2015

Annual Report

Taiwan Forestry Research Institute

行政院農業委員會林業試驗所

一〇四年度年報

序

2015 年 10 月，美國奧勒岡州世界林業中心 (World Forestry Center) 主任 Eric Vines 的一篇文章引起我的關注。大意是說現今生長在德國的花旗松 (Douglas-fir) 其實並非當地的原生種，而是遠從北美洲引進栽植的。然而根據化石資料顯示，不過就在 2 萬年前，花旗松還曾遍布於歐洲北部地區，為何會由盛而衰，變化如此之劇？原因竟然不是野火、疫病、旱澇等干擾，也不是因為它的競爭力不如闊葉樹或耐陰性樹種所致，而是因為阿爾卑斯山脈 (the Alps) 的關係！由於當時歐洲氣候變冷，冰河自北方南下，花旗松為求生存於是南遷至溫帶地區，其移動速率大約是每年一個足球場的距離。若干年後，它們終於來到阿爾卑斯山北緣；但是東西走向的巨大山脈，讓花旗松無法跨越南行與繼續演替。及至冰河退卻，原先的花旗松領域已由闊葉樹取而代之。

相對地，北美地區的主要山脈多半是南北走向，植物在遭逢異常的降雨、溫度等環境條件改變時，可以透過後代不斷地南北遷移、演替等機制而存活下來，於是出現了一幕幕的求生冒險故事。植物透過不斷的調適 (adaptation) 克服了地理、氣候的種種挑戰！ Vines 特別強調，雖然許多數據顯示，全球氣候正在快速變遷，科學家仍然無法得知地球暖化可能帶給樹木的所有影響。事實上，前述的冰川作用 (glaciation) 造成的衝擊還算是緩慢的，容許樹木能有足夠的時間去遷移和適應。反觀目前全球氣候變化加劇，樹木倘要藉由遷移達到調適，可能必須在 100 年內移動 1,000 公里才能達成，而這早已超過樹木自然演替的能耐。Vines 的文章確實讓我印象深刻。

就在全球暖化與物種消逝的擔憂還揮之不去的同時，氣象專家證實 2015 年竟是人類有溫度紀錄以來最燠熱的一年，此種高溫在 2016 年 1-4 月仍持續著；這種情況可能意味著未來乾旱、強降雨、熱浪、風暴等極端天氣將會屢見不鮮。我擔心如果這樣的惡夢成真，北歐花旗松的歷史難保不會在臺灣其他的原生物種身上發生，而阿爾卑斯山脈的藩籬，在臺灣可能換成是周圍不斷上升的海平面或是各個獨立的山峰。

狄更斯的《雙城記》說：「這是最好的時代，也是最壞的時代。」面對全球日趨嚴峻的氣候變化與充滿挑戰的林學研究，我經常提醒同仁，把握每一次難得的研究機會，也正視森林每一項可貴的功能，以為人類與森林的未來尋求更多更好的可能。值此本所 104 年度年報出版之際，謹以 2015 年第 14 屆世界林業大會的「德班宣言 (Durban Declaration)」與國人共饗：一、森林不只是林木而已，更是糧食安全和改善生計的基礎。二、整合性的土地利用方式，可改善政策與實務，以因應毀林的驅動因素。三、森林是調適與減緩氣候變遷必要的解決方案。四、要實現這個願景需要森林、農業、財務、能源、水資源和其他部門共同建立新的夥伴關係，以及原住民與在地社區之參與。

行政院農業委員會林業試驗所

所長 黃裕星 謹誌

2016年5月

Preface

In October, 2015, an article by Dr. Eric Vines, Executive Director of the World Forestry Center, in Oregon, USA, caught my attention. The gist of which described that Douglas-fir growing in present day Germany is not endemic, but rather introduced from North America. According to the fossil records, however, no more than 20,000 years ago, Douglas-fir existed extensively in northern Europe. Why had it tumbled from summit of prosperity to total extinction with such dramatic change? The causes were neither interferences of wild fire, diseases, draught, nor the failure to compete with broadleaved trees or trees of shade tolerance. It disappeared because the Alps! At the time European weather turned cold, glacial advanced from the north, in order to eke a living, Douglas-fir had to migrate southward to warmer climates. It had a moving speed roughly one football field a year. After several years, they finally arrived at the northern foothills of the Alps. However, the east-west running great mountains rendered Douglas-fir an insurmountable obstacle, preventing them from moving farther south and continuing their succession. Until glacial eventually retreated, the original Douglas-fir was replaced by broadleaved species.

Contrarily, the main mountain ranges in North America are mostly running along the north-south direction, when plants encountered unusual rainfalls, temperatures etc. environmental condition changes, they can migrate and carry on successions continuously south- or northward through their offspring and lived on. Thus, stories of a scene after another of venture to persist were enacted. Plants through their incessant adaptations have overcome geographic and climatic challenges! Dr. Vines stressed that although numerous data indicated that the global weather is changing rapidly, scientists are still unable to fathom how the global warming will affect trees in its entirety. As a matter of fact, the aforementioned glaciations action impacted rather slowly, allowing trees to have sufficient time to migrate and adapt. In retrospection, at present, the global climate changes are becoming more drastic, if trees want to adapt through migration, they might have to move 1,000 kilometers in 100 years. This has far exceeded the natural succession capability of most tree species. Dr. Vines' article rather profoundly impressed me.

At the same time that we have lingering worry about global warming and disappearance of many species, meteorologists have confirmed that the year 2015 was the hottest year since the human began temperature recording. The kind of searing heat still persisted in January to April of 2016. The situations thus bode ill for future scenarios of extreme weather events of draughts, torrential rains, heat waves, storms etc. at an ever increasing frequency. I have serious concerns that if such nightmares become true, the history of Northern European Douglas-fir could well happen also to many indigenous species in Taiwan. Whereas the barrier of the Alps in Europe could translate to an ever raising sea level or individual mountain peaks.

In "A tale of two cities" by Charles Dickens, there was the famous saying "It was the best of times; it was the worst of times." Facing with the worsening global climate change and challenging forestry research issues, I would like to remind our colleagues to grasp well each hard-to-come-by research opportunity, to look hard on the eyes each precious function of forests, so as to seek better and more possibilities for human from the future forests. At the time of the publication of 2015 TFRI Yearbook, I would like to share with my fellow countrymen the Durban Declaration transpired in the XIV World Forestry Congress (WFC), which says: 1) Forests are not merely sources of timber, they are the basis of food security and improvement to livelihood; 2) Integrated land use methods could improve both policies and practices so as to cope with the driving factors of deforestation; 3) Forests are necessary solutions to adjust and mitigate the climate changes; 4) In order to achieve this vision, there must be new partnership inputs among foresters, agriculturists, officials of financial, energy, water resources and other departments, as well as the participations of aboriginal people and local communities.

Director General, Taiwan Forestry Research Institute, Council of Agriculture, Executive Yuan
May, 2016

目錄

Content

林發計畫暨所外委辦計畫 Forestry development projects and outsourced projects

科技部預算計畫 Projects subsidized by the Ministry of Science and Technology

2015

Annual Report

壹

前言

Introduction

前言

林業試驗所104年度編制員額為142人，歲入預算數11,173千元，較上年度增列988千元，歲出預算數591,291千元，較上年度減列10,254千元。為利各界瞭解本所104年度施政概況，本刊援例以計畫領域為編纂軸心，刊載已結案之計畫成果38項，分作三類呈現：一、林業科技試驗研究計畫25項(佔65.8%)。二、林業發展計畫暨所外委辦計畫5項(佔13.2%)。三、科技部補助專題研究計畫8項(佔21.0%)。除完成各類計畫外，104年度亦推動多項施政簡述如次：

一、在林業資源生產技術研究方面：開發土肉桂品種檢定性狀表；完成選育牛樟品系8個，山胡椒高精油品系種源2個；推廣休耕地造林面積13公頃；建立速生固氮樹種栽培試驗地1公頃；建立3處混農林業生產專區並進行監測；選拔抗風耐澇赤桉品系2個，耐熱泡桐品系1個，及耐熱牛樟品系3個；發展青脆枝毛狀根生產抗癌藥物喜樹鹼的生物反應器培養方法；選育降低木質素與提升纖維素雙基因轉殖桉樹；發展山葵健康種子生產技術等。

二、在樹木健康管理及樹木保護研究方面：由樹木醫學中心提供診斷及防治諮詢服務1,742件，並開辦研習班20場次共有1,000人參加；辦理樹藝學專業研習班2期共有126人參加；開發都市樹木健康之目視基準重要檢測技術1式，及都市林樹木嚴重缺點部位檢查測試技術1式；完成以5種不同木材養植牛樟菇之試驗；建立林木病蟲害入侵種資料庫20種及資料600筆；開發靈芝核酸快速萃取技術1式等。

三、在試驗林生態系示範經營方面：完成造林撫育作業33公頃及造林地清查100公頃；執行林地巡護939次及林地巡視抽查作業4次；完成太麻里研究中心林地鑑界及侵占地收回；完成恆春熱帶植物園區之小花蔓澤蘭防治1.1公頃；採集、製作森林昆蟲標本350份；新增昆蟲標本資料371份及昆蟲標本數位化影像392份等。

四、國家植物園建設方面：於台北植物園蒐集原生植物104種2,581株，完成解說導覽13,996人次及資訊網服務689,336人次，辦理生態保育志工培訓14場次及種子教師專業班12場次，共培訓1,098人次；於福山植物園蒐集原生蘭科植物49種60株、野牡丹科植物4種48株，辦理解說導覽99,359人次；於恆春熱帶植物園完成植物蒐集43種，辦理解說導覽11,063人次；於植物標本館完成植物標本製作及資料建置19,154份，並數位化植物標本20,607份，同時透過網路查詢提供32,008人次瀏覽使用等。

此外，本刊亦檢附104年度之重要記事、專題演講、出版品、技術移轉案件、發表報告、人力資源、預決算等訊息，謹供各界檢視本所當年度之整體施政成效。

Introduction

In 2015, the Taiwan Forestry Research Institute (TFRI) had 142 formal staff members, and an annual receipt budget of 11,173 thousand NT dollars, increased 988 thousand NT dollars from the previous year; and an annual expenditure budget of 591,291 thousand NT dollars, decreased 10,254 thousand dollars from the previous year. In order for the public to have a glimpse of what we did in 2015, this yearbook shall follow the previous example and uses project domains as an axis of compilation, in which 38 projects with completion reports are listed. These projects fall into 3 categories of presentations: 1) forestry science and technology research projects account for 25 items (or 65.8%) of the total; 2) forestry development and external entrusted projects for 5 items (13.2%); and 3) Ministry of Science and Technology granted special topic research projects for 8 items (21.0%). In addition to the various completed projects, in 2015, there were several administrative achievements that we have transpired. These are described briefly below:

Ⅰ. On the studies of forest resources production technology aspects: We've developed a checklist table for *Cinnamomum osmophloeum* strains; selective bred 8 strains of *Cinnamomum kanehirai*; established 2 provenances of mother tree sources with high essential oil yields for *Litsea cubeba*; thirteen hectares of dormant arable land were afforested by our behest; one hectare of experimental field for cultivating fast growing nitrogen-fixing tree species was established; three special agro-forestry production zones were set up and monitored; two strains of *Eucalyptus camaldulensis* with wind-resistance and flood-tolerance characteristics were selected; one strain of heat-tolerant Paulownia and three strains of heat-tolerant *Cinnamomum kanehirai* sp. were established; we've developed a bioreactor-based method for producing an anticancer drug, camptothecin, from the hairy roots of *Nothapodytes foietida*; double gene-transferred *Eucalyptus* sp. trees to decrease its lignin content and increase the cellulose content were selectively bred; and a production technology for produce healthy seeds from wasabi (*Eutrema japonica*) was established.

Ⅱ. On the tree health management and tree protection research aspect: The tree medical center offered diagnostic and preventive inquiries to 1,742 cases; hosted 20 workshops and seminars on the subject with 1000 persons attended; two professional training classes on arboriculture were held with 126 persons attended; developed one set of visual assessment standard on important inspection techniques of urban tree health and one set of inspection and testing techniques for serious defect parts of urban trees; completed *Antrodia cinnamomea* culturing on 5 different wood species substrates; established a database containing 20 kinds of forest trees diseases and insect infestation of invasive species with 600 items; and developed a rapid nuclear acid extraction technique for *Ganoderma* sp.

Ⅲ. On the ecosystem demonstrative management of experimental forest aspect: Completed afforestation and tending operations on 33 hectares of forestland and 100 hectares of forestland inventory check; executed 939 rounds of forest cruises and 4 cases of forestland inspection and random check; completed forestland boundary redefinition and reclaimed incursive land in Tamalee Research Center; completed 1.1 hectare of *Mikania micrantha* eradication and prevention in Hengchun Tropical Botanical Garden; collected and prepared 350 items of forest insect specimens; and increased 371 items of new insect specimen information as well as 392 items of digitized images.

Ⅳ. On the construction of national botanical gardens aspect: At the Taipei Botanical Garden, 104 species and 2,581 endemic plants were collected; completed interpretive guided tours to 13,996 person-time and the information network serviced 689,336 person-time, 14 ecological conservation volunteer training courses and 12 seed teachers professional classes were held with 1,098 person-time received instruction; at the Fushan Botanical Garden, 49 species and 60 individuals of endemic Orchidaceae plants, and 4 species and 48 individuals of Melastomataceae plants were collected, the garden also conducted guided tours to 99,359 person-time; at the Hengchun Tropical Botanic Garden, 43 species plants were collected, a total of 11,063 persons were provided with guided interpretive tours; and at the Taipei Herbarium, 19,154 items of plant specimen preparation and information entry were completed, also 20,607 items of plant specimens were digitized which provided 32,008 person-time of browsing through the network.

In addition, the yearbook also includes 2015 chronicle of important events, special lectures and speeches, publications, technical transfer cases, published reports, information on human resources, the budget and audited reports of expenditures etc., so that the interested party may inspect the overall administrative efficacies of the TFRI.

2015

Annual Report

貳

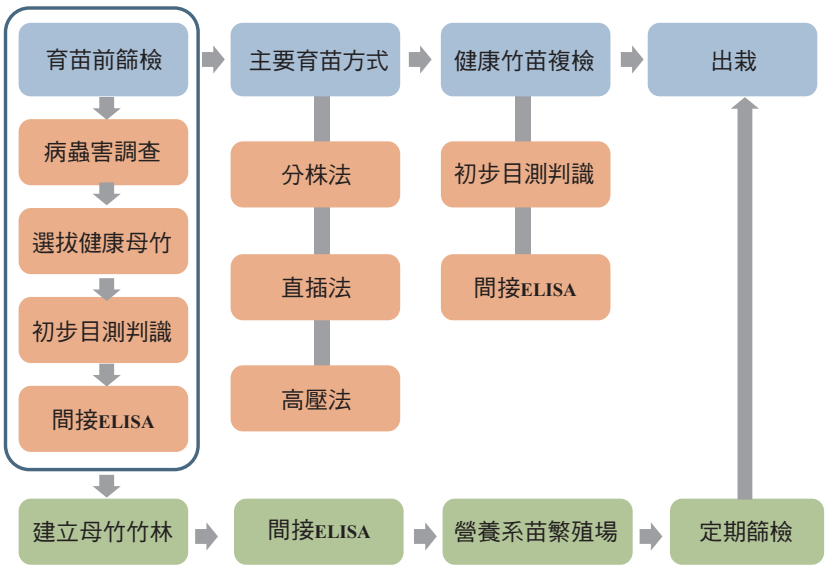
研究計畫推動及成果

Development and results of research projects

荒廢麻竹林管理與產筍量之研究

陳財輝

麻竹(*Dendrocalamus latiflorus*)林分依人為經營的程度差異，可分為荒廢竹林：已久經無人為採筍或伐採老竹等作業之林地；粗放經營：現在仍有人為採筍及部分老竹之伐採整理者；以及集約經營：除了有人為採筍及老竹伐採作業之外，通常還會集約進行灌溉、培土、施肥及竹稈密度管理等人工管理作業。本試驗調查高雄六龜(荒廢竹林)與臺南白河地區(粗放經營)麻竹林分之生長及生物量。林分生長性狀方面，兩試驗地之平均胸徑差異不大，六龜與白河樣區分別為6.9±2.6 cm、7.3±1.7 cm，而六龜樣區之平均竹高為12.4±3.5 m較白河地區之8.8±1.8 m高；地上部乾重方面，六龜樣區因竹叢稈數低且竹叢數少，其地上部林分總生物量亦遠低於白河樣區，六龜與白河樣區之總生物量乾重分別為17.4±2.7 ton ha^{-1}、94.5±8.4 ton ha^{-1}，其中六龜樣區各齡級之生長及生物量結果，4年生及以上之總生物量最高、且隨齡級遞減而減少，六龜麻竹林明顯出現生長衰退的現象。另外，蓮華池三角崙麻竹集約栽培試驗地方面，新植劈接法以及高壓法育成之麻竹無菌苗，並設置樣區進行調查，劈接法麻竹苗新植樣區，平均胸徑為2.69±0.32 cm，竹高為4.90±0.60 m，枝下高為1.13±0.02 m；高壓法麻竹苗新植樣區，苗較小，生長較緩慢，平均胸徑為1.34±0.28 cm，竹高為0.91±0.34 m。集約麻竹筍生產流程管理方面，不僅從麻竹筍生產管理之無菌苗登記、施肥、用藥等生產履歷記錄，竹筍採收後之加工處理及產銷方式等皆須詳加掌握。尤其，麻竹筍在採筍生產過程中，容易受到挖筍刀之接觸而感染竹嵌紋病，如何建立健康麻竹苗良好的生產履歷極為重要。



健康麻竹苗良好培育體系。
The health ma bamboo seeding nursery system

Management technique and variation of bamboo shoot yield in an abandoned *Dendrocalamus latiflorus*

Tsai-Huei Chen

Depending on the management intensity, three management techniques of ma bamboo (*Dendrocalamus latiflorus*) for shoot yield were available. The first is the abandoned bamboo stands which do not harvest bamboo shoots and cut old bamboos for a long time. The second still harvests bamboo shoots and cuts old bamboos, but without additional efforts. It is, therefore, called extensive management. Last (i.e., intensive management) refers to those which, in addition to harvesting bamboo shoots and cutting old bamboos, usually also carry out irrigation, earth coverage, fertilization and stand density control works. This study investigated the plantations and biomass of ma bamboo in Liukuei, Kaohsiung (an abandoned stand) and Baihe, Tainan (an extensive managed stand). There was no significant difference in average of diameter at breast height between the experimental sites. It was 6.9±2.6 cm and 7.3±1.7 cm at the plantations of Liukuei and Baihe, respectively. The average height of 12.4±3.5 m at Liukuei was higher than 8.8±1.8 m at Baihe. The above ground biomass, the amount of culms and clumps in the plantations of Liukuei are lower than those in Baihe. The above ground biomass at Liukuei and Baihe were respectively 17.4±2.7 ton ha^{-1} and 94.5±8.4 ton ha^{-1}. The above ground biomass of Liukuei at different ages indicated that old bamboo 4-year or more of age has the highest above ground biomass. The biomass of bamboo decreased gradually from age 4 to 1, therefore, it appeared there were signs of recession at the Liukuei area. We planted the ma bamboo seedling by cleft grafting and air layering at Sanjiaolun plantation. The average DBH of the ma bamboo seedling in cleft grafting plot is 2.69±0.32 cm with the height of 4.90±0.60 m and the height under branch was 1.13±0.02 m, which were larger and grow faster than the DBH (1.34±0.28 cm) and the height (0.91±0.34 m) of air layered ma bamboo seedling plot. The standard operating procedures of intensive management to produce ma bamboo shoots includes records of production process and marketing channels. However, during the production process, due to *BaMV* (*Bamboo mosaic virus*) infection caused by contaminated knife cutting bamboo shoots, it is important to build a health ma bamboo seedling nursery system.

桉樹人工林皆伐地更新策略之研究

游漢明

歷時5年之桉樹萌芽更新二代林林分生長調查，林分處理之後，留存根株於前二年每公頃之存活根株數由平均820株/ha減少至574株/ha，對照區維持546株/ha，除蘗處理區為603株/ha，直至目前維持穩定。每公頃總萌蘗株數，對照區每公頃1809株，除蘗處理區，每公頃則留存1117株。對照區單一根株，平均萌蘗株數為3.3±2.0株、平均胸徑生長10.0±3.8 cm，樹高生長10.5±4.5 m；除蘗處理區單一根株萌蘗株數為1.9±1.1株、平均胸徑生長12.0±3.5 cm，樹高生長11.6±3.8 m。就單一林木生長，除蘗處理後平均胸徑及樹高生長均優於對照區，尤其平均胸徑生長可高達120%。林下栽植相思樹、桃花心木、烏心石以及黃連木等台灣重要經濟造林樹種，至2015年止，總成活率達64%。林下栽植桃花心木平均成活率達87%，苗高可達472.6±113.1cm，4年生的高生長率達516%；黃連木之成活率79%，苗高可達200.1±77.4 cm，高生長率252%；相思樹苗高可達337.3±105.9 cm，成活率73%，高生長率達310%；而烏心石苗高可達200.0±56.6 cm，但成活率僅有17%，較其他三樹種苗高生長及成活率均不佳，烏心石造林木主因蟲害嚴重及乾旱而導致成活率逐年下降，驗證選擇樹種適合當地生育地環境之重要性。

桉樹二代林的萌芽更新調查。
Sprouts survey of *Eucalyptus regeneration* forest.

Study on regeneration strategy of Eucalyptus clear cut land

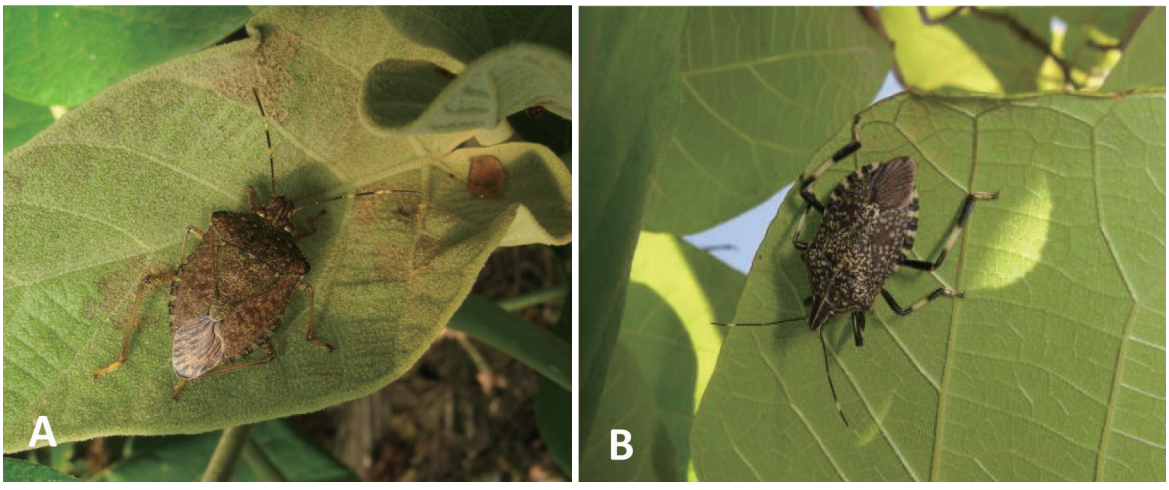
Han-Ming Yu

We investigated the growth of 5-year-old *Eucalyptus* sp. regenerated secondary stand of sucker shoots. The results indicated that the survival shoot number 2 years after cutting varied widely. The surviving shoots decreased from the original 820 existing shoots per hectare to an average of 574 shoots. After 2 years, the surviving shoot number remained stable. In which the control plot has 546 plants per hectare; deshooting treatment retained 603 plants per hectare. In the 5-year forest, control plot retained 1,809 shoots/ha; the deshooting plot retained 1117 shoots/ha. In the control plot, a single stump averaged 3.3±2.0 shoots with average dbh of 10.0±3.8cm and shoot length of 10.5±4.5 m; in the deshooting plot, each stump retained 1.9±1.1 shoots with average dbh of 12.0±3.5 cm and shoot length of 11.6±3.8 m. The results also indicated that the dbh and height growth of shoots in the deshooting plot were better than the control plot. The total dbh cross-sectional area in the control plot was 16.7 m^2/ha; and in the deshooting plot was 13.6 m^2/ha. The more shoots retained on the control plot, caused that the total dbh cross sectional area of the deshooting plot to be poorer than did the control. However, the net dbh and tree height growths after deshooting were greater. In subsequent investigations, we hope to establish more clearly the effect of deshooting treatment. In a survey of natural regenerated seedlings in the secondary *Eucalyptus* sp. shoot forest, there were 363 plants belonging to 22 species; whereas in the deshooting forest, there are 567 plants of 27 species sprouting from seeds. The species appeared both in the control and deshooting plots included *Acacia auricuriformis* , *Macaranga tanarius*, *Breynia officinalis*, *Aleurites montana*, *Murraya paniculata* etc. There was only scattered presence of other plants, such as *Cinnamomum camphora*, *Melia azedarach* and *Gardenia jasminoides*, indicating that renewable species showed little variation. However, the post-sprouting treatment released environmental resources can provide forest trees with a more varied regeneration opportunity, even facilitating seeding renewal of *Eucalyptus urophylla*. Comparing the emerging plant species, we found that the environmental resources released by deshooting treatment apparently allowed more plant species to take hold. Secondary planting of important endemic reforestation species of high economic values such as *Acacia confusa, Swietenia macrophylla*, *Michelia compressa*, and *Pistacia chinensis* in understories was also carried out. In 2015, the total survival rate after 4-year of all species averaged 64%. *S. macrophylla* had the highest surviving rate of 87% with average sapling height of 406.5±121.1 cm, the highest of all species; *Acacia confusa* had survived rate of 73%, with average sapling height of 303.2±120.5 cm. The survived rate of *P. chinensis* droped from 97% to 79%, with tree height only of 193.6±73.1cm; *M. compressa* grew to a height of 83.4±65.2 cm, with survival rate of only 45%. These results are useful reference for selecting trees for understory planting in a local planting programme.

泡桐抗耐簇葉病之評估與健康管理研究

陳怡蒨、莊鈴木

臺灣泡桐早年曾被譽為臺灣的綠色黃金，並且在1960-1970年代被廣泛種植。然而1980年代，臺灣泡桐造林地普遍受到泡桐簇葉病 (Paulownia Witches' broom, PaWB) 的為害，嚴重摧毀了泡桐產業。泡桐簇葉病的病原是植物菌質體 (phytoplasma)，屬蟲媒傳播之系統性病害，同時也可經由受感染的無性繁殖材料快速傳播。泡桐簇葉病目前尚無有效的藥劑防治措施，本計畫針對泡桐簇葉病開發了PCR診斷方法，配合專一性引子對，可用於簇葉病發病生態及抗病品種篩選的研究。針對不同泡桐品系苗木進行接種試驗，並使用PCR技術監測菌質體增殖的情形，結果臺灣泡桐完全不抗病，貴州泡桐以及白桐與貴州泡桐的雜交品系則呈現不同程度的耐抗病性，顯示接種測試配合PCR檢測，可以加速篩選耐抗病的雜交泡桐品系。為了解泡桐簇葉病四季發病情形，並監測菌質體在泡桐植株內的周年變化，自2014年2月開始至2015年6月為止，針對台東樣區17株樣木進行逐月採樣，PCR結果顯示菌質體數量在泡桐植株內有隨季節消長的情形。菌質體含量以及發病率在夏季達到高峰，且PCR檢測可以在病徵未出現前偵測到菌質體。經由田間採集以及餵蟲試驗證實茶翅椿(*Halyomorpha mista*)是泡桐簇葉病的媒介昆蟲(圖A)，此外在太麻里試驗區亦觀察到另一種可能的媒介昆蟲黃斑椿象（*Erthesina fullo*)(圖B)。藉由PCR檢測技術進行田間泡桐林木及媒介昆蟲帶原率監測，並持續追蹤媒介昆蟲族群變化，可以做為防治最佳時機之判斷依據進而擬訂防治對策。雖然病蟲害監測可以協助早期防治泡桐簇葉病，然而，選育優良的抗耐病泡桐品系以及培育健康種苗，將會是建立健康泡桐產業更重要的關鍵。



田間觀察到可能的泡桐簇葉病媒介昆蟲：A. 茶翅椿 (*Halyomorpha mista*), B. 黃斑椿象（*Erthesina fullo*)。
Putative vector insects observed in paulownia plantations. A. *Halyomorpha mista*, and B. *Erthesina fullo.*

Assessment of resistance and tolerance of paulownia to witches' broom disease and the health management research

Yi-Chiann Chen, Lin-Mu Jaung

Paulownia taiwaniana is a fast-growing timber species, which was earlier hailed as Taiwan's green gold and planted extensively during the 1960s and 1970s. However, in the 1980s, paulownia witches' broom (PaWB) infection destroyed paulownia plantations and resulted in significant economic losses. Phytoplasma is the causative agent of PaWB, which can be transmitted by vector insects and infected propagation materials. So far, no effective chemical treatment strategy is available for PaWB control. In this project specific and effective PCR primer of PaWB phytoplasma was designed and applied for PaWB detection, field research and resistant breeding. Artificial inoculation of test paulownia seedlings indicated *P. taiwaniana* plants were susceptible, however, seedlings of *P. fortunei* and *P. kawakamii* x *P. fortunei* hybrids showed varying degrees of tolerance to PaWB. The results showed artificial inoculation with PCR testing accelerated screening paulownia strains resistant or tolerant to PaWB. Seventeen paulownia plants in Taitung area were sampled monthly from February 2014 to June 2015 to evaluate the infection rate and variation of phytoplasma concentration in paulownia plants. PCR results indicated phytoplasma content in paulownia plants showed seasonal fluctuation. Phytoplasma content and incidence rate peaked in the summer, and the PCR test can detect the early presence of phytoplasma before symptoms occurred. The results of field collection, artificial feeding test, and PCR test confirmed that *Halyomorpha mista* (Fig. A), an insect vector, could sucessfully transmitted phytoplasma. Meanwhile, a yellow-spotted stink bug, *Erthesina fullo* (Fig. B), was observed in the Taitung sample area, and was suspected as another possible insect vector of PaWB. Information provided by monitoring the population change of vector insects and using PCR technique to monitor phytoplasma infection rate of paulownia plantations and of vector insects can be used to judge the best time of prevention and to develop better disease and pest control strategies. Pest and disease monitoring can help early prevention of PaWB, however, to establish a healthy paulownia industry, breeding of elite disease-resistant paulownia clones and nurturing healthy seedlings, will be the more critical steps.

轉基因桉樹之遺傳與環境友善性狀檢測

鍾振德

本計畫發展桉樹之基因堆積技術，培育出吻合產業需求，具有多重遺傳性狀改良之桉樹新品種，研究主要包括基因選殖、基因轉殖以及基因堆積，堆積方法包括連續性基因轉殖、共同轉殖與控制授粉之基因堆積。

基因之選殖已完成5個赤桉纖維素基因*EcCes A1~A5*、赤桉纖維素降解酶*KORRIGAN*與控制開花*LEAFY*基因之選殖。其中*EcCesA1~3* cDNA (GenBank accession no., HQ864583~5)選殖自初生木質部，*EcCesA4~5* cDNA (GenBank accession no., HQ864586~7)選殖自次生木質部。5種纖維素基因以赤桉no. 48進行基因轉殖，5種纖維素基因成功獲得轉殖細胞團，但只有*EcCesA4*進一步將細胞團誘導出芽體，芽體經由扦插繁殖培育成苗木後栽植於隔離田作進一步性狀檢測，纖維素分析結果顯示，轉殖*EcCesA4*全纖維素含量分別為81.6%，略高於控制組的80.2%，但與控制組並沒有顯著差異。

連續性基因轉殖，培育出帶有反義式*Pt4CL1*與順義式*CAld5H*轉殖基因之赤桉苗木，並將選用已轉殖順義式*CAld5H*基因之赤桉轉殖系之組織培養苗，連續性轉殖SiRNA之*CAD*重組基因，已經獲取轉殖細胞系。共同轉殖方面，已培育帶有反義式*Euc4CL1*與順義式*CAld5H*雙重轉殖基因之赤桉苗木，已經培養出多重基因之組織培養苗木。在控制授粉之基因堆積技術發展方面，已經培育出基因轉殖赤桉(*Euc4CL1*, *CAld5H*)與雜交桉(*E. grandis* x *E. urophylla*)及赤桉組合之苗木，並完成熱裂解(pyrolysis)銜接GC-MS之木質素單體檢測技術發展。

以基因堆積帶有反義式*Euc4CL1*與順義式*CAld5H*雙重轉殖基因植株，以扦插繁殖培育苗木出栽至隔離田間性狀檢測，檢測具順義式*CAld5H*轉殖基因苗木，S/G 為8.3，高於控制組的3.1，且與控制組呈顯著性差異。雙重轉殖基因苗木在高生長與胸徑生長呈顯著性差異，選得MAI超過50 m^3以上植株共計17株，萌糵扦插育苗後，將栽植到同地點進行遺傳性狀與生物安全評估。

4.5年生基改桉樹林。
Transgenic *Eucalyptus* trees at 4.5 years old, grown in a field trial.

