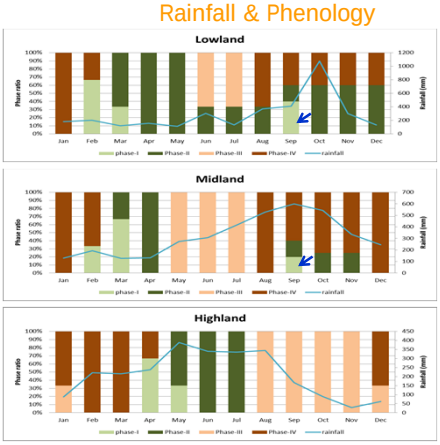

Disturbance


Onset
HOBO


Results


Temperature
lowland mean
highland mean
midland mean
Temperature (°C)
35
30
25
20
15
10
5
0
-5
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep
Oct
Nov
Dec
Month

Rainfall & Phenology



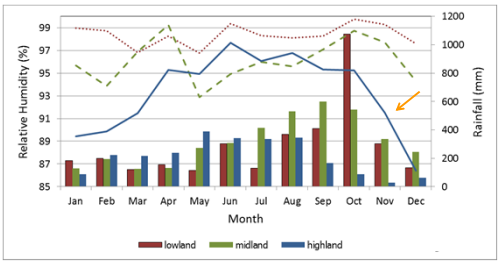
Phase-I:
Leaf budding

Phase-II:
Leaf elongation

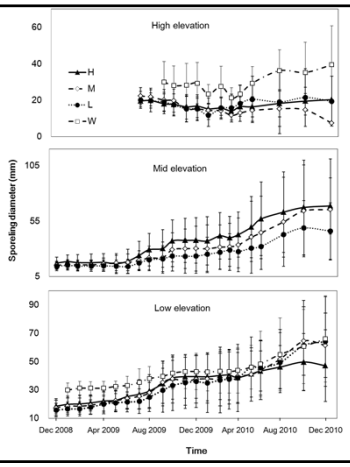
Phase-III:
Sporangia development

Phase-IV:
Spore release

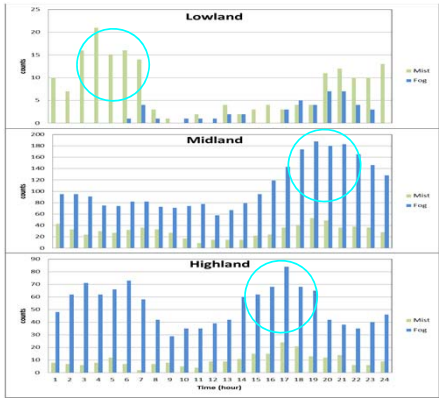
Rainfall & Humidity



JUVENILE GROWTH

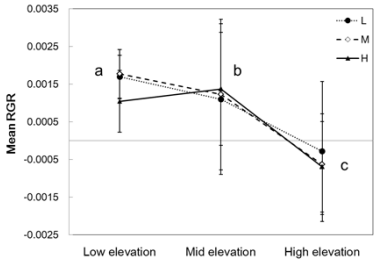


Fogs



Relative growth rate (RGR)

RGR = (ln(D2) – ln(D1))/(t2 – t1)



Relative growth rate (RGR)

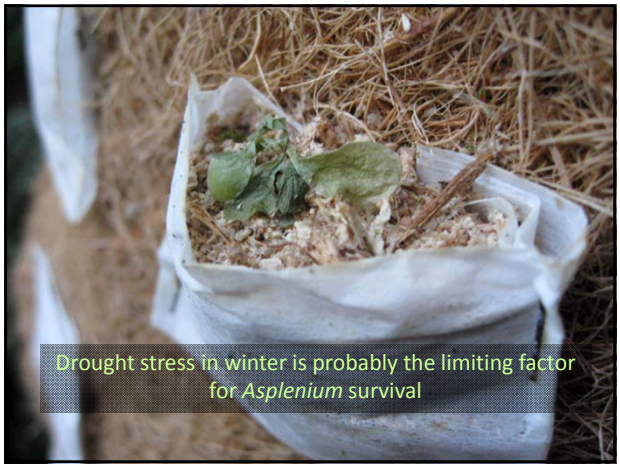
Dependent Variable	Covariate	n	F	P
RGR (among sites)				
	Initial size	88	11.331	0.001***
	Elevation	88	22.1	< 0.001***
	Origin	88	1.202	0.306
	Elevation × Origin	88	3.11	0.02**
RGR (within sites)				
Low elevation	Initial size	53	6.602	0.013**
	Origin	53	3.98	0.025**
Mid elevation	Initial size	23	2.449	0.134
	Origin	23	0.414	0.667
High elevation	Initial size	12	3.082	0.117
	Origin	12	1.36	0.31

Codes for significance: *** p < 0.01, ** p < 0.05, * p < 0.1.

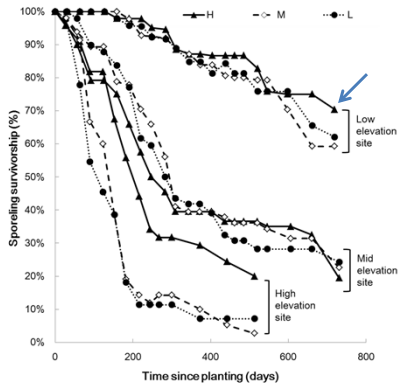
RGR vs Microclimates

Correlated (Controlling) factors	Source	Correlation coefficient					
		Lowland origin		Midland origin		Highland origin	
T	Low elevation	0.68	(0.015)**	0.723	(0.005)***	0.506	(0.078)
(RH)	Mid elevation	0.223	(0.464)	0.527	(0.064)*	0.435	(0.137)
	High elevation	-0.114	(0.724)	-0.502	(0.096)	-0.201	(0.53)
RH	Low elevation	0.229	(0.452)	-0.536	(0.059)*	0.513	(0.073)*
(T)	Mid elevation	-0.072	(0.814)	0.568	(0.043)**	0.631	(0.021)**
	High elevation	0.15	(0.642)	0.604	(0.038)**	0.222	(0.488)

Codes for significance: *** p < 0.01, ** p < 0.05, * p < 0.1.

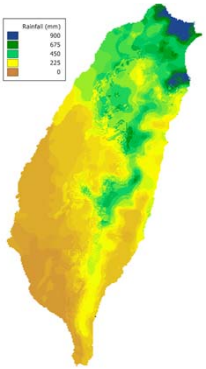


SURVIVORSHIP



REGIONAL CLIMATE VARIATION

Rainfall of the cold quarter brought by NE-monsoon in winter



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Our experiment has shown that there seems adaptive genetic differentiation among populations of *A. antiquum* growing at different elevations

A. antiquum is not expected to be negatively affected by climate change, owing to its wide distribution and genetic adaptation at its range margin.

At the high elevation site, the higher survivorship of local sporelings suggests a certain degree of genetic adaptation, resulting in higher tolerance to drought stress and low temperatures.

Conclusion

The study suggests that intraspecific variation should be considered when establishing the potential impact of climate change on biodiversity.

The highland sporelings express the advantage of slow growth during the accidental frost of the experiment, and had higher survivorship even at the lowland site.

Slow growth, a trait that is advantageous at high altitude was maintained by highland sporelings at low elevations, indicating a genetic basis.