Verification of genetic and environmental friendliness traits in transgenic *Eucalyptus* trees

Jeng-Der Chung

This project was proposed to develop gene-stacking technology for the breeding of new *Eucalyptus* varieties in which multiple genetic characteristics were improved to meet the industrial demand. The study topics included gene cloning, gene transformation and gene stacking by sequential transformation, co-transformation and controlled pollination.

In the topic of gene cloning, we cloned the *Ces A1~A5* gene involved in cellulose biosynthesis. *KORRIGAN* and *LEAFY* gene in *Eucalyptus camaldulensis*. *EcCesA1~3* cDNA (GenBank accession no., HQ864583~5) has been successfully cloned from primary developing xylem tissues. However, *EcCesA4~5* cDNA (GenBank accession no., HQ864586~7) was cloned from secondary developing xylem tissues. The *EcCesA1~5* genes were transferred to a superior clone (no. 48) of *Eucalyptus camaldulensis via Agrobacterium tumefaciens*. Transformed cells and calli were obtained in all *EcCesA1~5* genes but shoots and plants were obtained in only *EcCesA4* gene. The cuttings derived from transgenic plants were produced and out-planted for further characterization. Thus, the holocellulose content showed that there is no significant difference between transgenic plant (81.6%) and the control (80.2%).

Gene stacking by sequential transformation was developed to raise transgenic *E. camaldulensis* plants with the antisense *Pt4CL*1 and the sense *CAld5H* (5H) transgenes. The transgenic *E. camaldulensis* plants previously transformed with the sense 5H transgenes has been sequentially transferred with recombinant SiRNA of the CAD gene to produce transgenic callus or shoots with the double transgenes. In co-transformation, transgenic *Eucalyptus* plants with the antisense *Euc4CL1* and/or the sense 5H transgene have been produced. The transgenic *E. camaldulensis* plants previously transformed with the sense 5H transgenes were selected and transferred with recombinant SiRNA of the CAD gene to produce transgenic callus or shoots with multiple transgenes. In controlled pollination of gene stacking, transgenic seedlings with the antisense *Euc4CL1* and the sense *CAld5H* (5H) transgenes derived from pollination between transgenic *E. grandis* x *E. urophylla* and *E. camaldulensis* were raised. For rapidly measuring monomeric lignol of transgenic wood, an analytical technique by using pyrolyzer coupled with GC-MS had been developed.

In gene stacking, the cuttings derived from transgenic plants with the antisense *Euc4CL1* and the sense *CAld5H* (5H) transgenes were generated and out-planted for further characterization. In one aspect, the S/G ratio showed that there is a significant difference between transgenic plant with the sense *CAld5H* (5H) transgenes (8.3) and control (3.1). On the other hand, among all the transgenic plants, it appeared that the height and DBH growth showed a significant difference. Moreover, we have observed that 17 selected transgenic plants having mean annual increments (MAI) of 50 m^3/ha. Therefore, we plan to further accomplish the task of transgenic plant genetic characteristics investigation and biosafety assessment.

本土森林植物之景觀產業開發

黃怡菁

觀賞植物的品種權，是未來產業利用的關鍵問題之一。臺灣植物資源豐富，因此開發我們特有植物為產業作物或是產業優良品種，是一個重要的課題。本所於2010至2011年間獲得三件與植物綠美化有關之新型專利，提供了室內觀賞植物尤其是具有懸垂生長特性者有新的展示及利用方式，為配合將來市場對此類苗木之需求，本計畫就對具懸垂特性之垂枝石松及長葉腎蕨或東方狗脊蕨進行大量健康生產系統之研發，對具有花卉觀賞潛力之華八仙，進行選優之種質蒐集，並就選定之品系進行固定繁殖。目前結果顯示，垂枝石松以有性孢子經體外培養的方式，經由孢子萌芽，長成配子體，再經受精過程，然後長出新的孢子體，至少需要2.5年以上。但體外無菌配子體細胞團增殖系統一旦建立，就可連續反覆培養受精至孢子體的過程，目前細胞團已至少維持3年以上的繼代，其生長活性沒有減弱。東方狗脊蕨可藉由母葉上的不定芽，長葉腎蕨可藉由走莖上的頂芽做為培植體，成功的建立體外無性繁殖系統，由起始培養至正常小植株建立，第一代最快約需1.5年，但藉由增生綠色再生細胞團，第2代後正常小植株的產生可依培養條件不同有異，一般只約需3-6個月。而且綠色細胞團似可經繼代培養長期維護，目前已正常維護3年。至於華八仙，經調查，確定野外自然族群中，就存在具有良好開花性狀的母株，所以可以直接經由體外培養或扦插方式建立營養系。

採集於仰德大道,編號為23號的華八仙，花序整齊且花瓣數多。
A regular inflorescence of *H. chinensis* (no.23) with a great number of petaloid sepals, collected at Yangde Blvd.

Developing endemic forest plants of Taiwan for landscape industry

I-Ching Huang

Plant Variety Right of the ornamental plants will be one of the key issues of the future industry utilization. Taiwan has very rich plant resources, so how to develop our endemic plants to be industrial plant or quality variety is a very important issue. We have obtained three new utility model patents about green landscaping during 2010-2011. These patents provide the new way for plant exhibition and utilization, especially for plants with the pendant growth characteristics. To satisfy the demand of these seedlings in the future market, we do the study about *in vitro* healthy production of the plants with pendent growth characteristics, such as *Lycopodium phlegmaria*, *Nephrolepis biserrata* (Sw.) Schott, and *Woodwardia prolifera* Hook.&Arn. We not only collected good germ plasms of *Hydrangea chinensis* Maxim with flower ornamental potential, but also fixed the selected clones.

Present results show that: sexual spore culture of *L. phlegmaria*, from germination of spore to regeneration of gametophyte, fertilization, and the regeneration of sporophyte needs at least 2.5 years. But after the establishment of *in vitro* proliferation system of gametophyte of *L. plegmaria*, the process of fertilization to regeneration of sporophyte can be repeatedly cultured. Now the cell cluster system has been maintained for more than 3 years and the regeneration growth rate has no reduced. The explant of *in vitro* system of *W. prolifera* and *N. biserrata* can be the adventitious bud on the mother leaf and the apical bud of the runner respectively. The first generation plantlet needs 1.5years. But from the second generation the time depends on the culture conditions, it need only 3 to 6 months. The green regeneration cell clusters seem can be maintained for long-term by regular subculture, and until now has being kept for more than 3 years. As for *H. chinensis*, after field survey we make sure that there exist mother plants with good flowering characteristics in the nature group. So, we can use *in vitro* culture or cuttings to fix the selected plants and establish the clones directly.

山葵經濟生產系統之研發

黃怡菁、傅春旭

臺灣山葵產業目前主要集中在阿里山地區，栽培主要使用分蘗苗，部分使用根段苗作為種苗來源，因此易有種苗帶菌之問題，又因長期連作，所以易有軟腐病、黑心病及黑腐病之感染，其罹病率達70%以上，所以為配合將來產業由高海拔移向中低海拔或植物工廠之專業栽培，建立健康苗(無論來自組織培養健康苗或實生整齊健康苗)之經濟生產體系，應是山葵產業發展之重要課題。

因此，本計畫就探討山葵經濟生產的必需條件，包括山葵實生整齊育苗的處理程序，及田間生產之最適肥培條件、病蟲害管理及處理程序等。

試驗結果顯示，種子來源及貯藏時間，都會明顯影響種子的有效性，顯然山葵種子是屬於不耐長期貯存的類型。目前利用植物工廠的培育方式，配合生長素促成處理，確實可有效的整齊育成山葵實生幼苗供田間定植，而田間的新栽培履歷經測試，也顯示在中高海拔地區具有相當的產業潛力，但仍有進一步調整的空間，所以相信將來在臺灣可以用新的經濟生產系統，在中高海拔地區培育山葵，使山葵產業，仍可在臺灣永續經營。

山葵新經濟生產系統在神木地區試作的情況。
New economical production system of Wasabia cultivated at Shenmu Village.

Study on the economical production system of Wasabia japonica Mastum

I-Ching Huang, Chuen-Hsu Fu

The Wasabia industry in Taiwan nowadays is centered around Ali Mountain (Alishan) area. Because the major cultural materials are tillage seedlings, and root cuttings, it is easy to have problems of disease arisen from seedlings. Moreover, due to the continuous cropping system, infection problem of soft rot disease, black rots (caused by *Phoma wasabiae*, and X*anthomonas campestris* pv. campestris) tends to be prevalent. The infection rate is often higher than 70%. So, establishing healthy seedlings production is a main objective for the future industry to move from high elevation to lower elevation areas, or to transfer to a profession culture in the plant factory. The top issue is how to establish a healthy seedlings production system. In this program, we study the essential conditions of economic production system for Wasabi, including neat seedling growing, effective fertilization culture and blight management system in the field. Result of this study shows that the source and storage period of the seeds significantly affect the effectiveness of the seeds. The seeds of Wasabi are not durable for long-term storage. Now, we used a plant factory to nurture the seedlings, together with the treatment of grow hormone, and found it to be effective for the neat seedling growth. The neat seedlings can then be used for field planting. Test results of the new production system showed that in middle and high elevation areas, Wasabia industry still have good potential. But there are still spaces for further adjustment. We believe, in the future, we can use the new economic production system to produce Wasabia, and the industry can remain prosper in Taiwan.

食用蕨類之研發及種源保存

黃曜謀

水蕨屬全世界共分為4種，其中包含一種臺灣原生種水蕨(*C. thalictroides*)。水蕨屬於一年生水生蕨類，曾廣泛分布於臺灣及離島濕地之中。在早期年代，臺灣農民從水稻田或水芋田中採集水蕨帶到市場販售，除臺灣以外，馬達加斯加及東南國家人們也有把它拿來吃，在馬來西亞和日本甚至被視為高級蔬菜。幼葉在完全開展之前顏色鮮綠最適合於烹調作為沙拉來食用。水蕨不僅是著名的野菜，也被廣泛應用於水族箱水草及學術研究(發育生物學及分子研究的模式植物)，換言之，水蕨是一種多用途的蕨類，很不幸的是，在現今農藥及除草劑的濫用情況下，它幾乎都要變成稀有植物了！

所幸，水蕨可以透過孢子有性生殖或利用葉子上不定芽達到人工繁殖之目的。有性生殖方面，幼苗在孢子播灑培養6週後開始產生，從播灑孢子到10公分葉長約需耗時3個月。營養繁殖方面，將具有不定芽的葉片浸泡於水中，1週後，不定芽開始產生葉片及根，2週後，葉片長度快速增加，4週後葉片幾乎已有10公分。儘管大量繁殖是孢子有性繁殖的特性之一，但相較於不定芽營養繁殖卻較為耗時。相對地，營養繁殖可在短期內產生幼苗，其生產數量卻較少(一片葉子約可產生18-48棵幼苗)。

水蕨是臺灣重要天然資源，由於它是一年生蕨類，活體植株長期保存幾乎不可能，孢子成了種源保存的替代組織。我們的研究結果顯示，低溫儲藏下孢子瓶均壽命8.43年，若孢子要完全喪失活力，更是超出預期的久(35年)，這意味著我們可以用低溫或超低溫的方式來長期保存此一種源。透過繁殖及孢子保存方式的建立讓我們得以永續利用此一資源。

可口美味的水蕨沙拉。
Delicious water sprite salad.

Research, development and resource preservation of edible ferns

Yao-Moan Huang

Four species had been classified in the genus *Ceratopteris* around the world, and one of the species – water sprite (*C. thalictroides*) is native to Taiwan. *C. thalictroides* is an annual, aquatic fern and is widespread among wetlands in Taiwan and islets. In an earlier stage, Taiwanese farmers collect water sprite from paddy or taro fields and sale it in markets. Apart from Taiwan, it is eaten in Madagascar and South-East Asia. In Malaysia and Japan, it is an established luxury vegetable. The young leaves before they have uncurled make excellent green and when cooked, they can be eaten as salad. Water spite is not only a wild vegetable but is widely used as aquarium grass, and academic research (model plant in developmental biology and molecular research). Thus, water sprite is a multipurpose fern. Unfortunately, it almost become a rare plant due to abuses of pesticide and herbicide.

Fortunately, the artificial propagation of water sprite may be approached by spore sexual reproduction or vegetative propagation of adventitious buds on leaf. In sexual reproduction, Production of young plant is initiated after 6 weeks of culture. It takes ca. 3 months from sawing spore to plants of 10 cm leaf length. In vegetative reproduction, the leaves with adventitious buds are immersed into water for culture. One week later, the adventitious buds initiate to produce new leaves and roots; two weeks later, the leaves rapid increase in length; four weeks later, leaves approach 10 cm. Despite mass propagation is one of characteristics of sexual reproduction by spores, but it is much time consuming compare to vegetative propagation by adventitious buds. In contrast, vegetative propagation could produce young plants but with fewer individuals (ca. 18-48 young plants production from one original leaf) in short term.

Water sprite is an important natural resource in Taiwan. But as an annual fern, long-term preservation of the entire living plant is almost impossible. Spores become a substitute tissue for resource preservation. Our results show that at low temperature (4℃)-stored spores have a mean lifespan of 8.43 years, and it takes far longer than expected (35 years) to completely lose viability. This means that we can apply low or ultra-low temperature to storage of this species for long period of time. Establishing the protocols of propagation and spore preservation will benefit us for the sustainable use of this resource.

森林永續經營之土壤健康指標

杜清澤、黃菊美、林國銓

森林經營必須依賴對土壤物理化性質和土壤微生物的知識，以評估生育地的生產力，因此有了健康土壤的觀念。對健康土壤，指標為一可測量的土壤性質，此性質可顯示土壤功能的強弱。對土壤健康指標而言，必須選擇對森林作業敏感的土壤性質，這樣才能比較森林作業隨時間變化對土壤的影響，國內在這方面的資料極為缺乏。

本研究以臺灣北部柳杉人工林、北部和中部檜木林、中部和南部相思樹木林為對象，分析土壤各項性質與林木生長的相關性，嘗試篩選出柳杉、檜木、相思樹人工林的土壤健康指標。結果顯示：1.烏來事業區柳杉林全碳和全氮量、有效性磷含量較低，以致隨樹齡增加，養分含量有減少的趨勢，可能造成土壤缺磷的現象，影響林分的生長；2.檜木林則土壤全碳量、全氮量、有效性磷有隨樹齡呈現增加之趨勢，且與林分單株平均生長亦呈現顯著線性相關，可以此三性質為土壤之健康指標；3.相思樹林其各區單株生長量與其土壤之各項理化性質之相關性呈現不規則，並無法歸納出適用之指標。

選擇一套特定的土壤性質為土壤健康指標是複雜的，也會因森林系統不同而變異。我們需要了解更多有關森林生態系統中，土壤與植物交互作用和養分循環的知識，再經討論與獲得專家學者一致的共識之後，才能建立土壤健康指標，提供作為人工林永續經營管理的參考。

紅檜單株年生長量與土壤物理化學性質之相關係數表 (r值)

The linear-correlation coefficients between annual mean volume increment of *Chamaecyparis formosensis* single tree and physical and chemical properties of the soil (r)

深度 Depth (cm)	總體密度 Bulk density	孔隙率 Porosity	pH 值 pH value	全碳 Total carbon	全氮 Total nitrogen
0-10	-0.43	0.35	0.28	0.44	0.54
0-50	-0.42	0.35	0.11	0.65	0.75

深度 Depth (cm)	有效性磷 Available phosphorus	鈣 Calcium	鉀 Potassium	鎂 Magnesium	鈉 Sodium
0-10	0.57	0.80	0.60	0.70	-0.07
0-50	0.57	0.64	0.59	0.71	-0.06

0.4≤|r|<0.7為顯著性直線相關；0.7≤|r|<1為極顯著性直線相關。

0.4≤|r|<0.7 Significant linear correlqation; 0.7≤|r|<1 Extremely significant linear correlation

Soil health index for sustainable management of forest resource

Chin-Tzer Du, Chu-Mei Huang, Kuo-Chuan Lin

Understanding the knowledge of chemical, physical, and biological properties of soils is very important in assessing capacity of sites to support sustainable productive forests. The concept of soil health index includes assessment of soil properties and processes as they related to ability of soil to function effectively as a component of a healthy ecosystem. Soil health index, like site quality or forest productivity, is one of the objectives of ecosystem management and is related to forest management and forest ecosystem. It is necessary to select soil health indices to be sensitive to forest management, in order to compare the effects of management practices on soil through time. However, the information to describe the relationships between soil health index and total net primary production of managed plantations is limited in Taiwan.

The goals of the project are to analyze the impact of soil physical and chemical qualities on sustainable plantation management and to build soil health index, in order to provide important indicators and references for sustainable management of health plantation ecosystems. To achieve the goals, plantations of *Cryptomeria japonica* in northern and northeastern Taiwan, *Chamaecyparis formosensis* in northeastern and central Taiwan, and *Acacia confusa* in central and southern Taiwan were selected to investigate the tree growth and soil properties in stands. The relationship between tree growth and soil properties were analyzed then, in order to select possible soil health indices for the stands.

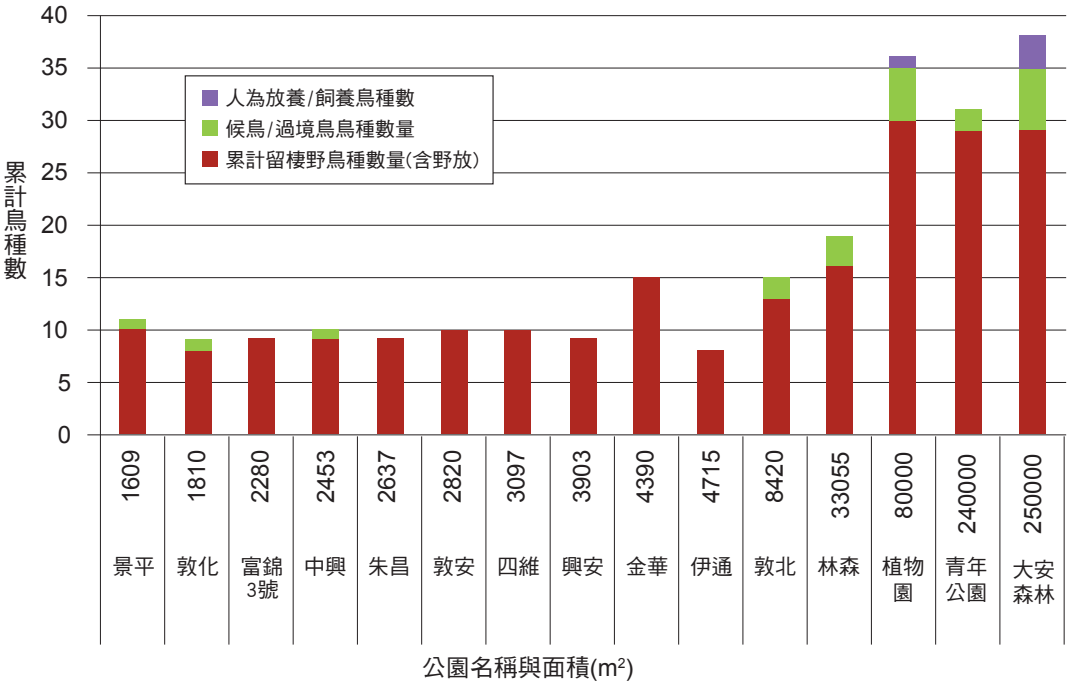
The main results are as follows: 1. For the *Cryptomeria japonica* plantations the soil total carbon and nitrogen and available phosphorus decreased with age. The available phosphorus declined the largest amount among them, which may affect stand growth due to phosphorus shortage in soil. 2. For the *Chamaecyparis formosensis* plantations, the soil total carbon and nitrogen and available phosphorus increased with age and were significantly and positively linear correlated with annual mean volume increment of trees, therefore, those three properties of soil might be selected as soil health indicators. 3. For *Acacia confusa* plantations the correlations between annual mean volume increment of trees and physical and chemical properties of soil were not significant, and no soil health indicator was selected.

Choosing a set of specific soil properties as soil health indices can be complicated, that may vary in forest ecosystems. We need to collect more knowledge of soil-plant interactions and nutrient cycling in forest ecosystems, and to get agreements through discussing with experts and scholars. Then the selected soil health indices will provide important information for sustainable management of health plantation ecosystem.

都市林生態效益之研究

王巧萍

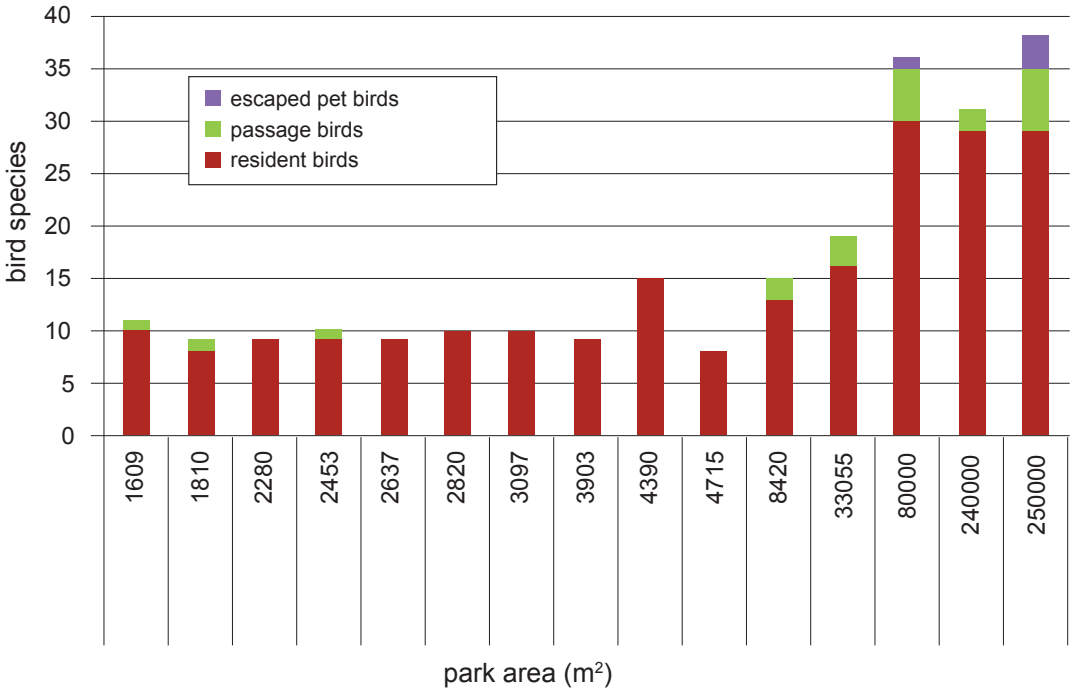
都市林的功能與經營技術近年來為各先進國家大都會之重要新課題，然而溫帶地區樹種單純的研究成果實難應用在物種豐富、終年常綠的亞熱帶。為提升臺灣都市林之環境效益與生態功能，本研究針對臺北市15個不同面積大小的都市林，進行棲地特性、冠層昆蟲及鳥類組成調查。研究公園棲地特性分析結果可知，臺北市除植物園與大安森林公園仍有近80%的地面可供土壤動物與微生物存活外，小公園的地表超過一半上以為人工鋪面與建物所覆蓋，使土壤的功能大量喪失。臺北市都市林之冠層昆蟲以鞘翅目為主，佔所取昆蟲樣本總數之57.0-71.0%；其次為膜翅目，約佔17.0-18.3%；更次為雙翅目者(3.0-12.9%)。由為期一年的鳥類調查結果，在臺北市15個公園共記錄23科43屬55種鳥類。依居留性質分為留鳥43種，遷徙性鳥類12種，留鳥中外來種(野化)8種，人為飼養3種。各公園各月分鳥類豐富度的變化情形，可分為全年出現的鳥種與種數無明顯差異的小公園，冬候過境季時會出現鳥種數高峰的大公園，及冬候過境季與繁殖季皆出現較高鳥種豐富度的金華公園與青年公園。綜合而言，公園面積與鳥種豐富度間呈對數關係，顯示公園面積大小為影響鳥種豐富度的主要因子，但當面積大到一個程度後，則公園的位置(與大型公園或近郊天然林的距離)、樹冠幅、樹種組成及植物的多樣性、棲地結構(包括水池的有無、天然地面的多寡、灌木及草叢的經營等)則扮演了重要的角色。



A study of ecological services of urban forests in Taipei

Chiao-Ping Wang

Studies on the functions and planning of urban forest are important new topics for the whole world. However research results based on deciduous temperate countries are difficult to apply to evergreen subtropical Taiwan, where the biodiversity is much greater. To understand the environmental benefits and ecological functions of urban forests in Taiwan, 15 urban forests with different areas and habitat characteristics were studied for their canopy insect and bird species composition. Besides the Taipei botanical garden and Daan Forest Park, where nearly 80% of the ground is still available for soil animals and micro-organisms; most small parks loss their soil functions due to over-construction. Most of the canopy insect are Coleoptera (57.0~71.0%), followed by Hymenoptera (17.0~18.3%) and Diptera (3.0-12.9%). The results of a one-year survey of birds showed that 55 species of birds were recorded in Taipei parks, including 43 resident birds and 12 migratory birds. The index of bird richness for each park changes monthly and can be divided into 3 groups: small parks showed no seasonal difference of bird compositions, big parks have a significant high richness in winter due to passage birds, 2 peaks of richness in winter and mating season in Jinhua Park and Ching-Nien Park. The relationship between park area and bird species richness is logarithmic, indicating that park size is the main factor influencing the bird richness. When the park size is larger than 2 ha, location (distance to large parks or natural forests), canopy width, forest composition, plant diversity and habitat structure (with or without pool, natural ground area, management of shrubs and the grass) then play an important role in the index of biodiversity.



中部地區臺灣肖楠林分生長模擬體系之建立

Establishment of a growth simulator for Taiwan Incense Cedar in Central Taiwan

汪大雄

Dar-Hsiung Wang

臺灣肖楠是臺灣中部地區之重要造林樹種。本計畫選擇臺灣中部地區不同齡級，不同地位之臺灣肖楠人工林樣區，進行各樣區肖楠人工林屬性之分析，推估單木樹高和優勢木(林分)樹高間關聯和不同時期林分之密度，使用相容性和數值等效之概念進行林分斷面積和材積生長模式之建立，建立肖楠人工林地位指數模式(圖1)，分析林分空間結構和胸徑分化指標。整合各單項生長之推估模式，組合成一整體之臺灣肖楠生長模式，使用FORTRAN電腦語言進行臺灣肖楠生長模擬電腦程式之開發與撰寫，最後，進行臺灣肖楠林分生長之模擬。

本研究發展出之臺灣肖楠生長模擬電腦程式是由一個主程式和眾多副程式組成。主程式主導模擬器之核心程序和各副程式間之相互關係，而各特定生長之推定則由對應之副程式運算後將結果送回主程式，如此則可完成臺灣肖楠整體生長之模擬作業，模擬程序如圖2所示。

使用者在使用本研究發展出之模擬器時必需按照模擬器之請求輸入相關訊息(如林齡，地位級，林分株數或斷面積等)，再配合提供預測林齡和撫育方式則可由模擬器提供該臺灣肖楠林分未來狀況，以便讓經營者能事先了解不同地位和不同撫育作業下對林分未來生長和結構之影響。模擬結果可提供經營者制定臺灣肖楠人工林經營策略之資訊。

Taiwan incense cedar is an important plantation species in Central Taiwan. In this study, we selected the sites with different age, site quality in a Taiwan incense cedar plantation in Central Taiwan. Using the compatibility and numeric equivalence among stand-level attributes concept, and based on data from permanent plots and stem analysis, the component of growth and yield model such as diameter, tree height, site index (Fig.1), stand density, and stand structure submodels were fitted separately in sequence and then integrated. Finally, a computer software using FORTRAN was coded for the implementation of the integrated growth and yield simulator. As an adjunct to the stand-level equations, compatible stand/stock tables were derived by solving for the parameters of Weibull distribution from attributes predicted with the stand-level equations.

Overall, one main program with 11 subroutines and functions were included in the growth and yield simulator. The simulation procedure of simulator was illustrated in a flow chart diagram presented in Fig. 2.

In using the simulator, users must provide data on the initial age, predicted age, site index, and at least one value either stand density or basal area or both values in stand density and basal area. Given the specified age and site, the simulator will compute related stand attributes and derive the stand table by a parameter recovery method. By inputing of the current stand age, tree density, basal area, projection length and management option into the simulator, the dynamic change for a given stand can be evaluated effectively.

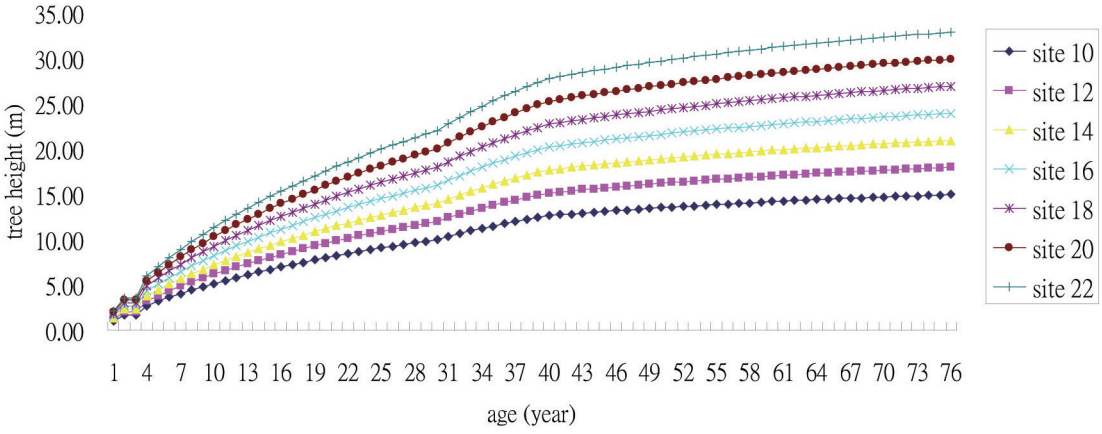


圖 1 肖楠地位指數曲線圖。

Fig. 1. Site index curves for Taiwan Incense plantation.

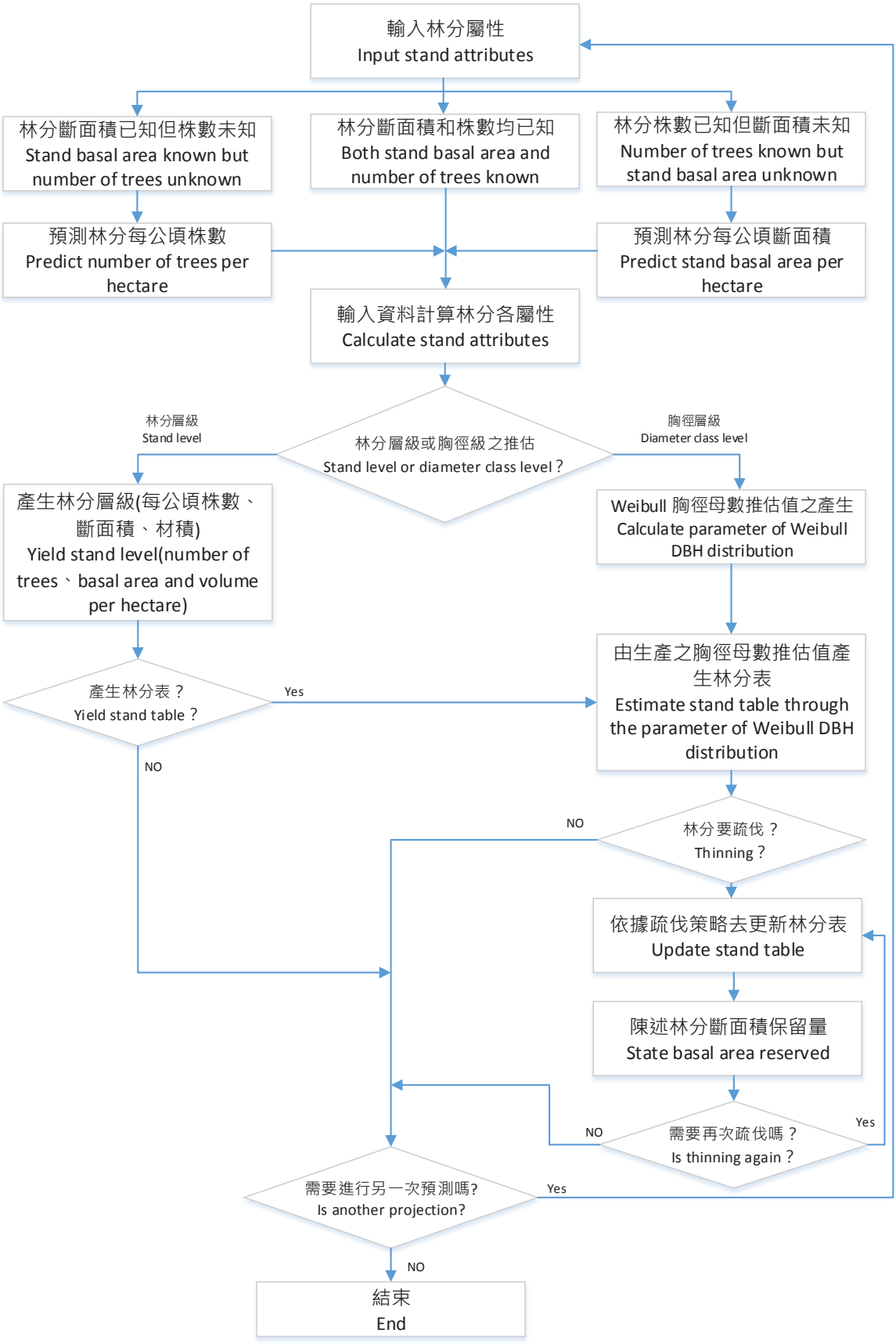


圖 2 臺灣肖楠林分生模擬程序示意圖。

Fig. 2. Flow chart diagram of Taiwan Incense plantation growth and yield simulator.

六龜試驗林人工林更新動態之研究

游漢明

針對六龜試驗林1998年建立之26年生臺灣杉人工林疏伐處理之樣區，其中對照區為未疏伐處理區，輕度疏伐區則保留800株/公頃，疏伐強度為20%；強度疏伐區為700株/公頃，疏伐強度近40%。至2015年之調查存活之臺灣杉造林木株數，對照區每公頃株數為778株/ha、輕度疏伐區為522株/ha、強度疏伐區為311株/ha。存活株數除了輕度疏伐區，其餘兩區皆在持續減少中。臺灣杉不同疏伐處理間之胸徑與樹高生長表現，2013年調查分別為對照區27.2±7.0 cm、輕度疏伐區為33.7±6.0 cm、強度疏伐區為35.0±7.8cm。2014年為對照區胸徑為27.7±6.9 cm、輕度疏伐區胸徑為33.7±6.0 cm、強度疏伐區胸徑為35.3±7.7 cm。至2015年為對照區胸徑為27.5±7.2 cm樹高13.7±2.0m、輕度疏伐區胸徑為32.8±7.3cm樹高19.2±1.3 m、強度疏伐區胸徑為35.3±8.3 cm樹高15.0±1.3 m，年度間之胸徑生長變化，顯示此42年生之臺灣杉造林木因彼此間生長競爭、病蟲害或受颱風等干擾，林分生長漸趨停滯，更因樹梢風折造成平均樹高的降低。由於樣區之冠層鬱閉連續性明顯受到干擾造成林下光環境改變後，便進入林下之光度增加，進而影響林下天然更新植群之種類與分布。 2015年調查之不同疏伐處理臺灣杉樣區林下更新物種出現之優勢冠層樹種發生比率維持不變，而藤本與草本發生比率減少5%以上，次冠層樹種與下層灌木則明顯增加，強度疏伐區次冠層樹種發生比率增加6%。不同疏伐處理臺灣杉林下更新物種數量數量最多前三大科的分佈，2015年對照區仍以紫金牛科佔82%最多，輕度疏伐區亦以紫金牛科佔48%最多。強度疏伐區則以樟科與紫金牛科為主各佔34%。比較2014與2015年疏伐處理六龜試驗林鳳崗山臺灣杉樣區顯示，主要還是紫金牛科之小葉樹杞、樟科之長葉木薑子以及茜草科之琉球雞屎樹族群族群消長，影響了人工林下天然更新植群之動態變化。調查臺灣杉樣區附近天然林樣區中的樹種多樣性，共出現樹種61種、445株，其中樟科共發生13種227株，殼斗科8種61株，可提供鄰近針葉人工林林下物種更新之更新材料來源，此從臺灣杉人工林試區樟科及殼斗科林木數量的增加，可見更新材料的不虞匱乏。

臺灣杉人工林下入侵的天然闊葉樹
Invasion of natural hardwoods under Taiwania plantation in Liu-kuei experimental forest.

Study on the regeneration dynamics of manmade forest at Liukuei experimental forest

Han-Ming Yu

Taiwan fir (*Taiwania cryptomerioides*) plantation trees at 26-year of age were treated to different thinning intensities in 1998. Subsequent Investigations and treatments were conducted. The control zone (no thinning) retained 1,044 trees/ha; the lightly thinned zone (with thinning intensity of 20%) retained 556 trees/ha; and the heavily thinned zone (with intensity of 40%) retained 378 trees/ha in 2012. As compare to 2015, only 778, 522 and 311 trees/ha were counted in the control, lightly-thinned and heavily-thinned zones, respectively. The tree no. decreased year by year except in the lightly-thinned zone. In 2013, the measurements showed that dbh of the control was 27.2±7.0 cm; the lightly-thinnd plot was 33.7±6.0 cm; and the heavily-thinned plot was 35.0±7.8 cm. In 2014, the measurements showed dbh growth of the control plot was 27.7±6.9 cm; and those of lightly- and heavily-thinned plots were respectively 33.7±6.0 cm and 35.3±7.7 cm. Whenas in 2015, the measurements showed dbh growth of the control plot was 27.5±7.2 cm and tree height 13.7±2.0 m; and those of lightly- and heavily-thinned plots were respectively 32.8±7.3 cm with tree height 19.2±1.3 m, and 35.3±8.3 cm with tree height 15.0±1.3 m. Thus, the results of yearly variation of dbh growth indicated that part of the 42-year-old plantation trees showed growth stagnation due to growth competition, disturbances like insect and disease infestations as well as typhoon assaults, which caused tree bole to break and then shorten the tree heights. As crown closure of plots were disturbed causing light environment change to increase light penetration onto forest floor, the composition and distribution of the regenerating vegetation could be influenced. In 2015, number of regenerated species appeared in the plantation among different thinned intensity plots showed that the rates of occurrence of predominant species keep steadily, while the rate of occurrence of liana and herbaceous plant communities reduced < 5% . The seedlings occurrence of sub-canopy tree species and understory shrubs of the Taiwan fir plantation plots of different thinning intensities apparently increased. The population fluxion of seedlings occurrence of *Ardisia quinquegona* (Myrsinaceae), *Litsea acuminata*(Lauraceae) and *Randia cochinchinensis*(Rubiaceae) greatly affected natural regeneration dynamics of Tawania fir forest. The investigation of richness and abundance of natural hardwood forest near the plantation plots showed there were 61 species and 445 trees appearing in a 900 m^2 plots. There are 13 species and 227 trees belong to Lauraceae and 8 species 61 trees belong to Fagaceae. Seedling numbers of both families increased in the plantations, and natural forest accounted for more regenerating materials facilitating increase numbers of predominant tree species entering into the plantations.

重大林木病蟲害健康管理及防疫平台之研究

吳孟玲、汪澤宏

本計畫針對國內目前重大病蟲害一樟白介殼蟲及樹木褐根病，研發健康管理技術。完成建立樟白介殼蟲注射試驗SOP技術及完成技術移轉；完成樹木褐根病害生物製劑健康管理研究，提供國內樹木健康管理應用。及針對造成樹木根莖腐最主要的病原之靈芝，研發高度專一性及敏感性之檢測，建立兩種靈芝病原菌(南方靈芝與熱帶靈芝)之快速檢測SOP流程之方法，包含病原菌樣本採集與核酸萃取流程之建立，專一性測試及PCR檢測流程與商品化技術建立。除可加快診斷鑑定各種根莖腐病害速度及正確性，並可應用於苗木或移植林木之健康篩檢，確保苗木或移植林木之健康外，可望杜絕病原菌藉由苗木或移植林木傳播之可能性，達根莖腐病預防及防治目的。為防範入侵疫病蟲種之危害，建立「林木外來入侵種病蟲害查詢系統」資料庫平臺，建立之林木病蟲害入侵種資料庫，進行風險評估，新增建立20種林木病蟲害入侵種資料庫，包含赤衣病菌、幹基白色腐朽病、幼苗黑腳病、木麻黃枯腐病、松針紅斑病、松幹基褐腐病、白松皮包銹病、山毛櫸樹皮病、橡樹枝枯病、雲杉簇葉銹病、臍腹小蠹、長林小蠹、松瘤小蠹、毛束小蠹、雲杉峰蚜、冷杉球蚜、雲杉大小蠹、納曼干脊虎天牛、榆近脈三節葉蜂及桉突眼蝽。更新建立高、中、低風險評估表及告警檢疫清單；並針對具高風險入侵種，建立檢疫及防治技術資料庫，共計3,000筆以上資料。

本計畫建立之樟白介殼蟲樹木注射技術。
Tree-injection technique for *Aulacaspis yabunikkei* control.

Research on health management and control platform for the important tree diseases and pests

Meng-Ling Wu, Liang-Jong Wang

In this project, the control of brown root rot by prochloraz and the tree-injection of *Aulacaspis yabunikkei* control technique were completed. We also completed the establishment of *Aulacaspis yabunikkei* injection SOP technology transfer. Healthy management of trees brown root disease by Biological agents was completed. It is urgent to establish a rapid detection technology for important forest stem and root rot diseases. In this project, we aimed *Granoderma sp*. as the major target and planned to use molecular biological techniques to develop detection methods with high specificity and sensitivity, which not only can promote the diagnosis and identification efficiency and accuracy for various stem and root rot diseases, but also can be applied to the screening for seedlings or transplant trees to ensure their health. We expect this technology can eliminate the possibility of pathogens spreading through seedlings or transplanted trees.

On the other hands, we had established an "invasive forest diseases and pest searching system" website, and keeps updating and maintaining the database. Update of 20 kinds of invasive forest pests and diseases which include *Corticium salmonicolor*, *Heterobasidion annosum sensu lato*, *Pythium ultimum*, *Macrophomina phaseolina*, *Mycosphaerella pini*, *Phellinus weirii*, *Cronartium ribicola*, *Neonectria faginata*, *Phytophthora quercina*, *Chrysomyxa arctostaphyli*, *Scolytus schevyrewi*, *Hylurgus ligniperda*, *Orthotomicus erosus*, *Scolytus intricatus*, *Elatobium abietinum*, *Adelges piceae*, *Dendroctonus micans*, *Xylotrechus namanganensis*, *Aproceros leucopoda*, *Thaumastocoris peregrine*. For the already-built database, we continued working on the risk analysis. Update the high-low risk evaluation table and the warning quarantine list every year, and develop diagnostic techniques for quarantine and disease control to those high risk alien species with over 3,000 data.

臺灣景觀林的外來種植食性昆蟲研究

Study of the invasive phytophagous insects in landscape forests of Taiwan

董景生、顏聖紘

Gene-Sheng Tung, Shen-Horn Yen

臺灣山區蘊含不同氣候帶的天然林，以及許多人為營造的景觀林，如平地造林、森林公園、都市林等。景觀林具有生活生產、遊憩觀光、研究教育、空氣淨化、生態廊道等多樣功能，近年來由於氣候變遷及人為活動，不同景觀森林面臨外來入侵種問題日益增加，進而影響景觀林多樣性的功能。本計畫乃經由數個國際害蟲資料庫(包含GISD, EPPO, APFISN, APHIS, ISC)，選擇近年入侵危害嚴重的入侵種，調查並建立景觀林外來種害蟲名錄，共篩選106筆資訊，其中28種在TaiBNET已有記錄，其餘78種在臺灣尚未被記錄過，針對高入侵危險之物種收集基礎生物學資料及分布資料，做為景觀林林木防檢疫之參考，本計畫期間共發佈6目14科17屬18種高風險外來種植食性昆蟲。現場分低中高海拔，共調查大雪山森林遊樂區、奧萬大森林遊樂區、阿里山森林遊樂區、扇平森林生態科學園、恆春熱帶植物園、臺大山地農場、溪頭森林教育園區、美濃雙溪熱帶樹木園等，根據四種取樣方法收集的結果，我們共採集到高風險外來種植食性害蟲種3目7科9種，並通報相關單位處理。

There are different climate zones of Taiwan forests, as well as many native forests and artificial landscape forests. Due to the climate changed and human activities in recent years, different landscape forests are facing increasing problems of invasive alien species. It also affects the biodiversity of landscape forests. We used several databases, such as the Global Invasive Species Database (GISD, EPPO, APFISN, APHIS, and ISC), and selected recent invasive species that cause huge damages. We then survey and build up the list of alien species of landscape forest pests. We selected 106 species as the reference records. Twenty-eight records of the 106 have been recorded in TaiBNET, and other remaining 78 records have yet to be recorded in Taiwan. During this project, there are 6 orders, 14 families, 17 genera and 18 high-risk invasive herbivore pests were recorded. In different altitude zone, a total of eight forest recreation areas or arboreta been investigated, including Dasyueshan Forest Recreation Area, Aowanda Forest Recreation Area, Alishan Forest Recreation Area, Shan-Ping Forest Ecological Garden, Hengchun Tropical Botanical Garden, the Highland Experimental Farm of National Taiwan University, Xitou Forest Recreation Area, and Meinong Shuangxi Arboretum. According to the four methods we used, we collected and issued 9 high-risk invasive herbivore pests warning which belonged to three orders and seven families in this project.

石斛長尾粉介殼蟲雌成蟲。

The female adult of *Pseudococcus dendrobiorum*.

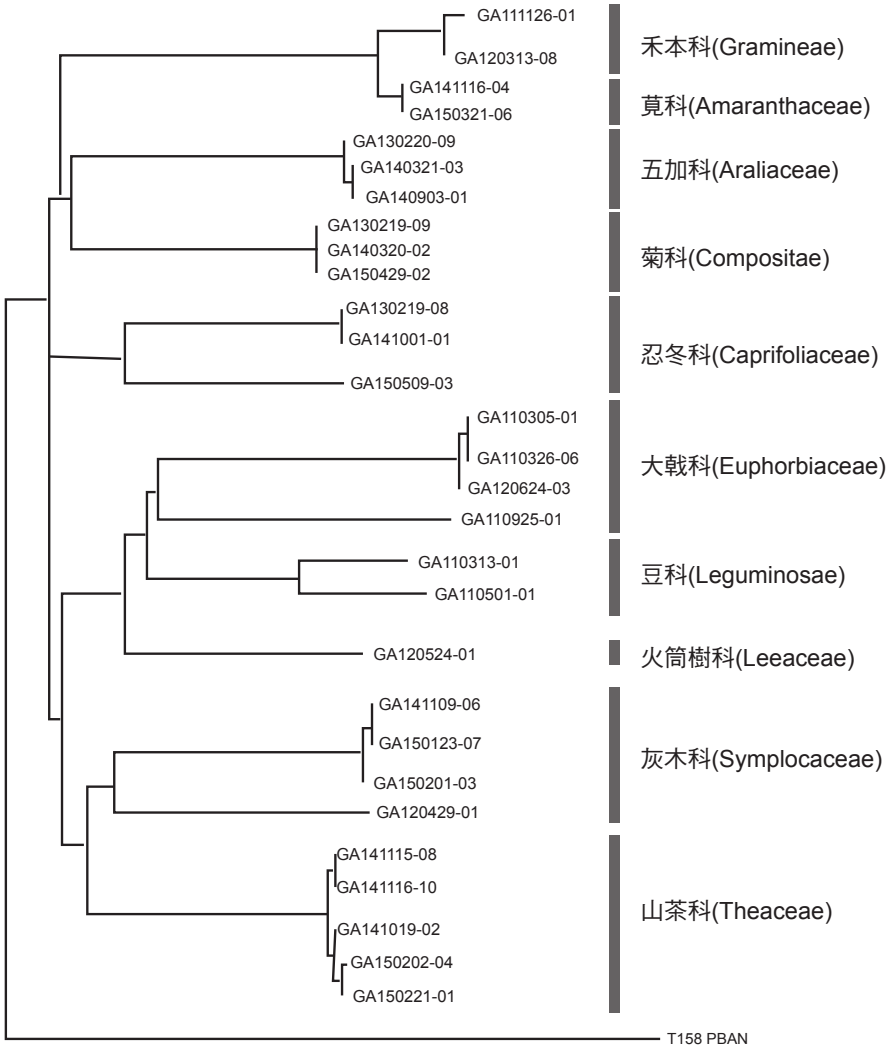
野外採集到的高風險外來種植食性害蟲
The high risk invasive herbivore pests collected in the wild

地點 plots	物種 species	採集方式 Method
102		
美濃雙溪熱帶樹木園 Meinong Shuangxi Arboretum	*Filodes fulvidoralis* (Geyer, 1832)	燈光誘集 Light trap
溪頭森林教育園區及臺大山地農場 Xitou Forest Recreational Area and the Highland Experimental Farm of National Taiwan University	*Saturnia pyretorum* Westwood, (1847)	燈光誘集 Light trap
溪頭森林教育園區及臺大山地農場 Xitou Forest Recreational Area and the Highland Experimental Farm of National Taiwan University	*Heortia vitessoides* Moore, (188)	燈光誘集 Light trap
103		
嘉義樹木園 Chiayi Arboretum	*Anomoneura mori* Schwarz	掃網 Sweeping net
恆春熱帶植物園及扇平森林生態科學園 Hengchun Tropical Botanical Garden and Shan-Ping Forest Ecological Garden	*Falana sordida* Moore, 1882	燈光誘集 Light trap
恆春熱帶植物園及扇平森林生態科學園 Hengchun Tropical Botanical Garden and Shan-Ping Forest Ecological Garden	*Olepa* sp. cf. ricini	燈光誘集 Light trap
104		
阿里山森林遊樂區 Alishan Forest Recreation Areas	板栗癭蜂 (*Dryocosmus kuriphilus* Yasumatsu, 1951)	寄主檢查 Host searching
大雪山森林遊樂區及奧萬大林遊樂區 Dasyueshan Forest Recreation Areas and Aowanda Forest Recreation Areas	石斛長尾粉介殼蟲 (*Pseudococcus dendrobiorum* Williams, 1985)	掃網 Sweeping net
大雪山森林遊樂區及奧萬大林遊樂區 Dasyueshan Forest Recreation Areas and Aowanda Forest Recreation Areas	棉絮粉蝨 (*Aleurodes floccosa* Maskell, 1895)	掃網 Sweeping net

臺灣景觀林蟲癭多樣性研究

董景生、張德斌

過去針對臺灣蟲癭多樣性的研究中，主要集中在以樟科及殼斗科植物為優勢的天然景觀林，較少針對其他景觀林區進行造癭物種調查，並且造癭昆蟲研究集中在樟科楨楠屬癭蚋與殼斗科癭蜂等重要科群，其他的物種資訊較少。本研究透過造癭知識的累積，針對不同類型景觀林類型及其主要造癭的寄主植物進行蟲癭樣本收集，以健全生物多樣性為前提，進行物種調查工作，本計畫執行期間總計共獲得 24 科 52 種產癭寄主植物，本年度共記錄 10 科 24 種被癭蚋造癭之寄主植物癭寄主植物，與 6 科 10 種被癭蜂造癭之寄主植物。依據之前所建立之分子生物資料庫，選取含外群共取 30 個雙翅目造癭昆蟲個體為 OUTs (涵蓋 10 科的寄主植物) 重建並嘗試釐清依據科級寄主植物分類群間之雙翅目造癭昆蟲的親緣關係。

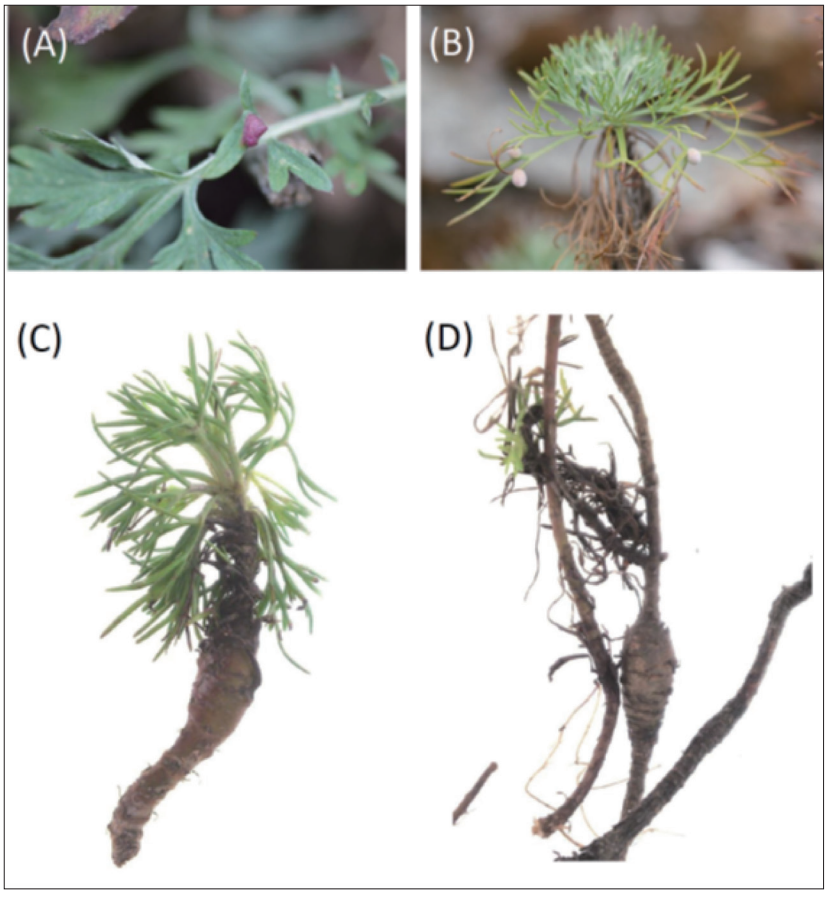


已採獲的造癭昆蟲之鄰接法樹形圖與其寄主植物分類群之親緣關係圖。
The neighbor-joining tree of the collected species between the galls and their host plants.

Research on insect gall diversity in landscape forests in Taiwan

Gene-Sheng Tung, Te-Pin Chang

There are highly diverse nature landscape forests in Taiwan for its uniquely geographical and climatic characteristics. There are many kinds of artificial landscape forests constructed based on the current forestry policy, such as lowland afforestation, forest parks and city forests. In the past, there were only a few studies focused on insect gall diversity, especially on host plant families, Lauraceae and Fagaceae, in nature landscape forests. There were fewer galling insects investigated in different landscape forests except for *Daphnephila*(Diptera: Cecidomyiidae) on *Machilus* spp. (Lauraceae). Therefore, the aim of this project is to build up the phylogenetic positions of gall insects in different landscape forests. Through literature review and field collection all around Taiwan, we also conducted morphological and DNA sequence analysis to build up fundamental information of gall insects in landscape forests. Of the host plants, we've collected 24 and 10 species found with gall midge and gall wasp, respectively. During the three years project, we've collected galls from a total of 52 host species belonging to 24 families. Comparing with the database we've constructed for years, we used 30 OTUs (including outgroup species) to reconstruct the phylogenetic tree with the COI fragment. We found the interesting correlations with the gall midges and their hosts. And it showed certain overview relationships among host plant families. We believe it's worthy to do the further studies of the more detail relationships of different gall midges within one family of host plant.



菊科 (Compositae) 高山艾 (A) 與細葉山艾 (B~D) 的葉部與莖部蟲癭。
The stem gall of the *Artemisia oligocarpa* (A) and *A. morrisonensis* (B~D).

試驗林集水區之崩塌潛勢評估模式應用和風險管理

黃瓊璁、謝漢欽

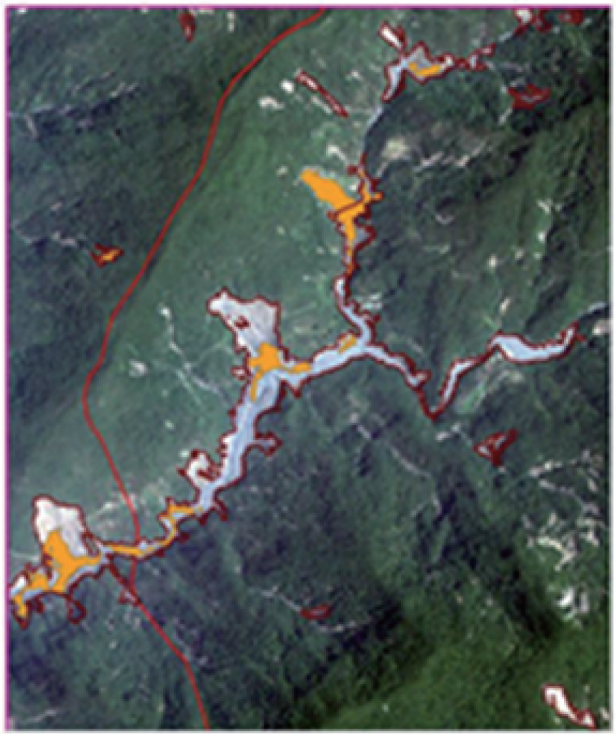
本研究計畫的目的，在試驗林集水區坡面，應用前人之崩塌潛勢評估模式，擬訂崩塌潛勢危險度分類或分級，給予適當之數值指標，做為衡量潛在危險性之基準。之後再根據研究區域降雨特性和地震致災程度，以不同降雨強度和地震等級模擬崩塌潛勢之變異，配合航遙測影像和相關資訊，進行崩塌動態追蹤，提出風險管理策略。經第一年之模式建立和今年上半年之影響因子及權重演算，發現以林道沿線較小區域和地形判釋法之配合運作，無法精確呈現當地崩塌潛勢現狀和趨勢，證明最便利和基本的專家分級評分法，已不能和更精密和大數據量的電腦模式相比較。因此於下半年改以不安定指數法進分析方法準確率的比較，選取的因子經由電腦計算的權重結果，分別為坡度(0.174)、高程(0.173)、坡向(0.138)、NDVI(0.240)、水系距(0.150)、道路距(0.125)等六項潛感因子，利用莫拉克風災前後地崩塌地做一比較，統計分析給予因子評分的方式，結合地理資訊系統，將問題概念化後，得到class1的準確率為96.83% ，class2的準確率為37.99% 。其第二級精準度較差的原因，主要是研究區域太小，導致地質因子無法成為影響因素。此外風險管理策略之擬訂，由於921地震和莫拉克災害衝擊力甚巨，導致研究期間內所觀測之地震和降雨災害資料，無法形成明確之致災條件，因此其實際降雨和地震級距之風險管理策略，並不具實用之義意，僅作若干定性之描述。

2009.08.19 福衛二號影像

紅色線 六龜試驗林地籍界

棕紅色範圍88後增加的崩塌地

橘色區塊為2009.05.09原有崩塌地



莫拉克風災扇平林道崩塌變動範圍。
Landslide area comparison before and after Typhoon Morak in Shan-Ping forest road.

An application of landslide susceptibility evaluating model and risk management of an experimental watershed

Chiung-Piau Huang, Han-Ching Hsieh

The purpose of this study is trying to apply an evaluating model of landslide susceptibility for predicting the trend of sliding possibility in slopeland of the experimental watersheds. And then a solid treatment of risk management could be proposed to fit the needs for the public by accompanying with rainfall and earthquake calculation. Through the processes of investigating the landslides basic data and analyzing several evaluating models, some useful criteria and its weights collected from concerning research literatures were to be reassessed comparing with the real situations of study area. And a new set of parameters and weighting factors would be established for using in this specific region. If there is a closed relationship between the simulating model results and the real field conditions, we could apply the model as a tool of predicting landslide potential and suggest a series of risk management proposals for practical uses. Due to the results by applying Geomorphologic Interpretation and Experts Grading method, we find that methodology could not be used in a small region. The additional alternative of this research is to use the technology of the geographical information system (GIS) and instability index method to set up a quantitative method to estimate hillside fields. Satellite images and the Digital Elevation Model (DEM) can extract six major factors, such as elevation, slope, aspect, NDVI, distance to rivers and distance to roads. A model is proposed to calculate landslide susceptibility, which expresses as: $Dtotal=D1^{0.174}\times D2^{0.138}\times D3^{0.240}\times D4^{0.173}\times D5^{0.125}\times D6^{0.150}$.

Accuracy of class 1 is 96.83%, and class 2 is 37.99%. These showed that the factor of geology played a very important role in evaluating susceptibility. Due to the insufficiency of data of rainfall and earthquake during the whole research period, the strategies for risk management are only focusing on qualitative statements to fit the needs of practical situation in the Shan-Ping forest road.

臺灣低海拔野生蘭之調查及繁殖研究

鐘詩文

臺灣的野生蘭380餘種，在臺灣維管束植物中約佔了1/10，在森林生物多樣性中有其重要性，其中低海拔的野生蘭族群破壞最嚴重，其因是由於臺灣近來低海拔環境的開發及地貌的遽變，使得許多原本就珍稀的蘭花，大量被移除，或失去原本的棲地而瀕臨絕滅；復加低海拔的珍美蘭花，較易在城市栽植，因此也常常是商業採集覬覦的標的物。為了避免這些物種，因人為因素在臺灣消失，對這些瀕臨絕滅的野生蘭從事區內及區外保育是必要的。本計劃已針對植物紅皮書所列之低海拔稀有蘭科植物，從事其生態調查，並蒐集其種實，進行各種繁殖研究。

三年總共蒐集了，紅花石斛、屏東捲瓣蘭、黃根節蘭、木斛、紫苞舌蘭、黃穗蘭、管唇蘭、櫻石斛、細花根節蘭、黃松蘭、臺灣蝴蝶蘭等野生蘭的種子並成功繁殖了許多的種苗，這些種苗將來可做為區外及區內保育所用，以避免這些物種，因人為因素在臺灣消失。

其中在紅花石斛無菌播種與幼苗生長的研究中，結果顯示，將紅花石斛置於六種無菌培養基中(¼ MS(有活性炭)、¼ MS(無活性炭)、½ MS, ½ VW, VW, and Hyponex-1)，實驗結果，紅花石斛的種子在靜置液體培養基中發芽比固體培養基更快，在另一實驗中1/4 MS (Murashige and Skoog, 1962)固體培養基得到了最高比例的種子發芽率。紅花石斛種子發芽後1 cm高幼苗，培養於½ MS 培養基中，給於不同濃度的活性炭(0, 0.1, 0.5, 1, and 2 g L^{-1})，培養在含為2 g L^{-1}活性炭16週後可增加小苗的株高、葉數及根長。紅花石斛的瓶苗的移植到溫室栽培後，每二週於葉面噴施50 ml 的0.5 g L^{-1} 花寶2號液體肥料，有助於增加小苗的莖粗及葉片寬度。

紅花石斛之小苗。
Seedlings of *Dendrobium miyakei.*

Survey and breeding research of wild orchids from the low elevation regions of Taiwan

Shih-Wen Chung

There are more than 380 species of wild orchids in Taiwan, accounting for about 1/10 of Taiwan's vascular plants, and revealing a high importance for forest biodiversity. However, the populations of wild orchids were severely damaged especially those in the low elevation regions because of the rapid development and change of terrain habitats there. Thus, many exiguous orchids have been largely removed or are on the brink of extinction due to the loss of their original habitats. In addition to the ease of being cultivated in city, the beautiful orchids in low elevation always become targets for commercial collection. It is necessary to engage in the *in-situ* and *ex-situ* conservation to avoid the threatened wild orchids disappearing from Taiwan by human factors. This project engaged in the ecological survey of those exiguous orchids listed in the red book plants, and collected their seeds for various breeding research. The main results of this year are as follows:

A survey and collection of the orchids of Taiwan have been conducted (2013-2015). A total of 11 wild orchids seed were collected, including *Dendrobium miyakei*, *Bulbophyllum pingtungense*, *Calanthe striata* var. *sieboldii*, *Flickingeria comate*, *Spathoglottis plicata*, *Dendrochilum uncatum*, *Tuberolabium kotoense*, *Calanthe graciliflora*, *Gastrochilus japonicus* and *Phalaenopsis aphrodite*, and many seedlings were bred. Those exiguous orchids will provide samples for *in-situ* and *ex-situ* conservation to avoid extinction of these wild orchids disappearance from Taiwan through human factors.

In results of seed germination *in vitro* and plantlet establishment of *Dendrobium miyakei* are as follow. The seeds of *Dendrobium victoria-reginae* Loher var. *miyakei* was sown on six basal media such as ¼ MS, ½ MS, ½ VW, VW, or Hyponex-1 *in vitro*. One quarter of MS supported the highest percentage of seed germination. This liquid medium gave higher percentage for seed germinate than that of seeds on solid medium. One-half MS medium supplemented with activated charcoal (0, 0.1, 0.5, 1, and 2 g L^{-1}) further the growth more. In response, 2 g L^{-1} of activated carbon enhanced plantlet growth, height of plantlets, number of leaves, and number of roots. The seedlings were successfully transplanted to pots in the green house and gave better response of the stem growth and leaf widths.

紅花石斛之花。
Flowers of *Dendrobium miyakei*.

臺灣萍蓬草遺傳資源保存及推廣利用之研究

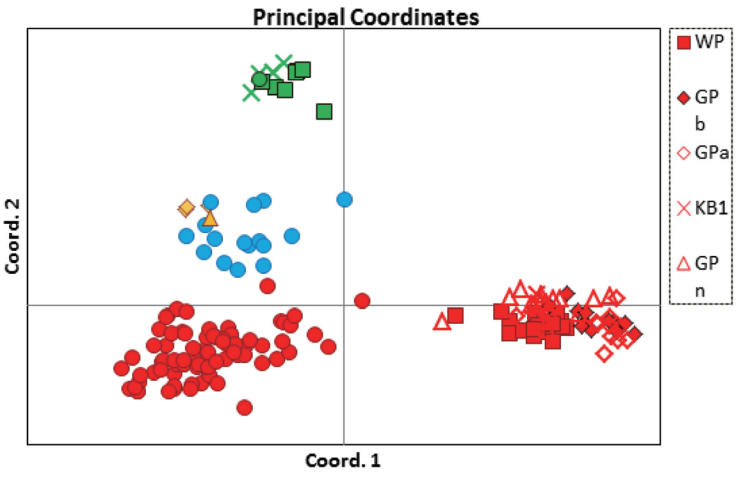
Study on the genetic diversity and utilization of *Nuphara sp*.

朱麗萍

Li-ping Ju

臺灣萍蓬草為近年之熱門之稀有水生植物，廣泛運用於生態教育之生態水池及校園景觀造景。由於現今全臺灣之族群皆為少量族群的後裔，臺灣萍蓬草可能有遺傳岐異度喪失之問題，並且栽培之萍蓬草亦常見日本或大陸產之萍蓬草冒用或混植，故近來亦有臺灣萍蓬草與日本或大陸產之萍蓬草雜交之傳聞。本計畫已完成龍潭地區現有3個臺灣原生族群共47個樣本，及不同單位栽植蒐集之臺灣地區萍蓬草亦78個樣本。並且加入日本地區及大陸地區之本種近緣種之材料總計170個體參試。本研究針對臺灣萍蓬草設計39組SSR引子並進行相關遺傳多樣性檢測，最大的歧異度39.33%保存在個體間，其次才是族群間30.65%。在PCoA分析部分，臺灣地區、大陸地區跟日本地區的種源可明顯區分成3個群團而羅東地區的人工栽植族群則不與任何族群有關聯，顯示應非本種。

Taiwan Nuphra has been identified as a rare aquatic plant species in recently years. It was widely cultivated in campus pool as landscape plants for ecological education use. So far, however, the study of Taiwan Nuphra has been far from completed. Some populations were suspected to derive from Japan and Mainland China. Hybrids among the Taiwan species and the exotic species might also exist in the field. The purpose of this study is to detect the population genetic diversity of the existed populations of Taiwan Nuphra in the field. The results indicated the present living plants of the species were derived from a few small populations. So far, 47 individuals from 3 native populations and 78 from planting populations, together with the Japan and Mainland China populations of some related species totalling 170 individuals had been collected and detected. Thirty nine pairs of primer were used for the study to analyze the genetic diversity of the species. The diversity of 39.33% existed among individuals, while there were 30.65% diversity among the groups. According to the PCoA analysis, populations of Taiwan, Mainland China and Japan may be divided into 3 groups, while the Luo-Dong population is not associated with any of the above groups.



主座標分析(PCoA) 的臺灣萍蓬草、中華萍蓬草和日本萍蓬草集合成3物群聚, 而羅東地區的人工栽植族群則不與任何族群有關聯。

PCoA analysis, populations of Taiwan, Mainland China and Japan may be divided into 3 groups, Luo-Dong population is not associated with any of the above groups.

由館藏標本篩選開花期對溫度變化較為敏感之原生指標植物

Screening temperature-sensitive indicator native plants from Herbarium specimens of Taiwan

王相華

Hsiang-Hua Wang

全球暖化已逐漸改變許多生物的物候現象，臺灣雖然缺少長期的植物物候調查紀錄，但是透過植物標本館保留的採集標本，仍可評估過往至現今的植物物候變化情形。本研究查閱臺灣亞熱帶山區的常見且館藏量較多的28個物種、11,679份標本，實際進行分析之開花標本數共2,078份，並與國家災害防救科技中心提供之「溫度網格資料」配對地點、時間，進行標本開花期與採集時間、地點及網格溫度的迴歸分析，以瞭解臺灣亞熱帶植物花期對溫度變化之反應，並篩選出對於溫度變化較為敏感的原生植物。分析結果顯示，許多臺灣亞熱帶植物之花期明顯受到開花高峰前幾個月溫度變化之影響，且每上升1℃開花日約提早2.2~7.9天，與國外學者針對溫帶植物的研究結果類似。海拔高度間接反應溫度差異，故本研究推薦開花日與海拔呈現正相關且和開花高峰前3個月均溫呈現顯著負相關的13個物種，包括小實女貞、紅子莢蒾、臺灣石楠、假柃木、臺灣胡麻花、狹瓣八仙花、大葉越橘、山龍眼、大葉溲疏、佩羅特木、黑星櫻、心基葉溲疏、及西施花，作為監測全球暖化的候選指標植物。

Global warming has influenced many animal and plant phenological phenomena. Although most areas lack long-term plant phenological records in Taiwan, researchers can still estimate plant phenological changes through the specimens reserved in herbarium. Our study focused on 28 common species of Taiwan's subtropical areas. Based on both of the specimens in Taiwan's main herbariums and the "Temperature dataset grids" from The National Science and Technology Center for Disaster Reduction (NCDR), we examined the influence of air temperature change on flowering time of plants in subtropical Taiwan, and tried to find potential indicator species. The results show that many of the subtropical specie flowering time showed negative correlation between flowering date and the earlier month temperature before peak flowering time, and flowering was advanced by 2.2~7.9 days per 1°C rise 3 months before peak flowering month. Thirty species with temperature and elevation change sensitivity in flowering time were evaluated as having the potential of being the indicator species to monitor climate change.

各物種標本開花日與開花高峰期前3個月迴歸的結果。

Line regression model between flowering date and mean temperature of 3 months before peak flowering month.

中文名 Chinese name	樣本數(N)	R^2	P	迴歸式 Regression model
小實女貞 *Ligustrum sinense*	54	0.556	< 0.001***	Y= - 7.923x + 271.196
紅子莢蒾 *Viburnum integrifolium*	71	0.322	< 0.001***	Y= - 3.795x + 148.855
臺灣石楠 *Photinia lucida*	34	0.306	< 0.001***	Y= - 3.565x + 148.672
假柃木 *Eurya crenatifolia*	55	0.297	< 0.001***	Y= - 4.263x + 112.565
臺灣胡麻花 *Heloniopsis umbellata*	31	0.281	0.001**	Y= - 3.991x + 100.112
狹瓣八仙花 *Hydrangea angustipetala*	90	0.219	< 0.001***	Y= - 5.698x + 205.412
大葉越橘 *Vaccinium wrightii var. wrightii*	30	0.218	0.009**	Y= - 3.904x + 174.514
山龍眼 *Helicia formosana*	70	0.218	< 0.001***	Y= - 4.589x + 258.083
大葉溲疏 *Deutzia pulchra*	188	0.176	<0.001***	Y= - 4.801x + 176.514
佩羅特木 *Perrottetia arisanensis*	87	0.169	<0.001***	Y= - 2.793x + 134.421
黑星櫻 *Prunus phaeosticta*	96	0.145	<0.001***	Y= - 2.172x + 144.613
心基葉溲疏 *Deutzia cordatula*	37	0.141	0.022*	Y= - 4.650x + 198.140
西施花 *Rhododendron ellipticum*	107	0.102	<0.001***	Y= - 2.227x + 139.304

備註:*表示P值<0.05；**表示P值<0.01；***表示P值<0.001

福山植物園自然探索活動之設計研究成果報告

范義彬

植物園所扮演的角色，具有保育、研究、教育與休閒遊憩的功能。本研究今年著重在福山植物園自然探索活動的模式設計、執行及評估，將研究成果轉化為環境教育素材、活動方案，讓遊客及學童更為瞭解森林與野生動物的相互依存關係，進而更懂得珍惜我們所擁有的森林與自然環境。

自然探索活動根源於真實世界和一手知識的學習，依據建構教育、探究教育模式，將生態調查、科學研究轉化成活動、遊戲。以團隊活動的方式進行，先拋出問題、透過學員從問題中提出假說、動手操作、由結果來驗證或推翻假說，讓學員動腦、動手、團隊合作完成交付的任務，最後透過成果分享報告，探討生態世界奧祕。濕地探索教育不以物種認識為目標、不以先備知識學習為導向，誘導學員如何觀察、描述、辨識物種，再從個體數量的觀念，延伸棲地環境的關係。

透過自然探索活動的模式設計、執行及評估，完成以下成果：完成463份探索活動單，完成度如下，回答13~14題有214份，回答11~12題有57份、回答10題以下有192份。遊客訪談20人次。自然探索學習單問卷調查101份，前測48份，後測53份。宜蘭學進國小4年級51位學生分為實驗組，參加自然探索；對照組，參加導覽解說，有效問卷20份。結果顯示在環境知識面項實驗組低於對照組，但後測進步幅度高於對照組；在環境感受面項實驗組高於對照組，但後測進步幅度高低於對照組。

本研究顯示透過自然探索活動引導，能夠觀察到許多平常沒有注意到的自然變化，比起只聽解說或自己閒晃，親身觀察記錄能讓參與者更為認識並對福山植物園的環境產生喜愛的感情。可增進參與者對自然觀察的敏銳度、及對樹木的知識有所增長。

本研究在探討傳統解說與動手操作之自然探索學習之差異。
This study was to explore the nature of the traditional explanations and hands-on exploration of differences in learning.

Design and study of natural exploration activities in Fushan Botanical Garden

Yi-Bin Fan

The roles of botanical gardens include conservation, research, education and recreational functions. This study explored the natural pattern of activities in Fushan Botanical Garden design, implementation and evaluation of research results onto environmental educational materials and activities program. Thus more tourists and students can understand the interdependence of forests and wildlife, and be more appreciative that we have such good forests and the natural environment.

Through natural exploration activities schema design, implementation and evaluation, we've completed the following results: the completion of 463 exploration activities, with the following completion rates: answering 13 to 14 questions 214 copies; answering 11 to 12 questions 57 copies; or answering

less than 10 questions, 192 copies. Guest interviewed 20 people. Nature Discovery Learning survey of 101 cases, 48 pre-tests, and 53 post-tests. A 4th grade Ilan small country school with 51 students was divided into experimental groups participating in the Nature Discovery program. The control group participated in guided tours, and completed 20 copies of valid questionnaires. The results showed that the experimental group in terms of environmental knowledge environment scored lower than the control group, but showed higher rate of progress afterward. The feelings of environmental appreciation in the experimental group were higher, but the rates of progress measured afterward were less than the control group. This study shows that through guiding of natural exploration activities, many natural variations usually not noticed were discerned, compared to just listen to the commentary or hang around on their own. Personal observations allow participants to be more aware of the environment and courted favorable feelings toward Fushan Botanical Garden. Participants thus may enhance their sensitivity to nature observation, and increased the knowledge of trees.

橫向振動法評估木竹品質與發展林木樹輪解析技術

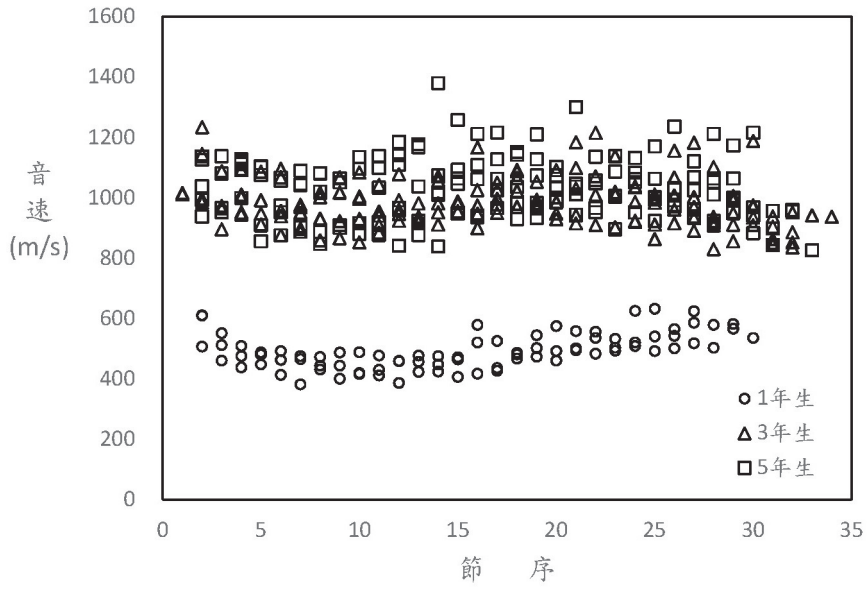
李金梅

臺灣竹林面積達17萬公頃，佔林地面積8.35%，竹之生長速度快，約3-5年即可成熟，若未進行適當之伐採與更新等經營作業，對竹材品質及竹林生長均會造成不良之影響，同時竹材之成熟與否，對竹材加工與產品品質亦會造成影響。現場竹農係以竹桿表面竹粉和苔蘚存在程度作為判斷，國內的竹工藝師在選擇竹材上，是憑藉以往經驗進行色澤和喜好的選擇，林業研究過去係以密度或含水率作為竹材是否成熟之依據，但竹農的經驗可能因為立地環境或微環境溫濕度而影響，竹工藝師僅憑藉色澤和喜好難有具體證據，以往的研究亦須進行伐採之破壞性方能計算密度和含水率。

本研究探討桿壁厚度(t)和竹桿徑(D)平方之比值(t/D^2)與共振頻率之關係，結果顯示桿壁厚度(t)和竹桿徑(D)平方之比值(t/D^2)與共振頻率是成正相關，可藉由共振頻率和竹桿徑的量測估算桿壁厚度，作為竹結構用材一定桿壁厚度選用之依據。

研究結果顯示:

1. 弦向音速與含水率之結果一致，1年生的音速約在400~600 m/s與3及5年音速約在800~1200 m/s之間差異較大，然3年生與5年生之差異較小。
2. 共振頻率與節序的關係是呈現U字，由於竹桿的共振頻率仍受竹桿形狀影響，藉由圓環的橫向撓曲振動理論，結果顯示桿壁厚度與竹桿外徑平方比值(t/D^2)與共振頻率成正相關。



音速與節序之關係。
Relationship between the sound velocity and internodal number.

Studies on the quality evaluation of wood and bamboo by lateral impact vibration method and a tree ring characterization technique

Chin-Mei Lee

In Taiwan, the area of bamboo forest reaches about 170,000ha (almost 8.35% of all forestland). Because of their rapid maturation, appropriate cutting and regeneration should be done to improve bamboo quality and growth. Mostly, bamboo farmers determine the maturity of bamboo by observing presence of whitening and moss on the bamboo culms, whereas, bamboo technical artists determine this largely using the color preference.

This study examined the relationship of culm wall thickness (t) and culm diameter square (D^2) ratio to the vibrational frequency, a positive correlation of t/D^2 ratio and frequency exists. So, we can estimate the clum wall thickness depending on (t/D^2) ratio to select specific thickness of bamboo structure. The following results were obtained:

1. The results of the sound velocities and moisture content are consistent. The difference is greater between the 1-year-old and the 3-year-old or the 5-year-old than that between the 3-year-old and the 5-year-old bamboo.
2. Positive correlations were obtained between frequencies of lateral impact vibrations and the ratio of culm thickness to culm diameter squared (t/D^2).

重要經濟造林樹種之保健活性成分分析

洪昆源

本研究選擇了茄苳(*Bischofia jabanica*)、樟樹(*Cinnamomum campho*)、桃花心木、苦楝、白千層(*Melaleuca leucadendra*)、櫸木(*Zelkova serrata*)、光蠟樹(*Fraxinus formosana*)、印度紫檀(*Pterocarpus indicus*)、楓香(*Liguidambar formosana*)及欖仁(*Terminalia catappa*)等10種重要經濟樹種，分別採集臺灣北、中、南及東部地區，枝葉試材，五年分別進行不同濃度之乙醇、甲醇、熱水萃取得到粗萃物。

粗萃物利用液相-液相分配分為Hexane、Ethyl acetate、Butanol及Water等4個可溶部，各部進行DPPH自由基清除能力、抗發炎、細胞內美白活性試驗進行篩選。

DPPH自由基清除能力方面，大葉桃花心木種子MeoH粗萃物之Ethyl acetate可溶部IC_{50}=8.63±2.18 μg/mL，欖仁葉部位中部區域熱水粗萃物有最佳的清除能力及抑制率，IC_{50}為6.75±0.90 μg/mL，楓香嫩葉EtOH之粗萃物具較佳的自由基清除能力，IC_{50}為9.98±1.15 μg/mL。

在抗發炎活性方面，經由LPS誘導巨噬細胞產生發炎反應，細胞存活率在濃度50及100 ppm，除了苦楝有些許毒性，其餘存活率皆大於85%，故不具有細胞毒殺之效果。在修復發炎反應，除了白千層葉及櫸木粗萃物較不具有抑制NO反應，其餘種類都有修復發炎反應之功效，白千層及樟樹精油在抗發炎反應下，效果更加。

在細胞內美白活性試驗方面，只有印度紫檀葉部之Hex及EA可溶部不具有直接抑制酪胺酸酶活性，其餘皆具有抑制黑色素生成之反應，白千層及樟樹精油方面皆具有不錯的抑制細胞內酪氨酸酶活性、抑制細胞黑色素含量，抗腐朽、抗病媒蚊及抗發炎活性。

經濟造林樹種桃花心木有大面積栽植。
Economic tree species, Mahogany has a large planted area.

Analysis of health-protection ingredients from important economic afforestation species in Taiwan

Kun-Yuan Hong

In this study, foliage materials from 10 important economic species: autumn maple (*Bischofia javanica*), camphor (*Cinnamomum camphora*), mahogany (*Swietenia macrophylla*), neem (*Melia azedarach*), melaleuca (*Melaleuca leucadendra*), zelkova (*Zelkova serrata*), ash tree (*Fraxinus formosana*), Indian rosewood (*Pterocarpus indicus*), sweetgum (*Liguidambar formosana*) and terminalia (*Terminalia catappa*) of were collected from north, central, south and east Taiwan in five years. The test materials were extracted respectively using different concentrations of ethanol, methanol, and hot water to obtain crude extracts. The crude extracts were partitioned with liquid-liquid phase distribution divided into hexane, ethyl acetate, butanol and water soluble fractions, then these were screened for bioactivities of DPPH radical scavenging, anti-inflammatory, and intracellular whitening reactive test. For DPPH radical scavenging capacity, ethyl acetate soluble fraction of big leaf mahogany seed from MeoH crude extracts had IC_{50} of 8.63±2.18 μg/mL; hot water crude extract of terminalia leaves from the central region of Taiwan having the best scavenging and inhibition rate, with IC_{50} of 6.75±0.90 μg/mL; and a fraction of the crude EtOH extracts of sweetgum leaves possessed free radical scavenging ability with IC_{50} of 9.98±1.15 μg/mL.

In terms of anti-inflammatory activity via the LPS-induced macrophages to produce inflammatory response, cell viability was tested at concentrations of 50 and 100 ppm. Besides neem to be slightly toxic, the others retained survival greater than 85%, and were not cytotoxic. On repairing inflammation, in addition to melaleuca and zelkova leaves crude extracts was less inhibiting to NO production, the remaining species have repairing effect of inflammation. Melaleuca and camphor essential oils had anti-inflammatory activities with even more effectiveness.

In terms of cells whitening active test, only the Hex and EA soluble fractions of the Indian rosewood leaves did not have directly inhibition of tyrosinase activity, the rest were inhibiting melanin production, Melaleuca oil and camphor all have good inhibitions of intracellular tyrosinase activity and inhibited melanin content in cell. They also showed anti-septic, anti-vector mosquito and anti-inflammatory activities.

改善紙質文物裝裱平整度之研究

徐健國

立軸雖為最常見之書畫裝裱格式，但常常可見裱件展掛時平整不平整，影響參觀者觀感，殊為可惜。而臺灣業界也一直為立軸裝裱不平整所苦，但各家的經驗又不願公開，造成優良技藝可能逐漸失傳，甚是遺憾，故實有探討之必要。本研究擬利用現代科學方法廣泛的探討影響裱件平整的原因，了解真正影響之因子並尋求解決方法，俾縮短裱件上板時間使裱件得以平整展掛，以作為業界將來裝裱之參考，進而提升書畫整體裝裱水準及增加紙質文物展覽之素質，實驗結果摘要如下：

1. 覆背上板停留在板上的時間以1個月以上較為穩定，3個月後幾乎不受展示環境溫溼度影響。
2. 裁切鑲料時可分平行緯線及垂直緯線兩方向裁切，若是綾絹等鑲料緯線方向垂直立軸方向鑲黏,則所裱出的作品翹曲情形較為嚴重，其翹曲高度為平行緯線作品高度二倍以上。
3. 研究發現畫心及鑲料同時下板與否與裱件翹曲差異相關性不大，而是影響裱件完成後，畫心與旁邊的鑲料是否呈現波浪狀的主因。
4. 傳統書畫立軸裝裱會在作品背面上蠟研光,主要是可以減少磨損書畫；但是經由實驗發現因為上蠟研光可以使整件作品厚度減少及舒緩纖維間應力，導致作品柔軟，減緩作品翹曲及利於書捲，且不論鑲黏材料經緯及上板天數為何，皆可有效減緩翹曲程度。
5. 第二次上板時作品並未噴水，因此幾乎無水分，故下板後收縮應力幾乎沒有，作品自然較為平整，而且不論是座覆還是乾覆，二次上板作品的平整度均較一次上板優。

研光與否對作品翹曲之影響
The relationship between the calendering process and the warping degree of the artworks.

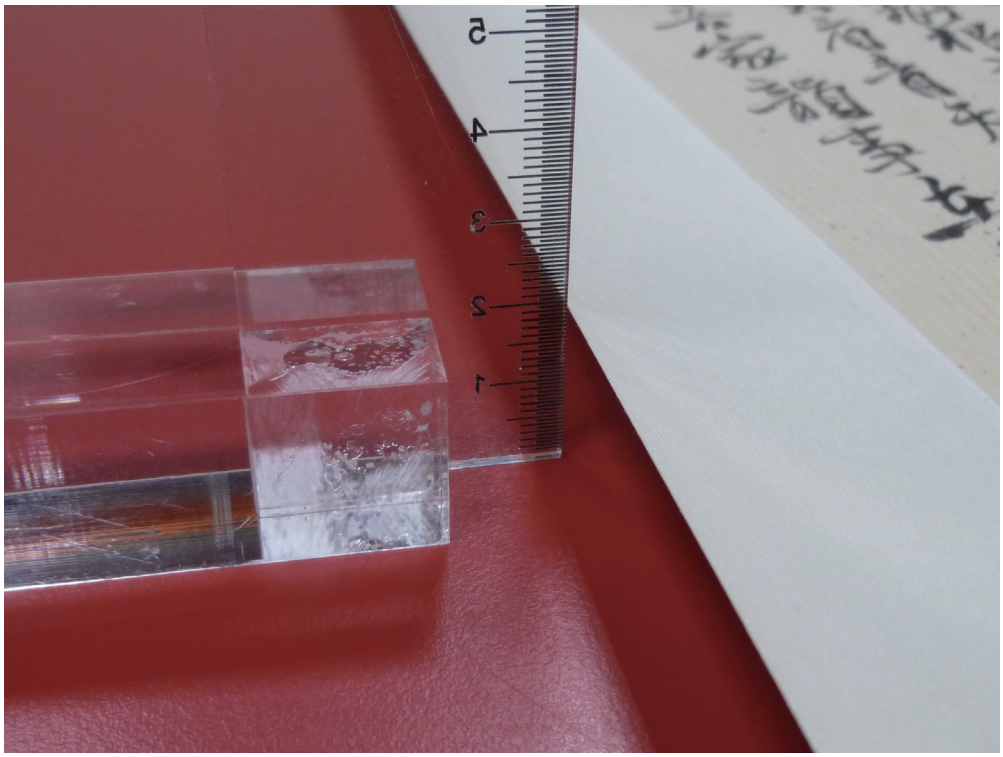
上板天數(Day)	3	4	5	6	7	8	9	10	12	14
研光前 (Without calendering)(cm)	1.14	1.15	1.26	1.34	1.3	1.27	1.3	1.3	1.4	1.3
研光後 (With calendering)(cm)	0.71	0.72	0.83	0.82	0.82	0.78	0.83	0.8	0.77	0.7

Studies on improving the flatness and evenness of mounted paper culture artifacts

Jiann-Gwo Shyu

Hanging scroll is one of the most commonly seen forms of mounted artworks. However, they often appear warped and not even, causing annoyance to viewers. In this study, we aim to examine the issue through mass preparation of mounted scrolls at varying conditions to derive at the probable causal factors and their resolutions. The results are summarized as following:

1. After backing the work with paper and remount to board, the duration of the treatment shall be more than 1 month. After more than 3 months, there is hardly any discernible effect on the works from temperature and humidity of the exhibition site.
2. The trimming of framing material could proceed either along or cross the weft direction. The warping would be twice or more serious if the weft is perpendicular to the scrolling direction.
3. The study found that regardless of the detaching time, there was no clear correlation to warping of the works, but probably was the main cause of waviness surrounding core and framing afterward.
4. The traditional scrolled artwork, upon removed from the panel, will be stone grazed. The original intention is to reduce the rubbing of backing paper to the artwork. However, the experimental work indicated that stone-grazing in addition to reduce rubbing damage of the artwork, it reduces the overall thickness of the work and alleviates the stress, causing the work to be more pliable and abated the warping and scrolling. The practice is effective regardless the duration of paneling.
5. The second paneling has no water spray, there is no shrinkage stress, the work shall remain flat. Regardless of seat or dry backing, the second paneling produced artworks with much better flatness.



量測裱件側邊翹曲高度。
Measuring the warping degree at the edge of the artwork.

國產材製材品規格化之研究

李金梅

本研究與國內製材廠研討目前製材之困難與突破，瞭解製材廠現行製材之尺寸規格，以作為製材品質改善之依據，調查市場製材品不同利用需求木材之尺寸規格，作為研擬國產材製材尺寸規格建議規範，提昇國產製材品質與市場競爭力。

臺灣地區木竹製品製造業調查結果如下:

1. 國內有33.33%的公司有使用有國產材，針葉樹以杉木38.64%為最多，紅檜和柳杉為34.09%次之，再其次為臺灣扁柏的20.45%；闊葉樹則以樟樹為多約有25%的使用率，楠木、相思樹及櫸木次之，有15.91%的使用率。
2. 選擇國產材做為原料乃為符合產品(消費者)需求及客製化需求，分別占59.1%及43.2%。

抽樣市售柳杉和南方松2種木材，結果顯示柳杉抗彎強度約為590kgf/cm^2，南方松抗彎強度約為656~718kgf/cm^2，進一步藉由抗彎強度計算柳杉之製材厚度，依南方松美規尺寸5/4x6之抗彎強度，建議柳杉製材厚度為2.6cm，南方松美規尺寸2x6之抗彎強度，建議柳杉製材厚度為4.4cm。

市售南方松和柳杉木材性質。
Wood characteristics of Southern pine and Cryptomeria.

	5/4″×″6		2″×6″	
	南方松	柳杉	南方松	柳杉
彈性係數w (kgf/cm^2)	59184±18300	70663±11616	91292±17499	65009±11312
抗彎強度 (kgf/cm^2)	656±126	591±84	718±130	593±90
最大荷重 (kgf/cm^2)	708±139	658±83	1200±207	968±152
密度 (g/cm^2)	0.5±0.04	0.49±0.03	0.57±0.06	0.51±0.04
含水率 (%)	8.47±1.48	10.76±1.36	8.9±2.52	8.63±0.84

Mean±SD。

Study on the dimensional specifications of lumber products from domestic logs in Taiwan

Chin-Mei Lee

To promote quality and market competitive advantage of the domestic lumber products, this survey explored the current status of lumber mills in Taiwan. The survey was planned to find out the management difficulties of the mills and to recognize the current lumber products dimensions for different utilizations in the market distribution. The results of this study would provide a reference to improve lumber quality and can be a basis to draw up proposal on dimension norms of domestic lumber products produced from domestic logs.

The following results were obtained:

1. The precise selection of materials in domestic wood is justified by merchandising needs and customization.
2. A primary strategy of promoting domestic wood usage is to push through green products requirements in all government purchases.

We've sampled commercial lumber of domestic Cryptomeria and imported Southern pine. The results found that Cryptomeria lumber has bending resistance of 590 kgf/cm^2; that of Southern pine 656~718 kgf/cm^2. To estimate thickness of saw lumber in Cryptomeria, we suggest an oversawn of 2.6 cm thickness based on the MOR of 5 (4×6) in Southern pine; and an oversawn of 4.4 cm thickness of in Cryptomeria sawn lumber based on the MOR of 2×6 in Southern pine.

耐逆境牛樟、泡桐與雜交桉種原選拔與利用

何政坤、張淑華

為檢定選拔的耐蟲引種桉樹品種、及耐熱的牛樟與泡桐品系，從2013-2014年分別花蓮臺糖光復糖廠農地、苗栗休耕田、及臺南中興大學新化林場建立耐逆性檢定區。3區都位於海拔約100 m，可檢定耐熱性，花蓮區易遭颱風之強風與淹水可檢定抗風與耐澇性，臺南常有長達6個月以上的乾季可檢定耐旱性，3地區都有簇葉病與桉樹釉小蜂可檢定抗病蟲性。在苗栗區具有硬盤水田可選拔抗貧瘠性。在逆境區栽植19-36個月後，引種自中國的雜交桉UG22與UG29在苗栗與台南，具有抗蟲及最佳生長，但花蓮區因連年颱風侵襲，赤桉K10與K20具有抗強風、耐淹水及穩定生長，是適合花蓮區的品系。牛樟D3與雜交牛樟E1可生長花蓮，但無法適應土壤性質不良的苗栗，及具乾旱期的台南。泡桐也無法在苗栗區生長，但在臺南與花蓮生長良好，且具有抗颱風力。牛樟組培技術成功技術移轉給二家生技公司，產業完成21公頃造林。苗栗造林區已呈現多樣化植群，被水保局選中完成農村活化展示區。本研究選拔出耐熱牛樟、耐風熱泡桐、與速生抗蟲桉樹品系。牛樟在氣候逆境下，材積生長增加4.2倍，耐熱泡桐材積增加7.9倍，引種尾巨桉材積增加8.9倍。

苗栗休耕地造林，被臺中水保局規劃為龍昇生態園區。
The plantation at Miaoli, where became a demo of Rural Revitalization named as Ryonghung-ri Ecological Garden established by Water Resources Bureau, Taichung.

Selection and utilization of tree varieties with stress tolerance for *Cinnamomum kanehirae*, *Paulownia* hybrids, and *Eucalyptus* hybrids

Cheng-Kuen Ho, Shu-Hwa Chang

Stress trials composed of *Eucalyptus* spp., *Cinnamoum kanehirae*, and *Paulownia* spp., were established in 3 areas in 2013 and 2014 at Hualien, Miaoli and Tainan. All 3 areas were located at elevations about 100 m and have hot weather in summer, where heat-resistance could be selected. Strong wind and flood caused by typhoon, especially in Hualien could be selected for wind and waterlogging resistant. Dry season more than 6 months in Tainan could be selected for draught resistant. All 3 areas have occurrence of witches' broom disease and insect of *Leptocybe invasa* could be selected for disease and insect resistant. And paddy field with hard pan in Miaoli could be selected for infertile soil resistant. After planting 19 to 36 months, *Eucalyptus* hybrids of UG22, and 29 which were introduced from China, showed great growth with insect resistance in Miaoli and Tainan, but failed at Hualien due to annual typhoons attacked. *E. camaldulensis* K10 and K20 showed greater resistant to strong wind and long period of waterflooding. *C. kanehirae* D3 and hybrids E1 grew well at Hualien, but not in Miaoli and Tainan. *Paulownia* was difficult to grow in Miaoli, but grew well in Tainan and Hualien. It could resist strong winds of typhoons. A micropropagation technology of *C. kanehirae* was successfully transferred to two biotech companies. They established two plantations about 21 ha in size. A Miaoli plantation which appeared to have diversified vegetation was chosen by Taichung Water Resources Bureau and established a demo Rural Revitalization Zone named Ryonghung-ri Ecological Garden. This study has selected stress-resistant races of *C. kanehirae*, *Paulownia* races, and *Eucalyptus* races which respectively increased volume growth 4.2, 7.9, and 8.9 times greater than the earlier selected races.

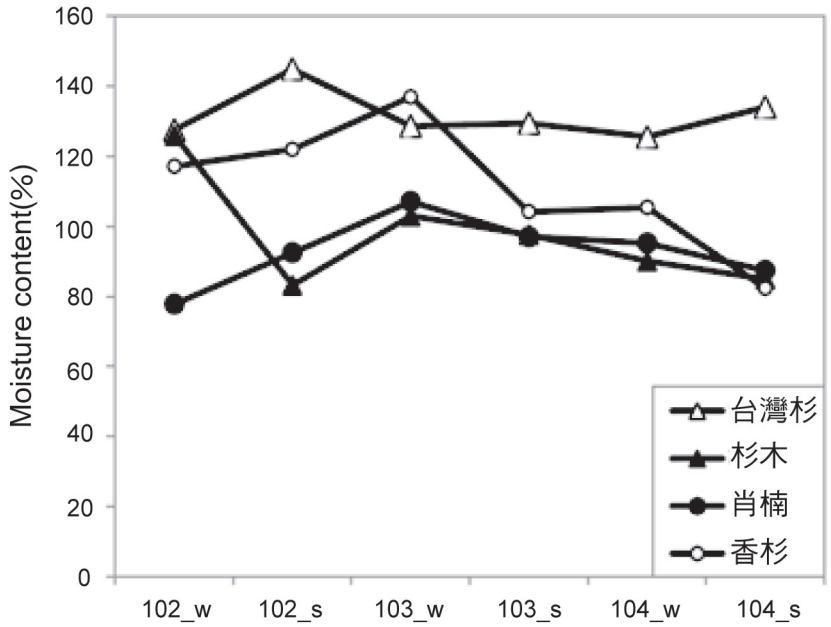
牛樟雜交種在花蓮造林生長良好。
The plantation at Hualien, where *Cinnamomum* hybrids grew well.

雜交桉UG品系在臺南造林生長良好。
The plantation at Tainan, where *Eucalyptus* hybrids UG grew well.

從人工林生長監測指標研擬因應氣候變遷造林調適策略

謝漢欽、鍾智昕、邱志明

為瞭解林業試驗所蓮華池試驗林主要造林樹種在極端氣候變遷下，林分組成、結構動態及各項生長性狀、分布、物候變動是否衝擊林木生長並探討氣候環境變動的適應能力。本研究針對林杉木、肖楠、香杉與臺灣杉4個主要樹種永久樣區分年按季連續調查；以木材性質及樹幹年輪測定法測量及分析不同季節時的冠層葉部含水率、樹幹生材含水率、容積密度及邊心材寬、含水率、邊心材比率和極端天候的關係；據以建立林分尺度林木生長監測評估指標，提出氣候變遷下人工林造林的調適策略，供人工林經營決策參考。研究結果顯示長期的氣候監測資料配合樹輪資料，可窺見氣候長期對林木生長的影響，當人工林木緩衝異常氣候的能力較為脆弱時會導致較高的死亡率。蓮華池試驗林的台灣杉與肖楠的調適能力優於杉木，可優先選擇臺灣原生樹種或混植生態耐受性較廣的樹種，以增進人工林分在極端氣候發生時對於氣候逆境的忍受力，同時能維持原有的林分生產力。



*102-w 為102 年的冬季、102- s 為102 年的夏季、103-w 為103 年的冬季、103-s 為103 年的夏季、104-w 104 年的冬季與104-s 為104 年的夏季

4種造林木樹幹木材含水率變動在6次調查結果的變動情形
The changes of wood moisture of the part of trunk of 4 kinds of plantation between the measures of 3 winter-summer intervals.

Using indicators of plantation growth monitoring to propose adaptive silvicultural strategies in response to climate change

Han-Ching Hsieh, Chih-Hsin Chung, Chih-Ming Chiu

In order to understand whither changes in phenology will affect the productivity of plantation stands under the threat of extreme climate change, this study used four seasonal growth monitoring data in 4 years from the permanent sampling plots of four main manmade forest stands, *Cunninghamia lanceolata*, *Calocedrus formosana*, *Cunninghamia konishii* and *Taiwania cryptomerioides*, at the Lien-hua-chih experimental forest, Taiwan Forestry Research Institute and applied wood moisture and dendroclimatic measures as monitoring indicators to analyze the changes of wood properties in the four seasons each year. The results show that in wet and dry season, the variation of water content of *Cunninghamia lanceolata* leaves was obviously different. When faced with dry weather in the future, the possibility of *Cunninghamia lanceolata* withering will be higher than usual. The adaptability of *Taiwania cryptomerioides* and *Calocedrus formosana* was better than *Cunninghamia lanceolata*. In the future, mixing with wide ecological tolerance species to improve adaptability and maintain wood productivity is a good adaptive strategy for the silviculture of plantations in the region of Lien-hua-chih.

國有林出租造林地違規使用改正經營方法之研究

陳芬蕙、何政坤

為解決國有林租地造林地林農栽植果樹等經濟作物衍生之問題，一方面要兼顧林農生計，另一方面也要增加造林面積以確保國土保安與植林減碳，本計畫目標為建立山坡地混農林業水土保育與永續經營相關的科學基礎資料和模式，以目前已具備混農林業型態使用之地區進行相關試驗。

觀察發現有管理與曾經有管理試點之土壤肥力會受到農戶之施肥等經營習慣影響，可能會有較高之pH及有效性陽離子。調查的果樹有管理試點的樹冠鬱閉度(50-70%)低於造林地(70-95%)。果樹高度多控制在2-5 m，果樹經營者矮化混植林木已影響其正常生長。調查果樹與造林木之根系，發現經營方式及生育地特性會影響果樹/造林木根系發展，果樹根系多集中在接近土表，初步觀察強度修枝、矮化會抑制根系健康發展。

減緩地表逕流深度、逕流率及土壤沖蝕的原因，是緩衝林帶與地被植生覆蓋密度的雙重功能，建議應全年維持地表覆蓋度70%以上。果園混植林木試點的水土流失量皆較造林地試點低，主要原因除了造林地試點之坡度較陡因此沖蝕率高，果園混植林木區以集約經營維持良好地被植生覆蓋，配合簡易水土保持處理減緩土壤流失，且混植的林木也提供覆蓋與穩固土壤的功能。

由於農民普遍不能接受果樹與造林木均勻混植，因此間植造林木建議栽植坡度較陡及表土易遭沖蝕處，以塊狀及等高橫坡帶狀混植造林木。有經營管理的果園，若合理施肥可改善土壤性質，減少沖蝕的發生。建議以符合聯合。

混農林試區樣態：
a.臺中甜柿區果樹有管理試點(甜柿混植銀杏)、b.臺南梅樹區果樹有管理試點(梅樹混植破布子)、c.臺東釋迦區果樹有管理但林木矮化試點(釋迦混植烏心石)、d.臺東釋迦區之造林地對照組(陰香、肖楠)。

Patterns of agroforestry sites:
a.Taichung persimmon site- managed orchard plot (persimmon interplanted with *Ginkgo biloba*), b.Tainan plum site- managed orchard plot (plum interplanted with *Cordia dichotoma*), c.Taitung cherimoya site- managed orchard with dwarfed interplanted tree plot (cherimoya interplanted with *Michelia formosana*), d.Taitung cherimoya site- plantation plot (*Cinnamomum burmannii* and *Calocedrus formosana*)

Study on management rectifications of illegally-used leased national forestlands

Fen-Hui Chen, Cheng-Kuen Ho

Fruits illegally planted on leased national forestlands have led to many problems and conflicts over the decades. A good solution to this issue must be able to balance farmers' livelihood with increasing plantation areas and sustainability. The purpose of this study is to obtain and accumulate knowledge and fundamental scientific data on soil and water conservation and sustainability of upland agroforestry systems.

Soils on managed or once-managed plots tended to have higher pH and effective cation exchange capacity. The canopy openness of managed orchards (50-70%) was higher than which of plantations (70-95%). Most fruit trees were maintained at heights between 2~5 m. The majority of fruit trees root system was disturbed near soil surface. Strong dwarfing and pruning practices have influence the normal growth and healthy root system of interplanted trees.

Both forestland buffer zone and ground cover vegetation are key elements in reducing surface runoff depth, runoff ratio, and soil erosion. Therefore, maintaining ground cover over 70% all year round is necessary. Plantation plots had higher soil erosion due to steeper terrains. Moreover, sound ground cover, simple soil and water conservation treatment, and interplanting trees all may contribute to the reduction of soil loss at intensively well-managed orchard.

Instead of planting evenly, patch or strip interplanting trees at areas with relatively steep slopes or vulnerable to soil erosion are recommended in practice. Reasonable fertilization of orchards can improve soil characters and decrease soil erosion. Following the definitions and rules of FAO on forest to regulate those illegally-used leased national forestlands is suggested.

人工林不同林況以不同疏伐方法之採運作業研究

湯適謙、邱志明

本計畫以行政院農業委員會林務局嘉義林管處阿里山事業區及南投林管處巒大事業區、埔里事業區，屏東林管處恆濃事業區，花蓮林管處林田山事業區柳杉、杉木、臺灣杉、紅檜人工林等共6個作業地為對象，進行疏伐作業之伐木造材、集運作業之工作研究，探討各作業單元之作業時間及分配比例，初步分析結果如次：

因地況、林況不同，其中伐木造材作業平均每株樹作業時間為163~611sec，平均為343sec，其中準備收拾所佔比例為7.5~17.8%，平均13.1%，實際作業所佔之比例為52.4~79.6%，平均為70.7%，寬裕所佔之比例為6.9~29.8%，平均為16.2%；集材作業平均作業時間為417 ~ 1,464sec，平均為785sec，其中準備收拾所佔比例為13.3~27.4%，平均為18.5%，實際作業所佔之比例為54.1~68.1%，平均為59.5%，寬裕所佔之比例為12.8~30.1%，平均為22.0%。

藉由「不連續差數重要度指數原則」得知影響伐木造材、集運作業各因子之相對權重(重要度)，其中伐木造材以「林地坡度」及「平均疏伐單木材積」為影響伐木造材作業最重要因子，集材作業則以「平均每公頃疏伐材積」、「每公頃蓄積量」及「平均疏伐單木材積」為影響疏伐木集材作業工作量最重要之因子；根據平均日工作量及重要度分析結果可求得伐木造材及集材作業之日標準工作量方程式。

疏伐木造材作業。
Bucking operations of thinned wood.

Work study on the logging operations for thinning of plantations with different factors

Shyh-Chian Tang , Chih-Ming Chiu

This project was undertaken in the 6 plantations of Forestry Bureau, Council of Agriculture (including Chiayi Forest District Office, Nantou Forest District Office, Pingtung Forest District Office and Hualien Forest District Office). The work study for the felling-bucking and logging of thinning operations was applied to investigate the operational time and percentage of work unit. The preliminary analysis results were as follows.

For the felling-bucking operations, the average operational time for each stand was 163~611 s (average 343 s). And the proportion for preparation-packing, practical operation, and allowance was 7.5~17.8% (average 13.1%), 52.4~79.6% (average 70.7%) and 6.9~29.8% (average 16.2%) respectively. On the aspect of logging, the average operational time for each logging cycle was 417~1,464 s (average 785 s). And the proportion for preparation, packing, practical operation and allowance was 13.3~27.4% (average 18.5%), 54.1~68.1% (average 59.5%) and 12.8~30.1% (average 22.0%) respectively.

On the other hand, using the "principle of discontinuous difference for weighted index", the weights of factors affecting felling-bucking and logging operations were then estimated. For the felling-bucking, the most important factors were "slope" and "average volume of stand". On the aspect of logging, the most important factors were "thinning volume per hectare", "volume per hectare" and "average volume of stand". The standard output formulas were obtained by the average productivity and factors weight indices.

疏伐木集材作業。
Yarding operations of thinned wood.

編撰租地造林樹種經營管理手冊

許原瑞

透過現有租地造林資料庫分析、租地造林樹種意見調查、林地現況調查及訪談等方式，檢討現有91個租地造林樹種及提供經營改善建議。資料庫顯示：林務局核可而紀錄之造林樹種有118種。經問卷調查及專家研商決議認為：應減少造林樹種，且以短伐期、具木材利用潛力、產業需求樹種為主，即以林農的收益列為首要考量的因素；原生種或馴化種優先採用。因此推薦櫸(*Zelkova serrata*)、烏心石(*Michelia compressa*)、臺灣肖楠(*Calocedrus marcolepis* var. *formosana*)、相思樹(*Acacia confusa*)、楓香(L*iquidambar formosana*)、光蠟樹(*Fraxinus formosana*)、牛樟(*Cinnamomum kanehirae*)、臺灣杉(*Taiwania cryptomerioides*)、杜英(*Elaeocarpus sylvestris*)、無患子(*Sapindus mukurossi*)、桃花心木(*Swietenia* spp.)、桉樹(*Eucalyptus* spp.)及殼斗科原生種。惟為符合經營現況及產業需求，增列柳杉(*Cryptomeria japonica*)、香杉(*Cunninghamia lanceolata* var. *konishii*)、油桐(*Aleurites fordii*)。另為提高林地的生態功能，列入原生楠木類樹種等。位在海岸地區的租地，則增列木麻黃(*Casuarina equisetifolia*)、白千層(*Melaleuca leucadendra*)、黃槿(*Hibiscas tiliaceus*)、海檬果(*Cerbera manghas*)、瓊崖海棠(*Calophyllum inophyllum*)。

國有林租地造林地現況調查及林農訪談結果顯示，以往可採用的樹種以林業管理單位建議為主，目標為生長適應性強、高經濟性、景觀等條件樹種。為因應未來租地造林發展，編撰手冊的內容包括樹種選擇、造林技術、林分撫育管理等作業，在森林利用與效益，森林動物、病蟲害、火災等森林保護等議題，力求周詳，但不繁雜，以利林業人員及承租人之參考採行。

The manual in management of tree species forestation at leased national forestland

Yen-Ray Hsui

This project is to examine the performances of 91 tree species that have been forestation at leased national forestland, using leased national data bank provided by Forestry Bureau (FB), tree species review and recommendation from forestry experts, investigation in field and interview with field staff. There have 118 tree species recorded in FB data bank. Decision of recommended species was done by two steps. Seventy-two species were favored by more 50% of interviewers in the result of questionnaire survey. These species are with two characters: suitable species grown at forestland and economical values. In the meeting of forestry experts, some suggestions were made as followings: 1. Reduction numbers of tree species, 2. Short rotation species with good wood quality to meet the requirement of industry. 3. Consideration of leaseholder income. 4. Choice of native and domasticated species. Tree species suggested were *Zelkova serrata*, *Michelia compressa*, *Calocedrus marcolepis* var. *formosana*, *Acacia confusa*, *Liquidambar formosana*, *Fraxinus formosana*, *Cinnamomum kanehirae*, *Taiwania cryptomerioides*, *Elaeocarpus sylvestris*, *Sapindus mukurossi*, *Swietenia* spp, *Eucalyptus* spp., and Fagaceae species. To adapt special fields, some species were additional listed, such as *Cryptomeria japonica*, *Cunninghamia lanceolata* var. *konishii*, *Aleurites fordii* to meet the current management conditions and industry needs, Lauraceae species to rich ecological diversity, and *Casuarina equisetifolia*, *Melaleuca leucadendra*, *Hibiscas tiliaceus*, *Cerbera manghas*, *Calophyllum inophyllum* to protect coastal environments.

Depending on different types of lease national forestland, choosing suitable tree species with economic and ecological regardless of detailed list. According to the information of field survey of leased forestland and interview with leaseholders, selection of tree species could be decided by local authorities, who plan to establish strong adaptable, or high economic, or landscaping tree species. To enhance healthy development of national leased forestland, the content of this manual was written including selection of tree species, silvicultural techniques, middle and late tending, and silvicultural system, etc. The topic of forest benefit, wood utilization, and forest protect such as animal, disease, insects, and forest fire were described. To promote the value of wood based on the certification of forest products were described too, which will give forestry staff a great information to manage leased forestland.

桉樹優良品系採穗園維護管理與苗木培育

鍾振德

農委會從2013開始調整耕作制度活化農地計畫。為了增加木材與紙漿原料供給，此計畫鼓勵農民將休耕地栽植林木，並以木材生產為目標，政策主要在增加木材與紙漿原料的自給率，以供給國內木材與造紙工業需求。桉樹優良品系的營養系林提供顯著的收穫，均質與高品質的木材。本研究之目的在於經營管理桉樹優良品系採穗園，這些優良品系為抗桉樹枝癭釉小蜂(*Leptocybe invasa*)，且選拔自生長優良精英樹，扦插繁殖苗木提供農民栽植。2013年我們建立三種型態的採穗園，包括土床、容器與礫耕栽培。然而，今年由於申請栽植的面積僅16.59公頃，因此我們選擇礫耕栽培的採穗園進行後續扦插繁殖。礫耕栽培的採穗園小母樹數量約4,500株，每株小母樹每個月可以採穗樹量約2.5支插穗。插穗剪取3~4節，帶有4片葉子枝條，扦插介質全部使用珍珠石，不同優良品系扦插發根率30~100%不等，所有插穗的扦插發根率平均約80%。今年我們共提供33,127株苗木給19位農民栽植，其中15位申請人在花蓮，1位在苗栗，其他3位在臺南。栽植後的大部分造林地成活率超過90%以上，但不同的品系表現不一樣的生長速率。我們將持續努力推廣提高農民參與本計畫意願。

桉樹3902品系扦插苗。
Rooted cuttings of *Eucalyptus* hybrids: clone No. 3902.

Clonal garden management and propagation by stem cuttings of elite clones of *Eucalyptus*

Jeng-Der Chung

The Council of Agriculture (COA) has begun to change the policy of "Paddy Land Utilization Adjustment Program" since 2013. In order to enhance the wood and wood pulp supply, this project encouraged land owners to plant more trees. The major advantage of the policy is to increase the self-supply rate of pulp wood for Taiwan's wood and paper industry. Clonal *Eucalyptus* plantations of elite clones have provided significant gains in forest productivity, uniformity and wood quality. The aim of this study was to manage the clonal garden and propagation by stem cuttings of elite clones of *Eucalyptus* with the aim of anti-galling pest (*Leptocybe invasa*). In 2013, we developed three types of clonal gardens including open-field soil, container and gravel-bed culture. This year, we selected the gravel-bed cultured type of clonal garden due to its low planting areas (16.59 ha). The amounts of scion mother trees in clonal garden of gravel-bed culture were ca. 4,500. On average, a scion mother tree produces 2.5 new stems per month. Cuttings were then prepared having 3 to 4 nodes with four leaves. The rooting media used was 100% perlite. The cuttings from different elite clones have rooting percentages from 30 to 100%. Average of the total cuttings was ca. 80%. Moreover, we offered 33,127 plants to 19 land owners; including 15 applicants from Hualien, 1 applicant form Miaoli as well as 3 applicants from Tainan. The reasonable survival rates in most of the plantations were over 90%; however, elite clones exhibited different growth rates. Finally, we would like to encourage more and more land owners to participate in this program.

東沙島植物相調查

陳建帆、伍淑惠、陳建文、張勵婉、陳佳玉、葉定宏、陳可芳

東沙島陸域植被歷經砍木取薪、採礦及開發設施等，且外來種銀合歡入侵，致植被破碎或退化，海洋國家公園管理處正積極推動外來種移除及植被復育之工作。本計畫主要進行植物相、植物社會、海漂種實、外來植物等調查，以及永久樣區設置、物候間測資料分析之工作，執行成果將提供植被復育綠美化及植被經營管理參考。

植物相調查結果顯示，東沙島現生維管束植物有54科131屬158個分類群，其中6種列屬東沙島稀有植物。植物社會劃分為白避霜花森林、草海桐灌叢、林投灌叢、海人樹灌叢、馬鞍藤草地、海馬齒草地、海茄苳樹叢。植被分布與離海距離、面潟湖或海洋側、土壤pH值等環境因子有顯著相關。此外，於各主要植物社會共計設置了10個永久樣區，建議每5年進行一次複查，長期監測植物競爭與組成的演替變化。

東沙島沙灘海漂種實定性調查結果，共有53種分屬28科43屬，來源以島外漂來居多，有37種(72.5 %)，屬於島上原生或栽植植物的種實僅13種(23.5 %)；其中具有發芽力者有25種(47.2 %)，以豆科最為豐富。定量調查結果顯示，樣區內共有32筆調查資料，分屬16種，整體來說，種類多而頻度低。沙灘上植物小苗共有15種，其中木本植物小苗4種15株，皆為島上原生之物種。

東沙島外來植物計有75種，依據物種入侵屬性及分布，細分為栽培種39種、偶見外來種15種、歸化種7種、入侵植物14種。各物種依擴散潛勢，分別建議暫不處理、強裸露地綠化造林及人力移除等防治措施。分析17種常見且觀測紀錄達4年以上之植物物候，植物的開花週期可劃分為四種形式，分別為全年開花、冬末初春開花、春夏開花及一年二次開花等；透過現有定性物候資料已能掌握主要綠美化及造林樹種採種適期，本計畫建議特定物種可深入進行定量物候監測。

東沙島陸域植被分布圖。
The terrestrial vegetation map of the Pratas Island.

The investigation of flora and vegetation of the Pratas Island

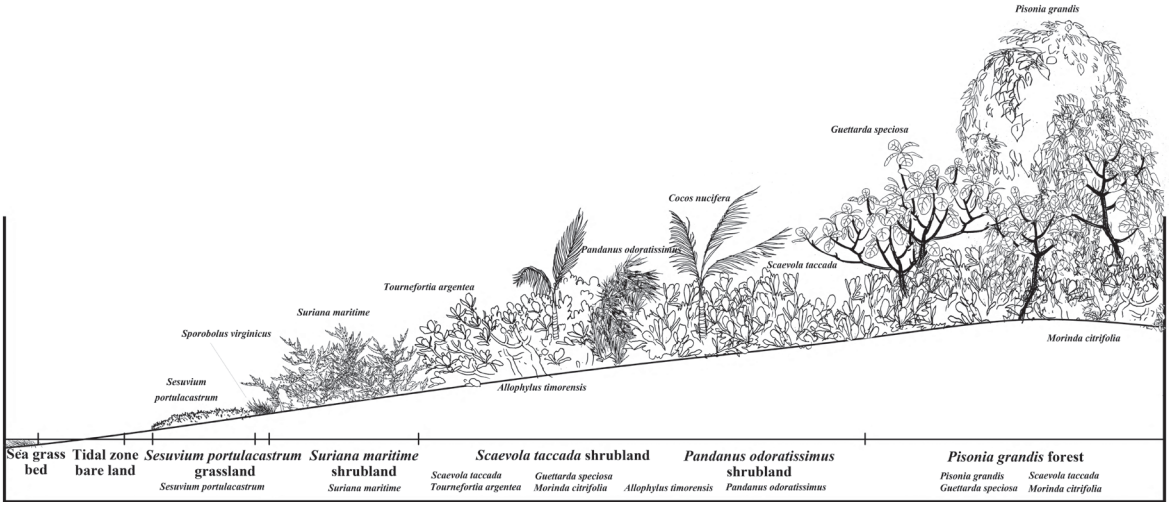
Chien-Fan Chen, Shu-Hui Wu, Chien-Wen Chen, Li-Wan Chang,
Chia-Yu Chen, Ding-Hong Yeh, Ke-Fang Chen

The Pratas Island has undergone human activities such as firewood cutting, mining, reclamation, and invasion of exotic species, (e.g., *Leucaena leucocephala),* which resulted in the fragmentation or degradation of its terrestrial vegetation. At present, removal of exotic species and vegetation restoration have been actively conducted. This project suggests establishing protocols for the reference of landscape vegetation restoration and vegetation management through information of local flora and plant community investigation, drift disseminule survey, inspection of exotic species and distribution, vegetation permanent plots, and phenology monitoring work.

The floristic data showed that the collections contained 54 families, 131 genera, and 158 species; including 6 rare species on the Pratas Island. Vegetation types were classified into 7 types, and named as i.e. *Pisonia grandis* forest, *Scaevola taccada* shrubland, *Pandanus odoratissimus* shrubland, *Suriana maritime* shrubland, *Ipomoea pes-caprae* subsp. *brasiliensis* grassland, *Sesuvium portulacastrum* grassland, and *Avicennia marina* clump. Distance to sea, lagoon or sea side and soil pH values are the most important factors influencing species composition and vegetation distribution. Additional 10 permanent plots were established this year. We suggest that the plots should be recensue every 5 years for monitoring the competition among plants and the change of composition during the process of succession.

Assemblages of drift disseminules were investigated on the seashore of Pratas Island. 53 disseminules taxa were recorded and identified, representing 28 families, and 43 genera. 37 taxa weren't native species that washed ashore by ocean currents taxa (23.5%) were dropped from native or planted trees on the Pratas Island; 25 species (47.2%) may still be viable among those. The pea family (Leguminosae) is the most abundant of the drifted disseminules. The results from the survey of the plots, 32 disseminules, belonging to 16 taxa were recorded. In general, the species richness is high but frequency of species is low. All of the seedlings are native plants, 15 taxa were recorded in the plots and 4 species 15 individuals are the seedlings of woody plants.

There are 75 exotic taxa on the Pratas Island. According to the invasive characteristic and distribution, the 75 taxa can be divided into 4 categories, cultivated plants (39 taxa), casual alien plants (15 taxa), naturalized plants (7 taxa), and invasive plants (14 taxa). Varied treatment options offered depended on what the potential of plant dispersal, “no treatment but monitoring”; “vegetation restoration (on highly exposed site)” and “removal” are our suggestion. To analyzed the phenology data which gathered from 17 tree species were observed over 4 years, there are four types of flowering pattern on the Pratas Island, “all year round”, “late winter to early spring”, “spring to summer” and “semiannual”. The proper seed collecting time of most afforestation species had already been established based on the current data. We suggest to focus on native species to conduct quantitative phenology monitoring.



東沙島陸域植被分佈剖面圖。
The profile of terrestrial vegetation of the Pratas Island.

臺灣原生植物種子物理休眠之研究

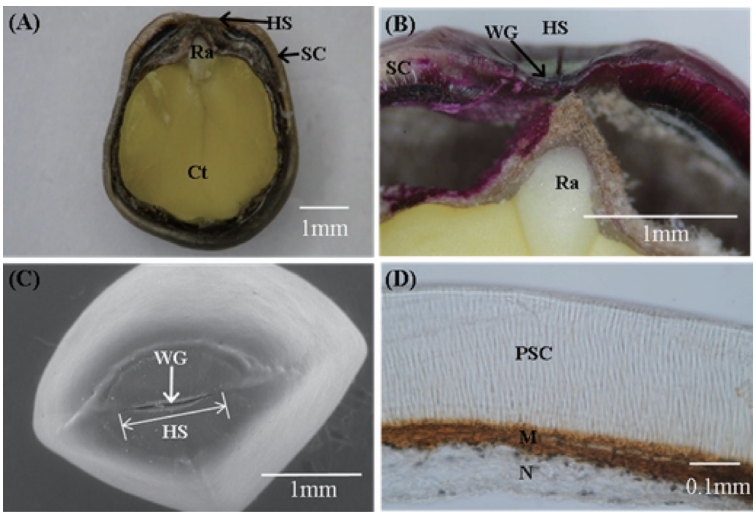
Study of physical dormancy in seeds of the native woody species in Taiwan

陳舜英

Shun-Ying Chen

種子的物理休眠主要起因是有一不透水的種皮或果皮，故磨破此硬種皮或果皮即能促進種子發芽。本研究利用種子水分吸收試驗當作標準，首先確定種子是否有物理休眠，並使用種子染色追蹤和顯微觀察，證明種皮(果皮)存在水隙口構造和不透水層細胞。研究結果證實，漆樹科木蠟樹、錦葵科繖楊和鼠李科亞洲濱棗種子都有物理休眠，差異在於木蠟樹種子的水隙口位於珠孔端，狹窄線形，其內果皮是由桿狀厚壁細胞、柵狀厚壁細胞和鋸齒狀厚壁細胞組成的不透水層，其中鋸齒狀厚壁細胞是首度被發現在植物種子內；繖楊種子的水隙口位於種皮合點栓，圓環狀，水分從合點栓和種皮連接縫處進入，此種皮不透水層是由柵狀厚壁細胞組成；亞洲濱棗種子的水隙口位於珠孔端，狹窄線形，其不透水層的種皮是由柵狀厚壁細胞組成。磨破種皮的發芽促進方式，是所有處理中能獲得最佳發芽率和發芽速率的方法。熱水處理雖可提高種子發芽率，但最適水溫各自不同，分別為木蠟樹70℃，繖楊和亞洲濱棗80℃。濃硫酸處理可解除木蠟樹種子的休眠，以90分鐘處理的效果最佳。就新鮮種子最適合的發芽溫度而言，木蠟樹是20/10℃和25/15℃，繖楊是30℃，亞洲濱棗則是30/20℃。

Seeds with physical dormancy have a water-impermeable seed coat or fruit coat (endocarp), and thus scarifying the hard coat improves germination. The purpose of the present study was to use water uptake as the criterion to determine whether the seed/fruit has physical dormancy, and to use dye-tracking to identify the water gap and impermeable layers of the seed/fruit coat in three species of woody plants native to Taiwan. The seed plus endocarp (hereafter called seed) of *Rhus succedanea* (Anacardiaceae), seeds of *Thespesia populnea* (Malvaceae) and *Colubrina asiatica* (Rhamnaceae) exhibite physical dormancy. The water gap of *R. succedanea* seeds is located on the micropylar end of the seed and is a narrow-linear opening. The endocarp has three water-impermeable layers, with macrosclereids on the outside, palisade sclereid cells in the middle, and serrulate sclereids on the inside, the latter is reported for the first time in plant seeds. The water gap of *T. populnea* seeds is located on the end opposite the micropyle and is a chalazal plug surrounded by a layer of palisade sclereid cells in the seed coat, and water can pass through the slit between the plug and sclereid cells. The water gap of *C. asiatica* seeds is located on the micropylar end of the seed and is a narrow-linear opening, and the seed has a water-impermeable layer of palisade sclereid cells. Mechanically scarified fresh seeds of the three species germinated to high percentages. Immersion of seeds in hot water and allowing them to cool in the water also increased germination percentages, and the optimal water temperatures were 70℃ for seeds of *R. succedanea* and 80℃ for those of *T. populnea* and *C. asiatica*. Concentrated sulfuric acid broke dormancy in *R. Succedanea* seeds, and the soaking time for the highest germination percentage was 90 min. The optimal temperatures for germination of *R. succedanea* seeds was 20/10℃ and 25/15℃, and that for *T. populnea* and *C. asiatica* seeds was 30℃ and 30/20℃, respectively.



亞洲濱棗種子的種皮解剖構造。(A)種子縱切面；(B)珠孔區；(C)種臍狹縫的SEM解剖構造；(D)種皮的縱切構造。HS：種臍狹縫，WG：水隙口，PSC：柵狀厚壁細胞，M：葉肉細胞，N：珠心，Ct：子葉，Ra：胚根。

Special features of seed coat (SC) of *Colubrina asiatica* seed. (A) Longitudinal section of seed, (B) micropyle region with hilar slit (HS) and water gap (WG) stained by acid fuchsin dye, (C) SEM of HS on seed coat, (D) longitudinal section of seed coat (optical microscopy). From outside to inside of seed, palisade sclereid cells (PSC), mesophyll cells (M) and nucellus (N). Ct, cotyledon; Ra, radicle.

臺灣杉人工林不同林分密度生長與自我疏伐研究

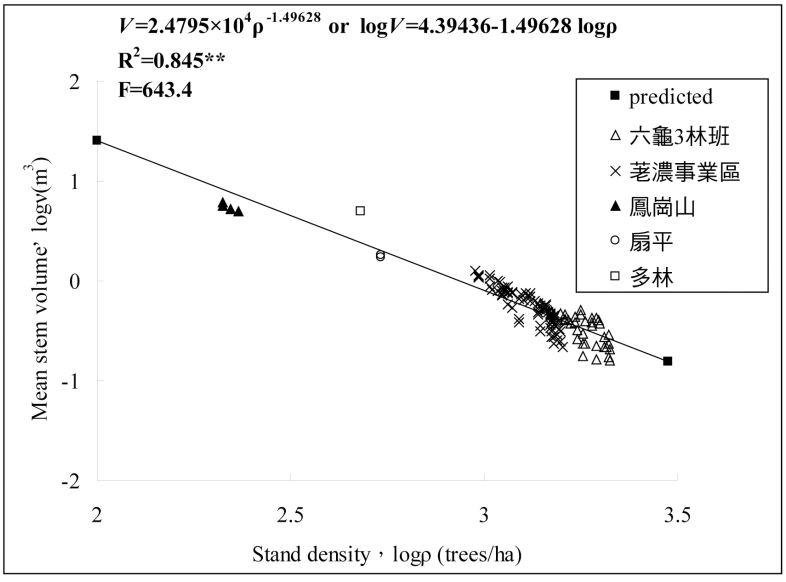
Studies on the growth different stand densities and self-thinning of Taiwania plantations

邱志明

Chin-Ming Chiu

為反應生態環境保護與自然資源保育之世界潮流，天然林之繼續禁伐仍為必然之趨勢，在此情況下，永續並集約經營現有人工林，使之成為林產物供應之主要來源，已成為林業經營上一項主要課題。臺灣杉為台灣最重要之造林樹種，目前林分大部分都已成林，均面臨隨著林木之生長，不同林齡林分最適密度之決定。因此，本試驗以臺灣南部歷年，經過不同疏伐處理(超過20年)，不同林分密度之樣區，除每木各項生長性狀調查外，並利用歷年生長資料及林齡超過70年之樣區資料，求算不同林齡之競爭密度效果、收穫密度效果實驗式，並藉發生自我疏伐之樣區求出林分最大密度曲線或自我疏伐曲線，求出林分最大密度或林分自我疏伐曲線 $V=2.4795\times10^{4}\rho^{-1.49628}$ 及林分密度與植株大小實驗式 $\log\rho=-1.615\log D+5.429$ (式中D、v及ρ分別代表林分平均直徑、單株材積及林分每公頃株樹)。結果可做為臺灣杉人工林決定不同林齡，林分密度、胸徑，以生產質與量俱佳林分之重要參據。

Protection of ecological environments and conservation of natural resources are the current global trend. Therefore, banning cutting of natural forests is still a continuing tendency. Under the circumstances, it is important that sustainable and intensive management of man-made forests through silvicultural and genetic manipulations should render them to be the main emerging provider s of forest products. Taiwania is one of the most important afforestation species in Taiwan and currently, the canopies of these plantations have already closed generating certain problems. Those problems have annoyed forestry agencies, such as, with increasing stand age, how to determine optimum numbers of standing trees per unit area and how to improve wood properties of the plantations. Therefore, we've select experimental sites in experimental plots for different thinning densities of Taiwania plantations in southern Taiwan. The different stand densities were last thinned more than 20 years ago. We also investigated temporal plots with Taiwania plantations is over 70 yr-old. We measured the growth of each tree for the stand densities. Moreover, the reciprocal equation of the competition-density effect, the yield-density effect, and the full-density curve or self-thinning curve was derived from the past 20 years' growth data after treatment. An equation, $V=2.4795\times10^{4}\rho^{-1.49628}$ was obtained, Equation of the relationship between stand density and tree diameter was found to be $\log\rho=-1.615\log D+5.429$, where D, V and ρ denoted the average DBH of stands, the mean stem volume per tree and the stand density per hectare, respectively.. The results could be used as a useful reference for tending practices of Taiwania plantations to control stand density at various age, DBH and to produce the both good qualitative and quantitative growth.



臺灣杉人工林發生自我疏伐之永久樣區實測值和最大密度漸近線。

Plot measurements and asymptote of the maximum size density for *Taiwania cryptomerioides* plantations for plots in which self-thinning occurred.

臺灣穗花杉胚胎發育與種子休眠性之研究

鍾振德

臺灣穗花杉僅分布於臺灣本島南端，由於族群稀少，被列為積極保育之本土樹種。臺灣穗花杉由於族群稀少有性生殖能力薄弱，使得種子產生不易。過去兩年研究已完成誘導花芽分化，以及完成生殖系統胚胎發育之解剖觀察。利用枝條環狀剝皮處理，環狀剝皮1.0 cm寬，誘導100%臺灣穗花杉花芽分化。另外對29株盆缽植株，進行有性生殖觀察，包括花粉與胚珠發育、授粉、授精以及胚胎之發育。雄毬在3月中旬結束休眠，小孢子形成於3月底漸漸發育成熟。成熟花粉大小約25 μm。雌毬在3月底結束休眠，胚珠裸露後不久即分泌授粉滴。約在4月初開始授粉，授粉期約1~2星期。大孢子於3月底開始逐漸發育，此時雌配子體尚未成熟，直到6月初成熟時才完成授精。當種子成熟掉落時，胚還未發育完成，而且發現同時間人工授粉，但種子的成熟時間卻從授粉後隔年的4月一直到12月。胚未成熟發育應該是主因，因此後續將聚焦種子生理與胚休眠之研究，探討解除胚休眠的過程中，荷爾蒙(包括激勃素、細胞分裂素、離層酸與IAA等等)之代謝變化。這個計畫的目標，研究臺灣穗花杉生殖生物學之知識，解決臺灣穗花杉生殖之困境，增加飽滿種子之生產。

臺灣穗花杉種子深度休眠，需經暖低溫層積處理後發芽。
Seeds of *A. formosana* have the deep dormancy; thus, warm stratification followed by cold stratification and then warm-temperature incubation are required for germination.

Study of embryo development and seed dormancy in *Amentotaxus formosana*

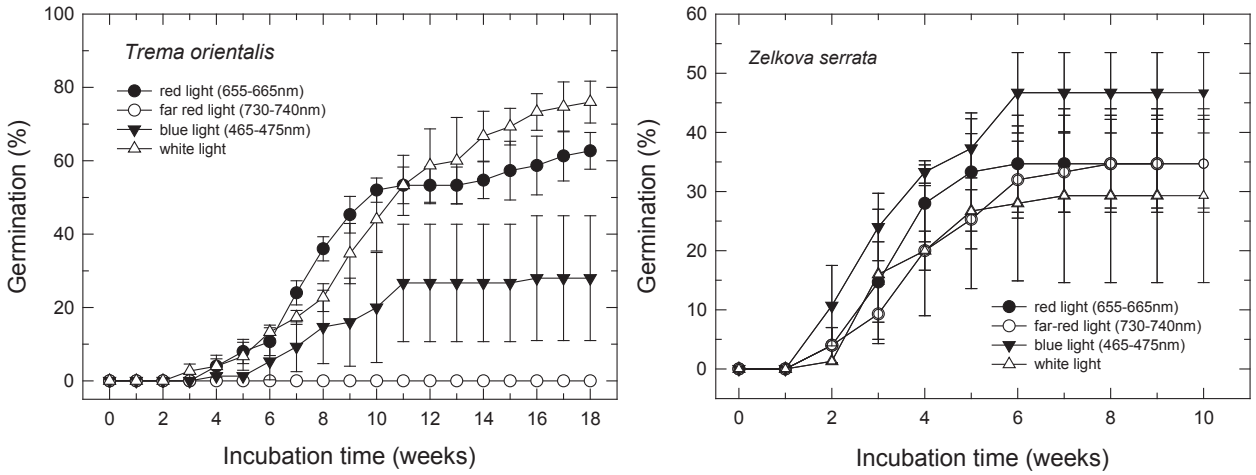
Jeng-Der Chung

Amentotaxus formosana is an indigenous tree native only in southern Taiwan. It is listed as a protected species by the Taiwan government due to the scarcity of populations and low seed production. For the last two years we have been working to achieve the goal of enhancing flowering bud initiation and accomplishing the anatomical survey of reproductive system of *A. formosana*. By using a girdling device to remove a 1.0 cm wide ring, the flower bud differentiation was consistent with all container-grown cultivars achieving 100% induction. Furthermore, the survey of reproductive system counted approximately 128 individuals including pollen and ovule development, pollination, fertilization as well as embryo development. Pollen cones ended dormancy in middle-March, microsporogenesis occurred in late March. Mature dry pollen was about 25 μm in diameter. The seed cones ended dormancy at the end of March, opened and exposing the ovules, soon after secreted pollination drops. Pollination occurred for about 1~2 week in early April. Megasporogenesis occurred in late March but female gametophytes did not mature and fertilization until early June. Embryos are not well developed when the seeds mature and shed. Thus, we found that the timing of seed maturity is probably from March to August of next year, even at the same time by hand-pollination. Therefore, the following topic is dedicated to researching seed physiology and embryo dormancy. Understanding the metabolic changes in phytohormones (including GAs, cytokinin, ABA, IAA etc) in breaking embryo dormancy is one of the goals of this project. To sum up, the goal of this study is to provide methods to increase cone and filled seed production.

光對林木種子發芽和生理反應之研究

簡慶德

種子發芽是種子受到外在環境因子的刺激，如水分、溫度和光，增加胚生長潛力，突破種皮發芽。光敏素(Phytochrome)是一群光接受者(Photoreceptor)，扮演種子感受光源誘導發芽。一般影響種子發芽的光譜區域在660-730nm間，波長660-670nm的紅光可以促進種子的發芽，而波長730nm的遠紅光有抑制作用。研究本土木本植物種子在紅光、紅外光、藍光、白光下發芽百分率，結果顯示構樹種子在紅光下發芽率最高43%，白光32%次之，但紅外光抑制種子發芽。烏桕種子在紅光刺激下發芽，其發芽率43%最高，紅外光和白光抑制種子發芽。車桑子和櫸木種子在任何光質環境下都可發芽；山黃麻和野桐種子以白光發芽率最佳，紅光次之，紅外光抑制此2種種子發芽。九芎種子除了紅外光不發芽外，其他光皆可發芽。因此，以上除了烏桕種子在全光下不利於發芽外，其他6種樹木種子皆可在空曠林地發芽生長，符合先趨樹種的條件。車桑子和櫸木種子可在紅外光下發芽，認為林下天然更新是可行的，然種子發芽後小苗生長期間仍需要陽光。研究山黃麻種子休眠性與植物荷爾蒙離層酸和激勃素關係，發現種子休眠性並非來自抑制物質離層酸，因為新鮮種子和5℃層積處理後的種子離層酸濃度皆低，且種子內激勃素濃度變化不大，山黃麻種子休眠性有待進一步研究。



山黃麻和櫸木新鮮種子在紅光、紅外光、藍光、白光下之累積發芽百分率。種子放在25/15℃變溫箱發芽。
Accumulative germination of *Trema orientalis* and *Zelkova serrata* fresh seeds incubated at red light, far-red light, blue light and white light (full light).

Study of light on seed germination and physiological responses

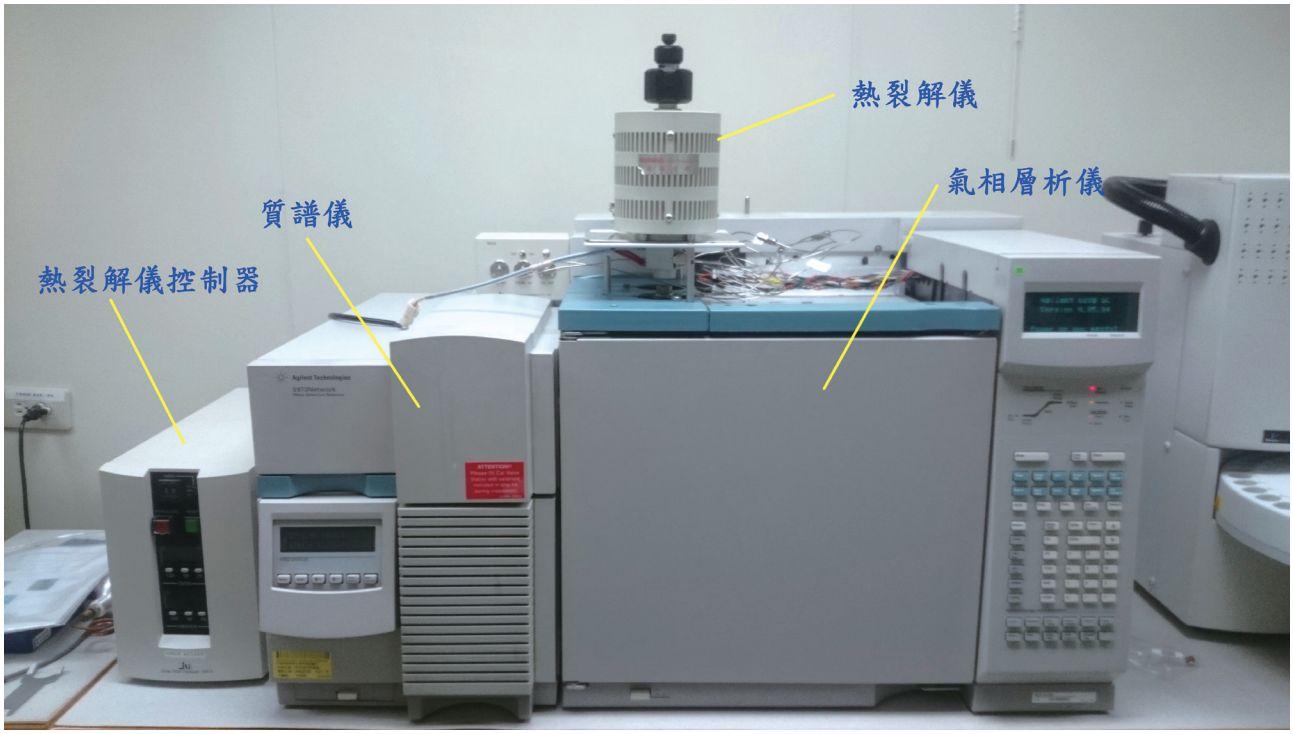
Ching-Te Chien

Seed stimulated by environmental factors, such as water, temperature and light, increased embryo growth potential, and finally germinates. Phytochromes, a class of photoreceptors, play an important role in perceiving light to induce seed germination. In general, the wavelengths of light that affect seed germination were between 660 nm to 730 nm. Red light (wavelength 660-670 nm) promoted seed germination and far-red light (730 nm) inhibited seed germination. Seed germination of seven woody species was studied when they were exposed to red light, far-red light, blue light and white light. Results showed that seeds of *Broussonetia papyrifera* germinated to 43% under red light and to 32% under white light, but far-red light prevented seed germination. Red light has been shown to stimulate seeds of *Sapium sebiferum* to germinate, but far-red light and white light inhibited seed germination. Seeds of *Dodonaea viscose* and *Zelkova serrata* could germinate under red light, far-red light, blue light and white light. During incubation under white light, seeds of *Trema orientalis* and *Mallotus japonicus* germinated to the highest percentage. Seeds of *Lagerstroemia subcostata* could germinate under red light, blue light and white light except for the far-red light. Except for *S. sebiferum* seeds that are unable to germinate under white light, the other 6 species mentioned above can germinate on the open lands, which is consistent with these species being pioneer and shade tolerant. Seeds of *Dodonaea viscose* and *Zelkova serrata* were able to germinate under far-red light and the natural regeneration in forests for the two species are feasible. However, sun light for seedlings growth is required after seeds germinated. Plant hormone ABA of *T. orientalis* seeds was analyzed and found that the seed dormancy was not related to ABA compound, because the concentrations of ABA were low between fresh seeds and cold stratified seeds. Further, concentrations of $GA_{1, 3, 4, 7, 20}$ in fresh seeds and cold stratified seeds were low and there was no significant increase in the cold stratified seeds. Identification of the precise dormancy in *T. orientalis* seeds requires further study.

熱裂解氣相層析質譜儀(Py-GC-MS)應用於漿料化學組成分析之研究

何振隆

本研究即為以柳杉(*Cryptomeria japonica*)及桉樹(*Eucalyptus* spp.)等材料，以四氫呋喃醇(tetrahydrofurfuryl alcohol, THFA)製漿法予以製漿，探討各漿料之特性。另以上述二樹種及稻草(rice straw)等漿料，利用熱裂解氣相層析質譜儀(pyrolysis-gas chromatography-mass spectrometer, Py-GC-MS)之三甲基苯胺(trimethylanilinium hydroxide, TMAH)衍生化方法，建立於漿料中之木質素含量分析。於桉樹及柳杉之四氫呋喃醇有機溶劑製漿性質中，所得漿料之卡巴值及收率，均隨著四氫呋喃醇及催化劑鹽酸(HCl)添加量濃度增高，其卡巴值及收率均呈現降低趨勢，此二樹種中，以桉樹所得漿料之卡巴值及收率為最佳；此四氫呋喃醇有機溶劑製漿蒸煮系統中，主要為攻擊木質素及溶解半纖維素，於蒸煮初期脫木質素效率高，且脫木質素效率為隨催化劑鹽酸濃度增加，脫木質素效率愈高，而二樹種中以桉樹脫木質素效率較佳。再者，以Py-GC-MS之三甲基苯胺衍生化後建立木質素含量測定法中，於面積百分率法及裂解化合物之感應因子(response factor)等二方法，其與傳統試驗方法所得之木質素含量進行迴歸比較，所得r值均大於0.95以上，其中以感應因子方法之r值為大於0.99以上，顯示此二方法，均可應用於木質素含量測定，但以利用感應因子方法較佳。

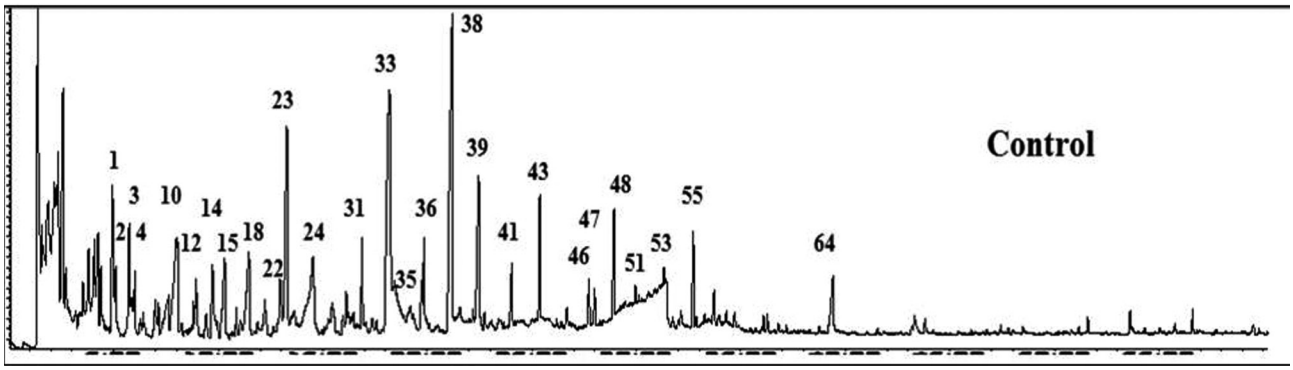


熱裂解氣相層析質譜儀各諸元設備。
The component units of Py-GC-MS.

Study of chemical compositions of pulps using pyrolysis-gas chromatography-mass spectroscopy (Py-GC-MS)

Chen-Lung Ho

This study examined the pulping characteristics of Japan cedar (*Cryptomeria japonica*) and *Eucalyptus* sp. using a tetrahydrofurfuryl alcohol (THFA) organosolv system. Moreover, pyrolysis-gas chromatography-mass spectrometer (Py-GC-MS) of trimethylanilinium hydroxide (TMAH) derivatized samples were assayed to determine the lignin content of THFA pulps from *Cryptomeria japonica*, *Eucalyptus* sp.and rice straw, respectively. With respect to the THFA pulps of eucalyptus and Japan cedar, the pulp kappa number and yield tended to decrease with increasing THFA and catalyst concentrations. Of the two materials, eucalyptus produced better kappa number and yield. In the THFA organosolv pulping system, the liquor mainly degrades lignin and dissolves hemicellulose with an exceptionally high delignification rate at the initial stage of pulping. In addition, the delignification rate increased with increasing catalyst, HCl, concentration. Furthermore, Py-GC-MS lignin content determination of TMAH derivatized pulps using either areal percentage or response factor of the pyrolyzates methods produced results having *r*-value > 0.95 when regressed with the results of traditional lignin content determination method. However, the response factor method generated *r*-value > 0.99. Thus, of the two methods of lignin content determination, the response factor was deemed a better method.



稻草之熱裂解氣相層析圖。
Py-GC-MS chromatograms of rice straw.

傳統生態智慧對民族生物的運用與管理—ICCA在蘭嶼的社區保育

董景生、陳科廷

仟禧年後，世界自然保育聯盟(IUCN)認定原住民族與在地社區在生物多樣性保育上的重要性，大力推動原住民社區保育區(ICCAs)構想，創造原住民族社群參與保護區的管道，由在地社群進行志願性的保育，透過原住民族的慣習或其他有效方法來管理，蘊含社會組織與傳統生態知識的概念。本計畫在ICCAs 群組計畫目標下，針對蘭嶼島上的達悟族原住民以參與式調查，逐年區分不同性別的社會生活領域，藉由歷史文獻回顧、焦點和團體訪談以及工作坊，紀錄在地傳統生態知識，整合管理者一土地一管理策略三個面向，配合子計畫的物種監測，找尋傳統生態智慧的現代生物學意義與限制。最後配合子計畫的體制建構、營運模式分析，從傳統知識中找尋符合社區保育原則的管理策略。蘭嶼島上的達悟民族自古以來利用多樣的植物、動物及海洋資源，發展出特有的雅美文化，日常的食、衣、住、行、祭典等傳統文化，皆與森林和海洋緊密結合，高度分化的民族生物運用特質，適足以符合ICCAs 的典範。在兼顧社區意識的自主監測管理下，透過傳統生態知識和管理系統的建構，紀錄水芋田、森林、濱水帶海域之民族生物知識，有助於達悟族社會生活場域之生物多樣性的永續經營管理。

婦女傳承傳統生態智慧選植好草留於田間，減少雜草的生長。
Following the traditional ecological knowledge, the “beneficial” plants are kept to replace weeds in the same fields by women.

Utilization of traditional ecological knowledge in ethnobiological resources conservation – a case study of ICCA (Indigenous and Community Conserved Area) community-based conservation in Orchid Island

Gene-Sheng Tung, Ke-Ting Chen

Since the year 2000, the International Union for Conservation of Nature (IUCN) has recognized the important role of indigenous peoples and local communities on biodiversity conservation. The IUCN promotes the concept of Indigenous & Community Conserved Areas (ICCAs) which provides indigenous communities the opportunity to participate in the conservation of protected areas. In this kind of grassroots conservation, local people utilize their traditional customs and other effective practices in natural resource management, which embody the local social structure and traditional ecological knowledge. The aim of this study is to explore the meanings and limitations of traditional ecological knowledge of Tao (Yami) people on Lanyu island in the realm of modern biological science and its applicability in the community-based conservation regime through reference review, focus group, workshop and participatory research on Tao people's social life and their traditional ecological knowledge along with a sub-plan of scientific species monitoring and the integrated analysis of the manager-land-policy dimensions and management regime building. Tao people on Lanyu island has been using the diverse natural resources of animals, plants and the ocean and have developed a unique nature-related Yami culture in all aspects of life which can be a paradigmatic example of ICCAs conservation strategy for its highly differentiated utilization of ethnobiological resources. With the respect to local community's autonomic management, we will record the knowledge of ethnobiology about the calla field, forests and tidal flat to construct TEK and management system. The work will be helpful for the sustainable management on biodiversity of Tao people.

好草 Beneficial plants
越橘葉蔓榕 Vaccinium fig (*Begonia fenicis* Merr.)

蘭嶼秋海棠
Lanyu begonia (*Ficus vaccinioides* Hemsl.&King)

中海拔人工林生態系永續經營及生物多樣性資源利用—中海拔人工林更新及環境與樹木生長及健康性關係之研究

林振榮

本子計畫目的在探究中海拔溪頭森林遊樂區環境與樹木健康關係之研究，以提供樹木管理政策之參考，本計畫從樹木外觀檢查及內部木質部的檢測作為樹木健康性的評估指標。結果得知可使用目視法檢查柳杉樹木外觀，依據樹木狀況及檢查目的，來評估樹木危險性及健康性的外觀指標。檢查樹木內部木質部狀況，採用不同的非破壞性技術，例如橫向打擊共振法、應力波斷面影像法、鑽孔抵抗法、樹芯取樣法、微破壞儀法、樹輪密度圖譜法的評估指標，建立健全柳杉樹木標準參考值，來檢查樹木的內部材質狀況。可使用應力波斷面影像法檢查腐朽受損的柳杉樹木，以橫向音速大小來評估樹幹橫斷面的劣化狀況。最後結合目視檢查及不同非破壞性技術檢測及評估柳杉危險性及健康性。初步結果得知中海拔森林的經營強度、頻率、人為干擾與樹木的健康性有關，為了營造良好的樹木健康性，需建立森林經營的目的及目標，採行樹木管理措施使維護樹木的健康性，以發揮樹木公益功能，具體健康影響因素待後2年繼續整合及收集資料完成。

樹木健全性檢查的目視樹木評估法及非破壞性技術
Inspection and assessment of growth and health in standing trees by visual tree assessment (VTA) and different nondestructive techniques (NDT)

方法Methods	評估參數Evaluated parameter
1. 目視評估法 (Visual tree assessment)	檢查表格 (Tree assessment form)
2. 應力波影像法 (Acoustic device 2D tomogram)	橫向應力速度 (Transversal acoustic velocity, m×sec^{-1})
3. 橫向打擊共振法 (Lateral impact vibration)	樹木直徑×共振頻率 (Diameter×Frequency, m×Hz)
4. 鑽孔抵抗法 (Drilling resistance method)	鑽孔抵抗值 (Drilling resistance value, %)
5. 生長錐法 (Increment borer)	目視樹芯法 (Observation of core by visual)
6. 微破壞壓縮強度法 (Fractometer)	縱向抗壓強度 (Green crushing strength, MPa))
7. 樹輪密度圖譜法 (X-ray wood density p4rofile)	九個樹輪寬度及密度特性 (Air dried ring width (mm) and density (g cm^{-3}))

Study on the relationship between the environment and tree health in the Xitou Nature Education Area

Cheng-Jung Lin

The purpose of this project was to explore the relationship between the environment and tree health in the Xitou Nature Education Area for providing reference to tree management policy. The study used visually inspection of Japanese cedar trees, and according to the conditions and inspection purposes, to assess the health of the trees and the risks of the appearance indicators. Using different nondestructive techniques such as Lateral impact vibration method, stress wave velocity 2D tomography, drilling resistance method, increment borer sampling, fractometer method, and X-ray ring density profile etc. to establish and improve standard reference values as evaluation indices of the Japanese cedar trees. These can then be used for checking the internal material condition of trees. Different nondestructive evaluated parameters could serve as indices of the diagnosis value. A table of standard values for the future use of these nondestructive methods when testing Japanese cedar trees with and without decay-damage is presented. The V tomogram and corresponding stress wave velocity maps of decay-damaged and undamaged Japanese cedar trees can detect the general location and area of wood deterioration. The proposed method can be combined with visual tree inspection and other non-destructive techniques to better examine and confirm the situations of trees for tree health assessment. Preliminary results indicated that tree health was affected by forest management intensity, the frequency, and human disturbance factors. Thus for tree health and tree public function targets, management objectives should be established based on the known indicator indices.

林木疫情監測及防治體系及重大病蟲害網路綜合管理研究

吳孟玲、莊鈴木

104年本計畫持續更新、維護、管理及開發農委會「林木疫情監測及防治體系」各網站系統。依體系分工架構協助林務局維護「林木疫情管制、策劃與防治中心」網站，擴充管理系統功能，以及強化林業試驗所「林木疫情鑑定與資訊中心」之網站功能，包括開放地圖範圍查詢、新增各縣市案件查詢及危害種類查詢等功能，並每日定時備份虛擬主機系統及網站資料庫，增加網站運作穩定及安全性，使二網站中心形成網狀聯繫，統合行政資源，協助落實國內林木疫情管制之效能。本計畫亦將「林木疫情鑑定與資訊中心」、「樹木褐根病調查通報系統」及「筆筒樹疫情監測網資訊網」三網站彙整於統一資料庫，提升資料整合查詢、分析之效能，並將褐根病檢疫及林木非破壞性檢測等服務新增至「林木疫情鑑定與資訊中心」服務項目內，104年1月1日累計至104年12月31日，受理林木疫情之通報案件共計1,742件。整合「樹木醫學中心」與「林木疫情監測及防治體系」網絡及服務業務，持續開發樹木醫學中心相關網絡服務系統，並辦理樹醫座談會及研討會共計2場，針對各縣市政府業務相關人員，持續辦理「林木疫情監測及防治體系」網站教育訓練課程共計20場，以利防疫工作之推展。

樹木注射示範。
Tree injection demonstration.

Research on forest epidemic diseases monitoring and prevention system

Meng-Ling Wu, Ling-Mu Jaung

This project provides continuous update, maintenance, management and development of “Forest Epidemic Diseases Monitoring and Prevention Systems”. According to the system architecture division, we assistedForestry Bureau to maintain the website of “Forest disease & pests control, planning and prevention center”, to expand managing functions, as well as to strengthen availability of the website, “Diagnosis and information center of forest diseases and pests”.

Accessible contents include search functions by regions of open maps, cases of individual counties and various problem types. Besides, daily scheduled backups of virtual host systems and website database are executed to increase stability and safety for website operation. The two website centers are connected to form a network, by integration of administrative resources to help improve the pest control efficiency of domestic forests.

The project combined “Forest disease & pests control, planning and prevention center”, “Brown root rot investigation system” and “Fern trees disease monitoring system” to establish a unified database for improvement of query data integration and performance analysis. The brown root disease quarantine and non-destructive detection techniques are added as new services of “Forest disease & pests control, planning and prevention center”. In the past year 1,742 cases were registered and accepted.

We integrated “Tree medical center” with “Forest disease & pests control, planning and prevention center” and provide other extensive services. Also we conducted 2 tree medicine symposium and conference and 20 training courses for local authorities, to urge the progression of epidemic prevention and control.

2015

Annual Report

參

附錄

Appendix

104年度 1月–12月

1 JAN

- 本所於1月6日在總所舉辦「民營林業與森林認證研討會」，會中針對國內民營林業的經營結構與挑戰從制度面與實務面進行檢討。除了邀請國立中興大學森林系榮譽教授羅紹麟博士主講「臺灣民營林業問題分析」外，並邀請國際FSC™森林認證組織亞太地區總監Alistair Monument先生發表「與臺灣林業共同改變全球林業－FSC森林驗證制度」的演講，共計130人參加。
- 黃裕星所長於1月6日在總所主持臺灣地區首張國際FSC™森林管理驗證系統合格證書之授證典禮，證書得主是國有林的租地造林業者正昌製材有限公司，由梁兆清董事長親自領證。頒證人是必維國際檢驗集團大中華地區總監Hubert De-Bonafos先生。觀禮貴賓包括：行政院農業委員會陳保基主任委員、國際森林認證組織FSC™亞太地區總監Alistair Monument先生、臺灣森林認證發展協會劉炯錫理事長等人。此張證書的誕生是本所與臺灣森林認證發展協會合作輔導成功的首例，代表臺灣林業的經營管理已邁入國際標準的永續管理新時代。

2 FEB

- 恆春研究中心轄管的港口白榕園因李安執導「少年PI的奇幻漂流」一片而聲名大噪，有鑑於開放參觀白榕園的要求不斷，經該中心、墾丁國家公園管理處與港口社區發展協會多次協商後，在兼顧自然保育、環境教育與推動地方生態旅遊的原則下，自2月6日起一連3天，試辦以每天60人為限的有條件開放導覽，據以評估長期開放入園的可行性。

3 MAR

- 本所於3月9日邀請義大利都靈理工大學(Politecnico di Torino)客座教授，也是「藍色經濟」概念的創始人Gunter Pauli教授，在總所以「生物經濟—森林是經濟發展和工業復甦的基石(The bio-based economy – How forests are the basis of an economic and industrial revival)」為題發表演說，共有140人參加。
- 中埔研究中心黃正良主任獲選為104年度林業及自然保育有功人士，於3月12日植樹節當天在林務局接受公開表揚。
- 恆春熱帶植物園志工團於3月19日至21日前往合歡山森林遊樂區、奧萬大國家森林遊樂區、東勢林區管理處等地舉辦戶外訓練，共有22人參加。
- 技術服務組於3月25日在總所舉辦「104年度第一次資料庫教育訓練」，共有25人參加。

4 APR

- 黃裕星所長於4月1日在蓮華池研究中心主持「蓮華池研究中心推動森林驗證座談會」，邀請國內推動森林驗證的專家解說森林驗證的相關內容與流程，以期該中心能成為國內第一個通過森林驗證的國有林經營者，共有30人參加。
- 法務部廉政署廉政人員訓練班第34期學員一行12人，於4月10日至木材纖維組紙張樣品陳列室參觀。
- 本所與臺灣都市林健康美化協會及臺灣大學園藝暨景觀學系於4月11日至5月23日在總所合辦「2015年第一屆樹藝學研習班」，共有72人參加。
- 彰化縣政府生態校園教師一行45人為參加「104年度十全十美生態校園外埠活動」，於4月17日至蓮華池研究中心參觀。

- 本所響應世界地球日宣言，於4月18日在台北植物園的南門町三二三舉辦「愛地球・做苔球」活動，教導民眾利用除草後的廢棄苔蘚與野草妝點成室內花飾，既能延續其生命，也能推廣環保理念。
- 美國竹會理事克里夫・蘇士曼(Cliff Sussman)先生於4月20日參訪台北植物園，由森林利用組林裕仁副研究員及竹類專家呂錦明博士陪同解說。
- 本所於4月28日在蓮華池研究中心舉辦「走出森林之詩歌及文化講習會」，藉由吟詩唸歌抒懷森林之美，進而珍惜森林資源並發揚森林文化。
- 泰國Kasetsart University森林學院(Faculty of Forestry)院長Chongrak Wachrinrat教授等一行5人，由國立東華大學自然資源管理學院夏禹九院長及張士杰教授陪同，於4月28日拜會本所，由黃裕星所長親自接待。

5 MAY

- 本所於5月1日至6月28日在台北植物園的欽差行臺舉辦「游藝之間—人工林撫育收穫創作成果展」，展出利用人工林撫育過程所留下的天然資材製作成的藝品，在賦予創新的價值後，能有效提升林農在造林期間的經濟收益。
- 六龜研究中心與恆春研究中心於5月2日至3日在扇平森林生態科學園合辦志工專業訓練課程，邀請國立中興大學曾彥學教授講解薑科植物的分類及月桃的特徵，志工們對於一次能夠認識全臺灣18種原生的月桃，並且在扇平就可以親眼目睹，咸感到課程安排用心，受益良多。
- 蓮華池研究中心於5月13日接待埔里鎮南光國小辦理「發現蓮華池－水資源、生態、林業、藥用植物」活動的教師，並分享推廣生態教育的心得。
- 蓮華池志工團於5月15日至16日赴桃園縣大溪鎮、滿月圓森林遊樂區等地辦理志工移地研習，共有28人參加。
- 本所創新育成中心於5月18日由農委會陳保基主任委員主持揭牌典禮，代表本所正式加入國內農業創新育成的行列，共同為「創新林業科技，育成產業商機」而努力。揭牌當日並有3家業者與本所簽署合作備忘錄，未來將陸續進駐該中心運作。
- 本所於5月22日在總所舉辦「2015森林集水區經營研討會」，共有93人參加。
- 本所與臺北市政府工務局公園路燈工程管理處、康寧大學、康寧醫護暨管理專科學校、台灣園藝福祉推廣協會等單位，於5月25日在康寧醫護暨管理專科學校合辦「2015園藝福祉與療癒國際研討會」。

6 JUNE

- 本所為活化利用台北植物園的南門町三二三空間並賦予人文氣息，自6月4日起至28日邀請蘇格蘭藝術家暨人類學家Jennifer Clarke在該館佈展，主題為「無形・物The Invisible Matters」，展出以園內植物為靈感的創作，以及插花演示的駐地創作。
- 蓮華池研究中心為協助埔里鎮南光國小辦理「發現蓮華池—水資源、生態、林業、藥用植物」活動，於6月10日及12日安排志工老師前往該校進行生態教育講座各1場，共有270位學童參加。
- 植物園組董景生組長、徐嘉君助理研究員與林謙佑助理研究員於6月15日在台北植物

園接待新加坡植物園助理園長王思平博士等一行8人，雙方就植物園保種與展示方式進行交流。

- 技術服務組於6月18日在總所舉辦「公益・環保・閱讀－第五屆二手書交換活動」，展出募得的書刊近900餘冊，共有60人參加。
- 蓮華池研究中心於6月27日在該中心舉辦「104年度第2季志工研習」活動。
- 森林保護組葛兆年副研究員為執行「都市鳥保育」研究，於6月29日至12月29日赴美國奧勒岡州波特蘭市世界林業中心（World Forestry Center）進行研習。

7 JULY

- 林國銓副所長率領育林組、森林利用組與技術服務組同仁，於7月1日在總所接待關島及北馬利安納群島邦議會領袖訪問團，成員包括關島議長旺帕(Judith Won Pat)及北馬副議長狄馬潘(Rafael S. Demapan)等7人。雙方就森林環境、林產業發展、綠能研究等議題進行討論。
- 本所與臺灣大學園藝暨景觀學系、台灣都市林健康美化協會於7月13日在總所合辦「都市林管理研討會」，特別邀請2位香港ISA的樹藝專家來臺分享經驗，同時ISA國際樹藝協會認證部長Kevin Martlage亦專程來臺頒授ISA的樹藝師證書。
- 本所與高雄市政府農業局、臺灣大學園藝暨景觀學系、台灣都市林健康美化協會於7月14日在高雄市政府舉辦「都市林管理研討會」，特別邀請2位香港ISA的樹藝專家來臺演講。
- 本所與高雄市六龜區公所及智冠科技文化藝術基金會合作，自7月18日起至10月18日止在扇平山莊舉辦「山林玩藝—小徑材設計創意展」。
- 本所於7月31日出席由農委會舉辦的「農業創新育成中心進駐廠商聯合畢業成果發表會」，會中有2家接受本所技轉的業者參與展出，其技術分別為育林組簡慶德研究員的「臺灣原生優良檫樹品系及其栽培技術」，以及森林化學組洪昆源助理研究員的「高效天然防蚊配方」。

8 AUG

- 森林經營組邱志明組長於8月6日赴金門縣政府林務所，為該縣管理行道樹之人員講授「樹木風險危木判定與目視評估培訓課程」，並在林務所的植物園內進行樹木風險評估及處置建議等演練。
- 行政院農業委員會沙志一副主任委員率領本所黃裕星所長、森林保護組吳孟玲組長及林務局官員等人，於8月7日出席在大陸地區哈爾濱市舉辦的「2015兩岸林業論壇」。黃所長並在會中發表「應對氣候變遷之山村林業發展課題」演講，吳組長另發表「都市林生態服務與樹木療癒規劃」演講。
- 大陸地區福建農林大學森林學院陳世品副院長由國立宜蘭大學森林暨自然資源學系林世宗教授陪同，於8月12日至13日前往蓮華池研究中心拜會，由許原瑞主任及許俊凱助理研究員接待導覽。
- 林業經濟組林俊成組長獲選為第39屆全國十大傑出農業專家，並於8月15日在國際同濟會臺灣總會第41屆全國年會中接受公開表揚。
- 技術服務組張勵婉助理研究員於8月15日至22日前往南非開普敦市，出席2015年「國

際圖書館協會與機構聯盟(International Federation of Library Associations and Institutions; IFLA)」年會，以觀摩各國圖書館之經營績效，並將本所歷年來之圖書典藏、古籍修復等成果與各國分享並進一步請益。

- 恆春研究中心於8月22日至23日在恆春熱帶植物園舉辦「南島風情趣」親子闖關活動，共有400人參加。
- 六龜研究中心沈勇強主任於8月25日晚間不幸驟逝，故舊同仁咸感震驚與不捨。沈主任於民國74年以計畫助理之職進入本所，歷任助理、助理研究員、副研究員等職，是本所研究森林蛾類的專家。其先後擔任中埔、恆春、六龜等研究中心主任，畢生所學盡奉獻予本所，令人感懷。
- 黃裕星所長、太麻里研究中心劉一新主任、森林利用組林裕仁副研究員等3人，獲得國科會科發基金補助，為執行「友善環境之木竹材採運機械與作業道規劃技術研究」計畫，於8月27日至9月4日赴芬蘭赫爾辛基(Helsinki)，考察歐盟(芬蘭)私有林政策與機械化收穫技術，以借鏡其推動友善環境林木收穫之永續利用經驗，提高我國國產材之自給率。

9 SEP

- 本所邀請插畫家鄭培哲先生自9月1日至27日於台北植物園的南門町三二三舉辦「二十四節氣與生活插畫展」，介紹各節氣當季或適宜的食材，以及專屬於台北植物園的節氣植物地圖。
- 技術服務組陳燕章組長於9月4日至18日前往南非共和國德班，參加聯合國糧食暨農業組織(Food and Agriculture Organization; FAO)舉辦之「第14屆世界林業大會(The XIV World Forestry Congress; WFC)」，藉以瞭解全球的森林現況，並觀摩先進國家林業研究之最新發展，尤其是日趨嚴重的全球氣候變遷問題。
- 技術服務組於9月9日在總所舉辦「104年度第二次資料庫教育訓練」，共有24人參加。
- 立法委員葉津鈴女士於9月16日蒞臨六龜研究中心及扇平森林生態科學園考察，由黃裕星所長率同陳永修主任、周富三特聘研究員等人接待與簡報。
- 技術服務組陳燕章組長於9月19日至26日前往馬來西亞吉隆坡，參加「亞太地區林業研究機構聯盟(Asia Pacific Association of Forestry Research Institutions; APAFRI)第七屆會員大會」，以期有效執行並維護本所在APAFRI之會員權益。經陳組長於20日出席會員大會並積極參選執行委員會之委員後，已順利獲選為執行委員。嗣後再參加馬來西亞跨機關共同舉辦之「2015國際科學與自然大會」，並於會後參訪吉隆坡植物園及馬來西亞森林研究所。
- 蓮華池研究中心於9月21日在該中心舉辦「104年度第3季志工暨員工生態研習」。

10 OCT

- 「2015年臺北國際發明展暨技術交易展—農業館」於10月1日至3日在臺北世貿一館盛大展出。本所參展的技術包括：育林組何政坤組長的「肉桂醛型土肉桂繁殖與肉桂醛及黃酮類生產利用技術」，以及森林保護組傅春旭副研究員的「山葵健康種子的生產技術」。而在成功落實商品化的參展業者部分，與本所相關的技轉業者包括：森林化學組洪昆源助理研究員「高效天然防蚊配方」之技轉廠商，以及林業經濟組王培蓉副研究員「木藝創作組裝材料包及成品」之技轉廠商。

- 為提升臺灣森林經營的作業效率，本所邀請日本作業道施作專家一岡橋清元會長於10月5日至總所舉辦「友善環境作業道施作要領」講習，共有30人參加。另為落實作業道規劃及路基邊坡的鋪設要領，岡橋會長於10月7日再赴蓮華池研究中心辦理上述講習的實務訓練，亦有30人參與。
- 以「垂直花園」建築工法聞名的法國植物學家兼藝術家一派屈克．布朗克(Patrick Blanc)以及法國知名歌手Pascal Héni等2人，由前文建會主委陳郁秀女士陪同於10月7日參觀恆春熱帶植物園，由林照松主任率領同仁接待導覽。
- 森林保護組吳孟玲組長、植物園組董景生組長及育林組陳財輝研究員等3人於10月19日至23日前往日本琉球，拜會森林資源研究中心、沖繩縣森林協會等單位，並針對琉球松遭松材線蟲危害、刺桐遭刺桐釉小蜂危害、林木育種瓊崖海棠抗風精英樹之選拔合作研究，以及琉球松抗耐品系之選育等議題進行交流。
- 蓮華池研究中心為協助埔里鎮南光國小辦理「發現蓮華池－水資源、生態、林業、藥用植物」活動，於10月19日至23日安排9位志工老師前往該校介紹「蓮華池生態展」之相關內容，共約900位師生參加。
- 技術服務組於10月20日在總所舉辦「104年度國際農業數位知識交流網絡平台系統」教育訓練。
- 由本所、臺灣義田協會及李萬財先生合辦的「藝術家具生活器物展－李萬財創作展」，自104年10月21日起至105年2月28日止在台北植物園的欽差行臺展出。透過陳列製作精美的手工木家具以及5場專題講座，民眾更能瞭解到木製家具的可貴與木藝文化的精湛。
- 生長於日本鹿兒島的田代安定先生是恆春熱帶植物園百年前的建園推手，在臺灣貢獻良多。鹿兒島民俗學會會員名越護先生夫婦為蒐集田代安定先生在臺灣的史料，於10月26日至28日專程拜會恆春研究中心，由林照松主任及呂錦明博士接待解說。

11 NOV

- 本所於11月2日在總所舉辦「2015年森林驗證與打擊非法木材貿易研討會」，邀請到歐盟森林法執行、治理和貿易駐亞洲辦公室(EUFLEGT in Asia)官員Vincent van den Berk先生、必維國際檢驗集團大中華地區總監Hubert De-Bonafos先生、國際FSC森林認證組織日本辦公室代表Chisato Tomimura女士、臺灣區木材輸出業同業公會許庚龍理事長、國立臺灣大學森林環境暨資源學系王松永名譽教授等專家參與討論，共有128人參加。
- 黃裕星所長於11月2日在總所主持臺灣地區第二張國際FSC™森林管理驗證系統合格證書之授證典禮，證書得主是永在林業股份有限公司，由蔡瑞鴻董事長親自領證。頒證人是必維國際檢驗集團大中華地區總監Hubert De-Bonafos先生。觀禮貴賓包括：行政院農業委員會陳保基主任委員、國際森林認證組織FSC™亞太地區代表Chisato Tomimura女士、台灣森林認證發展協會劉炯錫理事長等人。
- 本所邀請美國加州的藝術家張昀叡(Fiona Yun-Jui Chang)與維多利亞．馬汀(Victoria Martin)於11月2日至29日在台北植物園的南門町三二三舉辦「Present」異文化聯展。藝術家以兩棟座落於台北植物園及南加州杭廷頓植物園的日式建築為出發點，展出以異文化交流為主題的作品。

- 吳俊賢主任秘書率領集水區經營組黃瓊璁組長、技術服務組陳燕章組長於11月11日上午視察太麻里研究中心依麻林道主線的2處大面積崩塌地，下午視察依麻林道支線及其他試驗地、造林地之作業道。翌(12)日並拜會水土保持局臺東分局，對於該分局協助修復依麻林道深致謝意。
- 本所與臺北市政府工務局於11月11日在總所舉辦「2015都市林管理國際研討會—防颱前準備及災後復建」，會中邀請到日本東京都主管綠化的專家山本正美先生介紹東京都的綠化策略及作法；同時請到澳洲的綠化專家Ben Gooden介紹如何將現有行道樹樹穴擴大的工法。

12 DEC

- 六龜研究中心於12月5日安排6位志工老師前往高雄市六龜區龍興國小第50屆校慶園遊會現場，擺設「種子好好玩」的闖關遊戲，藉以推廣植物種子形態和傳播的相關知識。
- 蓮華池研究中心與本所油茶團隊於12月5日至6日赴國立臺灣大學實驗林管理處溪頭營林區，出席「第14屆竹文化節－優質森林文化創意推廣活動」，並宣導「找好油－油茶生態」的展示內容。
- 蓮華池研究中心於12月12日在該中心舉辦「104年度第四季研習暨志工年會」，共有32人參加。會中選出105年度志工團幹部，並討論來年的研習課程與研習地點。
- 蓮華池研究中心與林業經濟組於12月17日至18日在該中心合辦「小徑材加工利用工作坊」，邀請國立嘉義大學木質材料與設計系蘇文清教授與二位研究生蒞臨指導木藝加工技巧，共有57人參加。
- 本所邀請日本當代藝術家川松康德(Yasunori Kawamatsu)、山本信幸(Nobuyuki Yamamoto)與大崎宣之(Nobuyuki Osaki)等3人，於12月19日至31日在台北植物園的南門町三二三展出「TAIPEIdabada」，以「媒介」（medium）為主要概念，透過渠等的錄像及駐地繪畫作品，探究潛意識發生的可能性。
- 本所在過去10年間積極協助經濟部加工出口區中港分處，將所轄的海埔新生地營造為多層次的海岸林，使得中港加工出口區能成為中臺灣濱海型綠美化的示範區。中埔研究中心傅昭憲主任於12月24日獲邀出席該分處的綠美化成果展示記者會，除代表本所領取綠化有功的感謝狀外，並進行綠美化的成果簡報。
- 蓮華池研究中心與本所油茶團隊於12月25日至27日赴國立中興大學實驗林管理處惠蓀林場，出席「亮點好茶在惠蓀－2016希望之樹暨茶產業文化節活動」，並宣導「找好油—油茶生態」的展示內容。

Major events

JANUARY–DECEMBER 2015

JANUARY

- On Jan. 6th, a "Seminar On Private Forestry and Forest Certification" was held at the TFRI headquarter. The seminar proceeded to review the structures and challenges of domestic private forestry from policy and practical aspects. In addition to inviting the honorary professor Shau-ling Lo of the National Chung-Hsing University to give a keynote speech on "Problem analysis of the private forestry in Taiwan," Mr. Alistair Monument, Asia-Pacific Regional Superintendent of the international FSC™ Forest Certification Organization was also invited to give a speech on "Changing the global forestry together with Taiwan Foresters—The FSC forest certification system." A total of 130 people attended.

- On Jan. 6th, the Director General Dr. Star YS Huang hosted the qualifying certification awarding ceremony of the first FSC™ forest management certification system. The certificate was awarded to Jang Chang Lumber Industry Ltd., a leasing and afforestation practitioner of national forest, and received by Mr. Chau-Ching Liang, company chairman. The Certificate was bestowed by Mr. Hubert De-Bonafos, Superintendent of the Greater China Region, the Bureau Veritas Group. Among the honorary guests attending were Dr. Bao-Ji Chen, Minister of Agriculture, Mr. Alistair Monument, Asia-Pacific Regional Superintendent of international FSC™ Forest Certification Organization, and Mr. Jon-Shi Liu, President of Taiwan Forest Certification Development Organization. The birth of the certificate was the first case of successful guidance by the TFRI and Taiwan Forest Certification Development Organization, and demonstrated that forest management of Taiwan forests has made stride to enter the new era of sustainable management demanded by the international standard.

FEBRUARY

- The white bark fig garden at Gangkou, administrated by Heng-chun Research Center has become famous due to its appearance in the "Life of Pi," a movie directed by Ang Lee. Besieged by constant requests to visit the garden, the Research Center, Kenting National Park Administration, and Gangkou Community Development Association, after several negotiations has reached a conditional guided tour agreement that took care the principles of of natural conservation, environmental education, and promoting local ecotourism. The garden would be open on Feb. 6th for 3 days for public visiting with a daily quota of 60 persons, so as to evaluate the feasibility of long-term garden opening.

MARCH

- On March 9th, the TFRI invited Prof. Gunter Pauli, visiting professor at Politecnico di Torino University, and the originator of "blue economy" to give a speech entitled "The bio-based economy—how forests are the basis of an economic and industrial revival." A total of 140 persons attended.

- Dr. Cheng-liang Huang, Chief of the Chung-pu Research Center, was awarded as a honoree of the annual forestry and natural conservation contributions for 2015. He received a public lauding on March 12th, the arbor day, at Taiwan Forestry Bureau.

- The Volunteer Corps of the Hengchun Tropical Botanical Garden visited the Houhan Mountain Forest Recreational Area, Aowanda National Forest Recreation Park, and Dongshi Forestry Management District during March 19th to 21st for an outdoor training session. A total of 22 persons attended.

- On March 25th, the Division of Technical Services has hosted at the TFRI headquarter the "First Database Training Course of 2015," a total of 25 persons attended.

APRIL

- On April 1st, the Director General Dr. Star YS Huang hosted a roundtable discussion of "Promotion of Forest Certification at the Lienhwachih Research Center." Domestic experts on forest certifications were invited to present the pertinent contents and procedures in a hope that the research center could become the first manager of national forest to pass the hurdle and be certified. A total of 30 persons attended.

- Twelve students of the 34th Training Classes of Agency against Corruption, Ministry of Justice visited the Paper Exhibition Room of the Division of Wood Cellulose on April 10th.

- The TFRI, together with the Taiwan Urban Forest Health and Beautification Association and the Dept. Horticulture and Landscape, National Taiwan University hosted on April 11th and May 23rd the "2015 First Workshop of Arboriculture." A total of 72 persons attended.

- On April 17th, a group of 45 eco-campus teachers of Changhwa County visited the Lienhwachih Research Center as part of their "2015 best external eco-campuses activity."

- On April 18th, in a sponsorship of the Earth Day declaration, the TFRI hosted a "Love the Earth and Make Moss Balls" activity at 323 Nanmending within the Taipei Botanical Garden. The activity aimed to teach the public how to use the waste moss and grasses after lawn mowing to make indoor decorations, thus extending the life cycle of these materials while promoting environmental protection concept to the public.

- Mr. Cliff Sussman, a director of the Bamboo Asssociation USA, visited Taipei Botanical Garden on April 20th. Drs. Yu-jen Lin, associate researcher, Division of Forest Utilization, and Jing-ming Lu, a retired bamboo expert accompanied him for an interpretive guided tour.

- On April 28th, the Lienhwachih Research Center hosted a "Workshop of Poems and Culture Egression the Forest." Participants praised the beauty of forests by reading poems and songs and thus instilling a sense of treasuring the forest resources and promoting forest culture.

- On April 28th, Prof. Chongrak Wachrinrat, Dean of Faculty or Forestry, Kasetsart University, Thailand with 4 other colleagues and accompanied by Prof. and Dean Dr. Yu-jeo Shah and Prof. Shih-je Chang of College of Natural Resources Management, National Dong Hwa University. Director General Dr. Star YS Huang personally received the guests.

MAY

- From May 1st to June 28th, at the Imperial Envoy Lodging, Taipei Botanical Garden, an exhibition entitled "In-between the Play and Art-creative Arts Made of Harvested Materials from Tending of Man-made Forests." The exhibition displayed artifacts crafted from natural materials obtained from tending operations of man-made forests. Upon endowing with innovative values, the artworks could effectively increase potential incomes to forest farmers in the interim of afforestation.

- On May 2nd and 3rd, at the Shanping Forest Eco-science Park, the Liukuei and Hengchun Research Centers jointly hosted a volunteer professional training course. During which, Prof. Yen-shuei Tseng of National Chung Hsing University spoke about classifications of plants of Zingiberaceae, and particularly the characteristics of the *Alpina* genus. The volunteers were excited to be able to learn about all 18 species of endemic Alpina plants and see them all at Shanping. They were gratified to learn much from the excellently arranged course.

- On May 13th, the Lienhwachih Research Center hosted teachers of Nankuang Elementary School, Puli Township on their activity of "Discovering Lienhwachih—Water Resources, Ecology, Forestry, and Medicinal Plants." And shared their insight to ecological education.

- On May 15th and 16th, the Volunteer Corps of Lienhwachih Research Center went to Dashi Township and Manyueyuan Forest Recreational Area for a translocational study tour. A total of 28 persons attended.

- The Innovation and Incubation Center of TFRI officially opened on May 18th. Dr. Bao-ji Chen, Agriculture Minister presided. This marked that TFRI formally joined the rank of domestic agricultural innovation and incubation processes. The centers jointly strive for innovative forestry technologies and incubating for commercial opportunities. On the day of opening, 3 companies signed memoranda of cooperation with the TFRI and will start their operations at the center site.

- On May 22nd, the TFRI hosted the "2015 Forest Watershed Management Seminar." A total of 93 persons attended.

- On May 25th, together with Parks and Street Lights Office, Public Works Department, Taipei City Government; Kang Ning University; Kang Ning Nursing and Management College; Taiwan Horticultural Welfare Promotional Association; the TFRI co-hosted a "2015 Horticultural Welfare and Healing International Symposium," at the Kang Ning Nursing and Management College.

JUNE

- The TFRI in a bid to better use the space of Nanmending 323 inside Taipei Botanical Garden and to endow a cultural ambience, invited a Scottish artist and anthropologist Ms. Jennifer Clarke to arrange an exhibition entitled "The Invisible Matters" from June 4th to 28th. The exhibition was inspired by the plants in the botanical garden and included on-site flower arrangements.

- The Lienhwachih Research Center assisted Nankuang Elementary School in Puli Township on June 10th and 12th in providing volunteer teachers to the school and giving one session each of eco-educational talk entitled "Discovering Lienhwachih—Water Resources, Ecology, Forestry, and Medicinal Plants." A total of 270 students participated.

- On June 15th, Dr. Gene-sheng Tung, Head of Botanical Garden Division, and assistant researchers Chia-chun Hsu, Chien-yu Lin received the visiting Dr. Shi-ping Wang, assistant curator of Singapore Botanical Garden and 7 other staff members. They exchanged ideas on plant species preservation and exhibition methods.

- On June 18th, Division of Technical Services hosted a "Public Welfare/Environmental Protection/Reading—the Fifth Exchange Activity of Second Hand Books." A total of nearly 900 books were on display, and 60 persons attended.

- On June 27th, Lienhwachih Research Center hosted the "2015 Second Season of Volunteer Corps Training Session" at the center.

- Dr. Chao-nien Koh, associate researcher of Division of Forest Protection in the course of her conservation of urban birds study went to the World Forestry Center, Portland, Oregon from June 29th to Dec. 29th to carry out exchange activities.

JULY

- On July 1st, Dr. Kuo-chuan Lin, Deputy Director General led several colleaguesof Divisions of Silviculture, Forest Utilization, and Technical Services received at the TFRI headquarter 7 visitors of leaders of Guam and North Mariana Archipelago State Councils including Guam Council Speaker Ms. Judith Won Pat, and North Mariana State Council Deputy Speaker Mr. Rafael S. Demapan. Bilateral exchanges on topics of forest environments, forest products development, and green energy research were carried out.

- On July 13th, together with Deptartment of Horticulture and Landscape, National Taiwan University, Taiwan Urban Forest Health and Beautification Association, the TFRI co-hosted at the headquarter a "Seminar on Management of Urban Forests." Two experts of International Society of Arboriculture (ISA) from Hong Kong came to give speeches. In addition, Mr. Kevin Martlage, Chief of the Certification Department, ISA also visited Taiwan specifically to award ISA arborist certificates to qualified individuals.

- On July 14th, the TFRI co-hosted with the Agriculture Department of Kaohsiung City Government, Department of Horticulture and Landscape, National Taiwan University, and Taiwan Urban Forest Health and Beautification Association at Kaohsiung City Government a "Seminar on Management of Urban Forests." Two ISA arborists from Hong Kong were invited to give speeches.

- From July 18th to Oct. 18th, the TFRI cooperated with Liukuei Town Hall and Soft World Arts and Culture Foundation and presented a "Playthings from the Mountain and Forests-design Innovation Using Small Diameter Wood" at the Shanping Lodge.

- On July 31st, the TFRI participated in the "United Graduation Exhibition of Achievements for Companies Moving in with the Agricultural Innovation and Incubation Centers." In the session, two companies that receive technical transfers took part in the exhibition. The relevant technologies were respectively "Superior endemic *Morinda citrifolia* strains of Taiwan and their culturing techniques," by Dr. Ching-te Chien, senior researcher of the Division of Silviculture; and "High efficiency natural mosquito repellent formulations" by Mr. Kuen-yuan Hong, assistant researcher, Division of Forest Chemistry.

AUGUST

- Dr. Chih-ming Chiu, Head of Division of Forest Management, went to Kinmen County on Aug. 6th, invited by the Forestry Department of the county, and taught street tree management personnel "Training Course of Risky Trees Determination and Visual Evaluation Method." He also led a rehearsal at the botanical garden of the Forestry Department on tree risk assessment and suggestion for disposal.

- On Aug. 7th, led by Deputy Minister Dr. Chih-yi Sha, the Director General Dr. Star YS Huang, and Dr. Meng-ling Wu, Head of Division of Forest Protection, went to Harbin, Mainland China for the "2015 Cross-strait Forestry Forum." Dr. Huang spoke about "Issues facing forestry development of mountain villages coping with climate change." Dr. Wu also gave a speech on "Urban forest eco-services and planning for tree health and healing."

- On Aug. 12th and 13th, Deputy Dean Shih-ping Chen of Fukien Agriculture and Forestry University of Mainland China, accompanied by Prof. Shih-chung Lin of the Dept. of Forest and Natural Resources, National Yilan University visited Lienhwachih Research Center. They were received and given a guided tour by Mr. Yen-ray Hsui, Center Chief and Dr. Chun-kai Hsu, assistant researcher there.

- Dr. Jiunn-cheng Lin, Head of Division of Forest Economics was awarded the honor as one of 39th National Ten Outstanding Agricultural Experts. On Aug. 15th, he received a public lauding at the 41st National Kiwanis Taiwan Meeting.

- From Aug. 15th to 22nd, Dr. Li-wan Chang, assistant researcher of Division of Technical Services flew to Cape Town, South Africa to attend the 2015 annual meeting of the International Federation of Library Associations and Institutions (IFLA) so as to learn how to manage library well from the perspective different countries. She shared the experience of TFRI library in book collections and restoration of ancient books and to further learn from different sources.

- On Aug. 22nd and 23rd, the Hengchun Research Center hosted a "South Island Panorama" of parents and kids fun and game activities. A total of 400 persons participated.

- In the evening of Aug. 25th, Mr. Yong-chiang Shen, Chief of Liukuei Research Center unfortunately passed away rather suddenly. Old friends and colleagues were shocked and saddened. Chief Shen entered TFRI in 1985 as a project assistant, and had served in positions as assistant, assistant researcher, and associate researcher. He was an expert of forest moths, and had served as chiefs of Chungpu, Hengchun, and Liukuei Research Centers. He had dedicated his entire life serving the TFRI. His passing will be missed by us all.

- From Aug. 27th to Sept. 4th, the Director General Dr. Star YS Huang, Dr. I-hsin Liu, Chief of Tamalee Research Center, and Dr. Yu-jen Lin, associate researcher, Division of Forest Utilization received grant from the Science Development Foundation of the National Science Council to carry out "Environmentally friendly wood and bamboo harvesting machinery and operational road planning technologies study." They flew to Helsinki, Finland to study EU (Finland) private forest policies and machine harvesting technologies, so as to learn from their environmentally friendly timber harvesting in a sustainable utilization mode. The experience could provide input to raise the domestic timber self-sufficiency rate.

SEPTEMBER

- From Sept. 1st to 27th, the TFRI had invited Mr. Pei-tse Cheng, an illustrator, to hold an exhibition of his works "The 24 Solar Terms and Life Pictures" to introduce seasonal or each solar term or suitable foodstuff, as well as a flora map showing the right solar terms to see certain plants in the Taipei Botanical Garden.

- From Sept. 4th to 18th, Mr. Yen-chang Chen, Head of Division of Technical Services went to Durban, South Africa to take part in "the XIV World Forestry Congress; WFC" sponsored by United Nations Food and Agriculture Organization (FAO). By coming to the congress, the global status of forestry could be understood, and the latest developments in forestry research in the advanced nations could be probed, particularly in how to deal with the worsening global climate change problem.

- On Sept. 9th, the Division of Technical Services held at the TFRI headquarter a "2015 Second Database Training Session." A total of 24 persons attended.

- On Sept. 16th, Ms. Jin-ling Yeh, Legislator arrived at Liukuei Research Center and Shanping Forest Eco-science Park for business inspection. Director General Dr. Star YS Huang led Mr. Yung-shui Chen, Chief, and Dr. Fu-san Chou, special appointed researcher of the Research Center received the visitor and presented briefings.

- From Sept. 19th to 26th, Mr. Yen-chang Chen, Head of Division of Technical Services flew to Kuala Lumpur, Malaysia to take part in the 7th Congress of the Asia Pacific Association of Forestry Research Institutions (APAFRI), in a bid to execute and maintain the member's rights of TFRI in the association. Upon attending

the congress on Sept. 20th, he campaigned and was elected an executive council member of the association. Afterward, he took part in the "2015 International Science and Nature Congress" hosted by several branches of Malaysian Government. After the congress, he also visited Kuala Lumpur Botanical Garden and Forestry Research Institute of Malaysia.

- On Sept. 21st, the Lienhwachih Research Center held at the center the "2015 Third Season Volunteers and Staff Ecological Study Session."

OCTOBER

- On Oct. 1st to 3rd, at the Hall One of Taipei World Trade Center, the "2015 Taipei International Inventions and Technology Trading Expo-Agricultural Hall" saw a grand opening. TFRI entries included: "Cultivation of cinnamic aldehyde type *Cinnamomum osmophloem* and the production technology of cinnamic aldehyde and flavonoids" by Dr. Cheng-kuen Ho, Head of Division of Silviculture; and "The healthy wasabi seed production technology" by Dr. Chun-shu Fu, associate researcher, Division of Forest Protection. On the part with successful commercialization, there were companies showing their technical transfer achievement: "High efficiency mosquito repellent formulations" invented by Mr. Kuen-yuan Hong, assistant researcher of Division of Forest Chemistry; and "Wood crafts innovative material packs and products" invented by Dr. Pei-jung Wang, associate researcher of Division of Forest Economics.

- In order to increase the operational efficiency of Taiwan's forest management, the TFRI has on Oct. 5th invited a Japanese forest operational road expert Dr. Kiyochika Okahashi, President, to give a presentation on "Guidelines for Environmentally Friendly Operational Roads." A total of 30 persons attended. Also to consolidate operational road planning and road bank paving practical training, Dr. Okahashi went to Lienhwachih Research Center on Oct. 7th and held a practical training session, there were also 30 persons attended.

- Mr. Patrick Blanc, a well-known French botanist and artist famous for his "vertical garden" architectural achievement, and a famous French singer, Mr. Pascal Héni was accompanied by the former Cultural Minister Ms. Yu-shui Chen visited Hengchun Tropical Botanical Garden on Oct. 7th. The group was hosted by Mr. Chao-song Lin, Chief of Heng-chun Research Center and colleagues for a guided tour.

- From Oct. 19th to 23rd, Dr. Meng-ling Wu, Head of Forest Protection Division, Dr. Gene-sheng Tung, Head of Botanical Garden Division, and Dr. Tsai-hui Chen, senior researcher, Division of Silviculture, flew to Ryukyo, Japan and visited the Forest Resources Research Center, Forest Association of Okinawa Ken etc. With respect to issues of pine nematode infestation of Ryukyo pine, infestation of coral trees by a galling wasp, and tree breeding efforts to produce wind-resistant elite trees of Alexandrian laurel and Ryukyo pine, there were bilateral exchange and agreements.

- In order to assist the Nankuang Elementary School, Puli Township to execute the "Discovering Lienhwachih—Water Resources, Ecology, Forestry, and Medicinal Plants" activities, on Oct. 19th to 23rd, the center arranged for 9 volunteer teachers to visit the school and introduced pertinent contents of "Ecology of Lienhwachih" show. A total of 900 teachers and students attended.

- On Oct. 20th, the Division of Technical Services held a "2015 Agriculture Digital Knowledge Exchange Network Platform System" training course at the TFRI headquarter.

- The TFRI, Taiwan Yitian Association, and Mr. Wan-tsai Lee co-hosted an "Exhibition of Artistic Furniture and Household Items-creative Works of Mr. Wan-tsai Lee." The exhibition spanned Oct. 21st of 2015 till Feb. 28th of 2016 at the Imperial Envoy Lodging, inside the Taipei Botanical Garden. Through the delicately

handcrafted furniture on display and 5 sessions of speeches by experts, the visiting public could understand the preciousness of handmade furniture and the profound and vast wood work creativity.

- Mr. Tashiro Antei who had grown up in Kagoshima, Japan, was the builder of Hengchun Tropical Botanical Garden about 100 years ago, and had made great contributions to Taiwan. Mr. & Mrs. Mamorimasu Nagoe of Kagoshima Folklore Association in a bid to collect historical information of Mr. Antei, visited the Hengchun Research Center on Oct. 26th to 28th. They were received and gave interpretation by Mr. Jau-song Lin, Chief of the center and Dr. Jing-ming Lu.

NOVEMBER

- On Nov. 2nd, at the TFRI headquarter, a "2015 Seminar on Forest Certification and Eradication of Illegal Lumber Trade" was held. The session invited European Union Forest Law Enforcement, Governance and Trade Office in Asia (EUFLEGT in Asia) representative Mr. Vincent van den Berk; Mr. Hubert De-Bonafos, Superintendent of the Greater China Region, the Bureau Veritas Group; Ms. Chisato Tomimura, Office Representative, International FSC Forest Certification Organization; Mr. Geng-long Hsu, President, Taiwan Lumber Export Association, Dr. Song-yong Wang, Honorary Professor, National Taiwan University to attend and discuss. A total of 128 persons attended.

- On Nov. 2nd, the Director General Star YS Huang presided over the granting ceremony of the second FSC™ forest management certificate. Recipient of the certificate was Yong-tsai Forestry Co. Ltd., and the company chairman Mr. Rui-hong Tsai received it in person. The certificate was awarded by Mr. Hubert De-Bonafos, Superintendent of the Greater China Region, the Bureau Veritas Group. Among the honorary guests attending were Dr. Bao-Ji Chen, Minister of Agriculture, Ms. Chisato Tomimura, Asia-Pacific Regional Representative of the International FSC™ Forest Certification Organization, and Dr. Jon-Shi Liu, President of Taiwan Forest Certification Development Organization.

- The TFRI invited Ms. Fiona Yun-Jui Chang and Victoria Martin, artists from California to arrange for a combined exotic cultural exhibition "Present" at the Nanmending 323 site, inside the Taipei Botanical Garden. The artists started by associating the Japanese style buildings in both Taipei Botanical Garden and the Huntington Garden, Southern California and developed works based on a theme of exotic cultural exchanges.

- Dr. Chin-shien Wu, Chief Secretary, led Dr. Chung-biao Huang, Head, Division of Watershed Management, and Mr. Yen-chang Chen, Head, Division of Technical Services, to visit the Yi-ma forest trunk road in Tamali Research Center on Nov. 11th for inspecting two large landslide areas. In the afternoon, they also inspected the branch lines of Yi-ma forest road and other operational roadways of experimental sites and afforestation sites. Next day (12th), they visited the Taitung Branch of the Soil and Water Conservation Bureau, to extend deep appreciations for helping restore the Yi-ma forest road.

- On Nov. 11th, the TFRI together with the Public Works Department of Taipei City Government held a "2015 Urban Forest Management International Symposium—Preparations before Typhoon Strikes and Post-disaster Restoration" at the TFRI headquarter. In the meeting, Mr. Masami Yamamoto who was in charge of greening of Tokyo Metropolis introduced the greening strategies and practices of Tokyo. In addition, Mr. Ben Gooden, an Australian greening expert also introduced how to expand the existing street tree planting holes.

DECEMBER

- On Dec. 5th, 6 volunteer teachers from the Liukuei Research Center were sent to the Long-hsing Elementary School, Kaohsiung City to participate in the 50th birth day school fair. They set up a "Lots of fun with tree seeds" multiple steps game so as to promote knowledge on plant seed morphology and propagation.

- The Lienhwachih Research Center and the camellia oil team of the TFRI went to Hsitou Forest Management District, National Taiwan University Experimental Forest Management Office on Dec. 5th and 6th to attend the "14th Bamboo Culture Festival—Activities for Promoting Superior Forest Culture Innovation." And presented the contents of "finding good oil—ecology of camellia oil tea trees."

- On Dec. 12th, the Lienhwachih Research Center hosted the "2015 Fourth Quarter Study Session and Annual Meeting of the Volunteer Corps," at the center. A total of 32 persons attended. During the meeting, officials of the volunteer corps were elected and study courses and sites of 2016 were discussed.

- Lienhwachih Research Center and Division of Forest Economics co-hosted on Dec. 17th and 18th at the center a "Small Diameter Log Processing and Utilization Workshop." Prof. Wen-ching Su and 2 graduate students of the Department of Wood Materials and Design, National Chiayi University were invited to provide guidance on woodwork techniques. A total of 57 persons attended.

- The TFRI invited Messrs Yasunori Kawamatsu, Nobuyuki Yamamoto, and Nobuyuki Osaki, 3 of contemporary Japanese artists to arrange for an exhibition entitled "TAIPEIdababa" at Nanmending site of Taipei Botanical Garden from Dec. 19th to 31st. The exhibition use "medium" as the main theme; and through their video and on-site painting works to probe the possibility of subconscious occurring.

- In the past ten years, the TFRI had assisted the Taichung Harbor Branch of the Export Processing Zone (EPZ), Ministry of Economic Affairs to create a multi-layered coastal forest on the reclaimed land administrated by the EPZ. This makes the Taichung Harbor EPZ a model of greening and beautification for coastal regions of central Taiwan. On Dec. 24th, Mr. Chao-hsien Fu, Chief of Chungpu Research Center was invited to the press conference of the greening and beautification of the EPZ. In addition to receive an acknowledgment of merit for the effort, a briefing on still on-going greening and beautification work was presented.

- From Dec. 25th to 27th, the Lienhwachih Research Center and the camellia oil study team of TFRI went to Huisun Forest Area of the Experimental Forest Administration, National Chung-Hsing University, to take part in a "Lighting up Good Teas at Huisun—2016 Tree of Hope and the Tea Culture Festival Activities." They also presented the contents of "finding good oil—ecology of camellia oil tea trees."

國內外學者專題演講

日期	講　　題	演講者	職稱	服務機關
06/08	擘劃未來：東南亞森林生物多樣性長期監測計畫 Potting the future: long-term forest biodiversity monitoring in Southeast Asia	中村彰宏	副研究員	西雙版納熱帶植物園
07/23	奧地利林業	Manuel Rakos	林務官	奧地利聯邦林業公司
10/05	友善環境作業到施作要領	岡橋清元	會長	清光林業株式會社
11/30	如何應用半導體元件與近代電子科技診斷森林病害	楊裕雄	教授	國立交通大學生物科技研究所
12/17	日本的林業與森林經營：森林生態系功能的變遷	鄭躍軍	教授	日本同治大學文化情報學報

科技研究專題演講

日期	講　　題	演講者	職　　稱	服務單位
01/30	臺灣地區原產殼斗科植物堅果的開發與利用 —索羅門群島植物誌之合作	張乃航	副研究員	育林組
01/30	櫸木、烏心石、樟樹精英樹選育及種子發芽儲藏之研究	簡慶德	研究員	育林組
03/27	6種人工林樹種之細根周轉及生產量	杜清澤	助理研究員	育林組
03/27	墾丁海岸林二階段復育造林之研究成果	陳芬蕙	特聘研究員	育林組
04/27	應用遙測及地理空間資訊技術於公私有林地崩塌監測與影響評估—以高雄那瑪夏及茂林地區為例	謝漢欽	副研究員	太麻里研究中心
04/27	以感測器網絡監測試驗林地物理環境	趙榮台	研究員	森林保護組
06/01	臺灣蜾蠃亞科昆蟲資源之研究	陸聲山	副研究員	森林保護組
06/01	不同結構設計之木質複合壁板的隔熱性能評估	塗三賢	助理研究員	森林利用組
07/31	熱處理竹材之基本性質	黃國雄	研究員	森林利用組

科技研究專題演講

日期	講　題	演講者	職　稱	服務單位
08/27	非破壞性技術應用於戶外用木質構件的檢測及評估	林振榮	副研究員	森林利用組
08/27	天然林疫病菌與腐霉菌的調查及影響評估	張東柱	研究員	森林保護組
08/27	木竹生質材料利用與能源開發研究	林裕仁	副研究員	森林利用組
10/19	樹種之纖維型態與化學組成對應於特種紙應用性質需求之研究	徐光平	約聘助理研究員	木材纖維組
10/19	海藻奈米纖維素作為紙漿添助劑之研究	何振隆	副研究員	木材纖維組
11/30	油茶之優良品系選拔及提升利用效能研究	許俊凱	助理研究員	蓮華池研究中心
11/30	不同林分密度檜木林之生長結構與自我疏伐曲線	邱志明	研究員	森林經營組
12/28	擴充「臺灣外來入侵種資料庫」：潛在外來入侵種	趙榮台	研究員	森林保護組
12/28	相思樹育種與育林技術之研究	陳永修	副研究員	六龜研究中心

出版品

圖書類｜林業叢刊

刊號	題名	作者	出版日
261	2015森林集水區研討會	黃瓊璁、林壯沛	5月
262	臺灣北部地區歸化植物圖鑑	周富三、廖俊奎、王豫煌 林朝欽	11月
263	誰得到好處？森林大宅院的祕密	周富三、林文智	11月
264	行政院農業委員會林業試驗所一〇三年度年報	林業試驗所年報編輯委員會	11月
265	演化與創造	楊恩生	12月

非圖書類｜推廣摺頁

刊號	題名	作者	出版日
123	恆春熱帶植物園—跨世紀的熱帶林木	伍淑惠	10月
124	台北植物園(中文版)	吳維修、董景生	3月
125	Taipei Botanical Garden	吳維修、董景生	3月
126	台北植物園(日文版)	吳維修、董景生	3月
127	臺北市行道樹常見病害及其防治	吳孟玲、傅春旭、莊鈴木	10月
128	臺北市行道樹常見蟲害及其防治	莊鈴木、吳孟玲、傅春旭	10月
129	林業試驗所植物標本館	陳建帆、陳建文、董景生	10月
130	蓮華池的蜻蛉	汪澤宏、許原瑞	10月
131	重要經濟造林木修枝作業	邱志明	12月
132	墾丁海岸林的復育造林	陳芬蕙	11月

非圖書類｜期刊

刊名	卷期（總號）	總編輯	出版日
台灣林業科學	30卷1期	林朝欽	3月
	30卷2期	林朝欽	6月
	30卷3期	林朝欽	9月
	30卷4期	林朝欽	12月
林業研究專訊	22卷1期(123號)	董景生	2月
	22卷2期(124號)	董景生	4月
	22卷3期(125號)	董景生	6月
	22卷4期(126號)	董景生	8月
	22卷5期(127號)	董景生	10月
	22卷6期(128號)	董景生	12月

非圖書類｜影音光碟

題名	製片/策劃	出版日
林業試驗所104年度技術影片 山地混農林業之永續經營 竹峰竹語 關心樹木健康大家一起來 五色鳥的都市生活小祕密	陳燕章	12月

技術移轉案件

技術名稱	單位	創作人	件數	授權種類	年限
小果油茶種子苗之培育技術	植物園組	楊正釧	1	非專屬	3
牛樟多芽體組織培養、出栽與繁殖技術	育林組	何政坤	1	非專屬	2
多角度複合式植物造景展示箱	育林組	黃怡菁	1	非專屬	5
雙重冷卻泛用型精油萃取裝置	福山研究中心	陳正豐	2	非專屬	5
木藝創作組裝材料包及成品	林業經濟組	王培蓉	2	非專屬	2
樹木褐根病防治檢驗流程及檢體檢驗標誌之製作一續約	森林保護組	傅春旭	2	非專屬	5
樹木危險性的檢查及診斷技術一應力波2D檢測技術	森林利用組	林振榮	1	非專屬	3
牛樟種子的生產與發芽技術	植物園組	楊正釧	1	非專屬	3
竹稈材之乾燥技術	技術服務組	李銘鐘	1	非專屬	5
樹木褐根病快速檢測套組	森林保護組	吳孟玲	1	非專屬	5

台灣林業科學

作者	英文題目	中文題目	頁數
張淑華、吳家禎 陳芬蕙、蔡錦瑩 陳　媜、何政坤	Micropropagation through Axillary Bud Culture and Cultivation of Davidia involucrata Bail.	珙桐腋芽微體繁殖與栽植	30(1): 16-29
吳孟玲、沈湯龍 張東柱、陳昭翰 洪挺軒、李芷芸 林雋軼	Establishment of a Rapid PCR Detection Method for *Antrodia salmonea* and *A. cinnamomea*	應用PCR鑑定技術區分牛樟芝(*Antrodia cinnamomea*)與香杉芝(*A. salmonea*)	30(1): 45-53
汪大雄、鍾智昕 謝漢欽、湯適謙 陳財輝	Three-year Patch Thinning Effects on the Stand Structure in Overstory Trees of a Japanese Cedar Plantation in Taiwan	塊狀疏伐對柳杉上層林木林分結構三年之影響	30(1): 55-74
陳一銘、何紋靈 翁瑞鴻、葛兆年	Mammal Assemblages of Different Forest Types in the Cilan Cypress Forest	棲蘭檜木林不同林地類型之野生動物群聚	30(1): 75-88
徐嘉君	Using Spatially Autocorrelated Environmental Conditions in Habitats to Project Potential Distributions of Rare Orchids	應用棲地空間自相關性推測稀有蘭科植物的潛在分布	30(2): 97-107
林俊成、陳溢宏 林裕仁、李金梅	Analysis of Procurement Factors and Recognition of Domestic Timber Supply by Wood- and Bamboo-Based Product Manufacturers in Taiwan	木竹製品製造業之原料採購考慮因素與國產材認知調查分析	30(2): 109-119
林俊成、陳幸君 吳孟珊	An Analysis of the Timber Harvest Volume and Production in Taiwan between 1991 and 2013	1991-2013年台灣木材伐採與生產量分析	30(2): 121-130
許天銓、洪信介 林謙佑、邱文良 黃曜謀、張藝翰	New Additions to the Fern Flora of Taiwan (3)	台灣蕨類植物誌增註(3)	30(2): 131-138
邱子芸、王相華 郭耀綸、久米朋宣 邱文良、黃曜謀	Ecophysiological Characteristics of Three Cyathea Species in Northeastern Taiwan	台灣東北部三種桫欏屬植物之生態生理特性	30(3): 147-156
張淑華、陳芬蕙 蔡錦瑩、吳家禎 陳媜、何政坤	Somatic Embryogenesis and Plant Regeneration from Immature Embryo Cultures of Cinnamomum kanehirae	牛樟未成熟胚培養之體胚發生與植株再生	30(3): 157-172
柳婉郁、邱祈榮 林俊成、王富鈺 陸人慈、陳雨農 陳宏文	A Study of Taiwanese Private Landowners' Participation in Afforestation Carbon Reduction and Their Intentions towards Carbon Trading	台灣私有地主參與造林減碳與碳交易意願之研究	30(3): 173-184
王培蓉、吳孟珊 孫銘源	Forest Tending Materials as a Strategy for Ecological Compensation	以森林撫育資材做為生態補償之策略應用	30(3): 211-216

台灣林業科學

作者	英文題目	中文題目	頁數
周富三、林文智 陳永修、廖俊奎	Monitoring the Vegetation Dynamics of Early Succession Following a Landslide on Shanping Forest Road	扇平林道崩塌地演替初期植被動態之監測	30(4): 317-228
張勵婉、黃正良 羅士福、李沛軒	Understory Plant Composition and Its Relations with Environmental Factors of the Lienhuachih Forest Dynamics Plot at a Subtropical Evergreen Broadleaf Forest in Central Taiwan	台灣中部低海拔蓮華池森林動態樣區之地被植物種類、組成及與環境之關係	30(4): 245-258
張楊家豪、蘇聲欣 王相華、林則桐 謝長富	Topography and Canopy Openness Influence Spatial Variations in Mortality, Recruitment, and Growth of a Subtropical Tree Community	地形與樹冠開闊度對於亞熱帶樹木群落死亡、新增、生長之空間變異的影響	30(4): 259-270
張勵婉、葉定宏 黃正良、陳意婷	Fourteen Years of Stand Dynamics of an Evergreen Forest in the Kaoshifo Experimental Forest, Southern Taiwan	恆春半島高士佛常綠闊葉林14年林分短期動態	30(4): 271-280
林朝欽、王豫煌 陸聲山	Forest Dynamics Plot Database of Taiwan: A Content Management Approach	台灣森林動態樣區資料庫：內容管理系統之應用	30(4): 281-288

其他學術期刊

作者	題目	書名期刊	卷(期)、頁碼、審查編號	TCCC/SCI/EI
Chun-Lin Huang, Chung-Te Chang Bing-Hong Huang, 鍾振德 Jui-Hung Chen, Yu-Chung Chiang,Shih-Ying Hwang	Genetic relationships and ecological divergence in Salix species and populations in Taiwan	Tree Genetics & Genomes	DOI: 10.1007/s11295-015-0862-1	SCI
張惠婷、林群雅、許富蘭 許立昇、張上鎮、	微膠囊處理對土肉桂葉子精油保存性之改善效果	中華林學季刊	48(4)	其它
張淑芬、邱輝龍、邱文良 陳建文	園藝作物野生近緣種地理資訊系統之建置與應用展望	台灣農業研究	64(4)	其它
Chun-Yi Lin, 吳孟玲 Ting-Hsuan Hung	Identification of two commercial tomato cultivars as new indicator plants for detecting Citrus exocortis viroid infection	植物病理學會刊	24(1): 1-11	其它
林哲緯、陳建帆、楊宗愈	Two new taxa of Melastomataceae Trib. Sonerileae: Phyllagathis rajah and Sonerila metallica from Batang Ai, Sarawak, Borneo	phytotaxa	DOI: http://dx.doi.org/10.11646/phytotaxa.201.2.2	SCI
陳財輝、劉瓊霰、王仁	台北五股與台南龍崎綠竹林之林分結構及生物量比較	林業研究季刊	37(3)	其它
Shuk-Man Ka, Jung-Chen Lin Tsai-Jung Lin, Feng-Cheng Liu 何振隆	Citral alleviates an accelerated and severe lupus nephritis model by inhibiting the activation signal of NLRP3 inflammasome and enhancing Nrf2 activation	Arthritis Research & Therapy	17: 331-343	SCI
汪澤宏	Yoloides Guignot, 1960, a Junior Synonym of Yolina Guignot, 1936 with Comments on the Genera Pachynectes Régimbart, 1903 and Yolina Guignot (Coleoptera: Dytiscidae: Hydroporinae: Bidessini)	Japanese Journal of Systematic Entomology	21(2): 325-329	其它
鐘詩文、Tian-Chuan Hsu	Persicaria humilis (Polygonaceae) a Newly Recorded Plant in Taiwan 台灣的蓼科新記錄一矮蓼	林業研究季刊	37(3): 161-164	其它
何振隆	Application of Near Infrared Spectroscopy Technique in Pulp and Paper Industry	Taiwan TAPPI Journal	19(1): 15-28	其它

其他學術期刊

作者	題目	書名期刊	卷(期)、頁碼、審查編號	TCCC/SCI/EI
Yu-Chang Su 徐光平、何振隆	Composition, in vitro Cytotoxicity, and Anti-mildew Activities of the Leaf Essential Oil of Machilus thunbergii from Taiwan	Natural Product Communications	10(11): 2013-2016	SCI
彭元興、王益真、徐健國	如何有效展開紙匹	Taiwan TAPPI Journal	19(3): 21-30	其它
何振隆	Bioconversion Technologies on the Pretreatment and Saccharification of Lignocellulosic Materials from Forest Biomass	Taiwan TAPPI Journal	19(2): 41-54	其它
謝漢欽、江昱仁、吳俊賢 陳財輝、楊蓓涵、汪大雄	應用Unity和Google Earth 於森林3D景觀視覺模擬	中華林學季刊	48(2): 185-204	其它
詹承勳、徐健國、彭元興 陳用佛	原子力顯微鏡於奈米科技及刑案現場之應用	台灣法醫學誌(13)	7(1): 1-28	其它
Chi-Feng Tsai, Ya-Fu Lee 陳永修, Yun-Hsiu Chen Wei-Ming Chen	Species turnover in tropical montane forest avifauna links to climatic correlates	Global Ecology and Conservation	DOI: 10.1016/j.gecco.2015.01.008	其它
Wei-Ming Chen, Ya-Fu Lee Chi-Feng Tsai, Cheng-Te Yao 陳永修, Shou-Hsien Li Yen-Min Kuo	Dawn chorus variation in East-Asian tropical montane forest birds and its ecological and morphological correlates	Contributions to Zoology	84(3): 255-265	SCI
Chun-Yi Lin, 吳孟玲 Tang-Long Shen, Ting-Hsuan Hung	A mutual titer-enhancing relationship and similar localization patterns between Citrus exocortis viroid and Hop stunt viroid co-infecting two citrus cultivars	Virology Journal	0.598611111	SCI
彭元興、徐健國	書畫裝裱材料染色及配色	國立臺灣博物館學刊	68(1): 1-18	其它
Kristin L. Vanderbilt 林朝欽、陸聲山 Abd Rahman Kassim	Fostering ecological data sharing: collaborations in the International Long Term Ecological Research Network	Ecosphere	6(10): 1-18	SCI
Pei-Chun Liao, Tsung-Shi Yang Ju-Ching Chou 何振隆	Anti-inflammatory activity of neral and geranial isolated from fruits of Litsea cubeba Lour	Journal of Functional Foods	19: 248-258	SCI

其他學術期刊

作者	題目	書名期刊	卷(期)、頁碼、審查編號	TCCC/SCI/EI
Yu-Chang Sua, 徐光平 Kuo-Feng Hua, 何振隆	Composition, in vitro Anti-inflammatory, Antioxidant and Antimicrobial Activities of Essential Oils from Leaf and Twig Parts of Cupressus cashmeriana	Natural Product Communications	10: 1461-1464	SCI
曾俊偉、陳明杰、林介龍 曹崇銘	不同土地利用型態對淺層土壤孔隙率特性之研究	臺大實驗林研究報告	29(3): 145-159	其它
Yoshitake Hiraku, 陸聲山	A New Hainokisaruzo (Coleoptera: Curculionidae) Discovered from a Taiwan Beech Forest in Mt. Taipingshan, Taiwan	Japanese Journal of Systematic Entomology	21(2): 235-239	其它
陳燕章、曾彥學、胡元瑋	樹木的耐陰性	中華林學季刊	48(1): 97-112	其它
洪聖峰 Su-Feng Roan, Iou-Zen Chen	Preliminary results of fruit selection and induced parthenocarpy of mabolo (Diospyros blancoi A. DC.)	Genetic Resources and Crop Evolution	62(8): 1127-1134	SCI
Chun-Ya Lin, Tzu-Cheng Chang Yu-Han Chen, 陳盈如 Sen-Sung Cheng, Shang-Tzen Chang	Monitoring the dynamic emission of biogenic volatile organic compounds from Cryptomeria japonica by enclosure measurement	Atmospheric Environment	DOI: 10.1016/j.atmosenv.2015.09.046	SCI
李佳如、陳昀芝、林振榮 楊德新	應力波斷面影像法應用於肯氏南洋杉立木材質之評估—以國立臺灣大學生物資源暨農學院實驗林管理處下坪自然教育園區為例	臺大實驗林研究報告	29(2): 109-123	其它
林振榮、黃裕星、黃國雄 吳孟玲	非破壞技術應用於白蟻危害小葉南洋杉立木的檢測及評估	臺大實驗林研究報告	29(2): 79-90	其它
鍾智昕、余欣怡、林振榮	VIS/NIR光譜非破壞檢測技術應用於商用木材強度性質的評估	中華林學季刊	48(2): 155-171	其它
Tzu-Yang Liu, 林國銓 Matthew A. Vadeboncoeur Ming-Zhen Chen, Meng-Yuan Huang Teng-Chiu Lin	Understorey plant community and light availability in conifer plantations and natural hardwood forests in Taiwan	Applied Vegetation Science	18: 591-602	SCI

其他學術期刊

作者	題目	書名期刊	卷(期)、頁碼、審查編號	TCCC/SCI/EI
陳子英、林振榮、鍾智昕 陳品邑	臺灣山毛櫸天然林木之樹輪分析	林產工業	32(4): 185-202	其它
鐘詩文、Tian-Chuan Hsu	Oenanthe thomsonii C. B. Clarke (Umbelliferae) a Newly Recorded Plant in Taiwan	林業研究季刊	37(2): 65-68	其它
Chia-Hsuan Sung, 吳家禎 Chen-Te Tseng, Jenn-Kan Lu Hsiu-Chin Lin	The complete mitochondrial genome of Poecilia formosa (Actinopterygii: Cyprinodontiformes: Poeciliidae)	Mitochondrial DNA	Early Online: 1-2	SCI
Yu-Chang Su, 徐光平 Eugene-I-Chen Wang 何振隆	Composition, in vitro Cytotoxic, and Antimicrobial Activities of the Flower Essential Oil of Diospyros discolor from Taiwan	Natural Product Communications	10: 1311-1314	SCI
Tian-Chuan Hsu, Hsin-Che Hung 鐘詩文	Appendicula lucbanensis (Orchidaceae): A Newly Recorded Orchid in Taiwan	林業研究季刊	37(1): 1-4	其它
Prashant S. Swamy, Chung-Jui Tsai Hao Hu, Sivakumar Pattathil Victoria J. Maloney, 鍾振德 Hui Xiao, Liang-Jiao Xue Virgil E. Johnson, Scott A. Harding	Tubulin perturbation leads to unexpected 1 cell wall modifications and affects stomatal behavior in Populus	Journal Of Experimental Botany	66(20): 6507-6518	SCI
張藝翰、張和明、洪信介 鄧為治、陳正為、許天銓	針葉蕨在台灣的再發現	臺灣生物多樣性研究	17(1): 59-65	EI
劉子銘、盧道杰、董景生	蘭嶼水芋田ICCA自主營運模式經濟可行性評估	臺大實驗林研究報告	29(4): 271-277	其它
董景生	台北植物園的典藏與展示	博物館與文化	9: 77-92	其它
翁群儀、賴廷鴻、王培蓉	消費造林中疏伐材料應用開發之可能性初探—以原木組裝材料包開發為例	BULLETIN OF ASIAN DESIGN CULTURE SOCIETY	9: 783-788	其它
簡慶德 Gord Nigh 邱志明	A comparison of 3 taper equation formulations and an analysis of the slenderness coefficient for Taiwan incense-cedar (Calocedrus formosana)	Australian Forestry	78(3): 159-168	SCI

其他學術期刊

作者	題目	書名期刊	卷(期)、頁碼、審查編號	TCCC/SCI/EI
Huey-Chun Huang, Ya-Chi Ho Jia-Min Lim, Tzu-Yun Chang 何振隆	Investigation of the Anti-Melanogenic and Antioxidant Characteristics of Eucalyptus camaldulensis Flower Essential Oil and Determination of Its Chemical Composition	International Journal of Molecular Sciences	16: 10470-10490	SCI
鄧書麟、黃正良、張怡萱 徐浚騰	四湖海岸低濕地木麻黃天然更新特性之研究	中華林學季刊	48(3): 205-220	其它
林振榮、楊德新	Detection of acoustic velocity and electrical resistance tomographiesfor evaluation of peripheral-inner wood demarcation in urban royalpalms	Urban Forestry & Urban Greening	DOI: 10.1016/j.ufug.2015.05.010	SCI
陳舜英, Shih-Han Chou Ching-Chu Tsai, Wen-Yu Hsu Carol C. Baskin, 簡慶德 erry M. Baskin Ling-Long Kuo-Huang	Effects of moist cold stratification on germination, plant growth regulators, metabolites and embryo ultrastructure in seeds of Acer morrisonense (Sapindaceae)	Plant Physiology and Biochemistry	94: 165-173	SCI
Yi-Chung Wang, Wan-Yu Liu Shu-Hsin Ko, 林俊成	Tree Species Diversity and Carbon Storage in Air Quality Enhancement Zones in Taiwan	Aerosol and Air Quality Research	15: 1291-1299	SCI
林俊成、陳溢宏	2003-2013年臺灣實木產品貿易分析	中華林學季刊	48(1): 71-86	其它
董景生、張德斌、林雅玲 廖國媛	外來入侵種桉樹枝癭釉小蜂在台灣地區的生活史	台灣昆蟲學報	34: 199-209	其它
董景生、張德斌、黃嘉龍 李璟泓、楊平世	台灣產印度大田鱉基礎生物學	台灣昆蟲學報	34: 251-261	其它
鐘詩文、Tian-Chuan Hsu	Crotalaria goreensis Guill. & Perr. (Leguminosae), a newly naturalized species plant in Taiwan	台灣生物多樣性研究 (TW J. of Biodivers.)	17(2): 149-152	其它
Yu-Chang Su, 徐光平 Eugene-I-Chen Wang 何振隆	Chemical Composition and Anti-mildew Activities of Essential Oils from Different Parts of Michelia compressa var. formosana	Natural Product Communications	10: 665-668	SCI
Ya-Ping Chang Shuk-Man Ka Wan-Han Hsu Ann Chen 何振隆	Resveratrol inhibits NLRP3 inflammasome activation by preserving mitochondrial integrity and augmenting autophagy	JOURNAL OF CELLULAR PHYSIOLOGY	230: 1567-1579	SCI

其他學術期刊

作者	題目	書名期刊	卷(期)、頁碼、審查編號	TCCC/SCI/EI
Kuo-Feng Hua Ju-Ching Chou Shuk-Man Ka Yu-Ling Tasi 何振隆	Cyclooxygenase-2 Regulates NLRP3 Inflammasome-Derived IL-1β Production	JOURNAL OF CELLULAR PHYSIOLOGY	230: 863-874	SCI
Louis Kuoping Chao Cheng-Hsiu Lin, Huan-Wen Chiu Wei-Ting Wong, 何振隆	Peroxyauraptenol Inhibits Inflammation and NLRP3 Inflammasome Activation by Inhibiting Reactive Oxygen Species Generation and Preserving Mitochondrial Integrity	Journal of Agricultural and Food Chemistry	63: 1210-1219	SCI
T.-C. Lin, P. L. Shaner L.-J. Wang, Y.-T. Shih 王巧萍, G.-H. Huang J.-C. Huang	Effect of mountain agriculture on nutrient cycling at upstream watersheds	Hydrology and Earth System Science Discuss	12: 4785-4811	其它
吳家禎、何政坤、張淑華	The complete chloroplast genome of Cinnamomum kanehirae Hayata (Lauraceae)	Mitochondrial DNA	Early online1-2	SCI
Cheng-Han Tsai, Yi-Ching Lin Thorsten Wiegand Takefumi Nakazawa, 蘇聲欣 Chih-Hao Hsieh, Tzung-Su Ding	Individual species-area relationship of woody plant communities in a heterogeneous subtropical monsoon rainforest	PLoS ONE	10(4): e0124539	SCI
伍淑惠、孫義方、陳可芳 王相華	墾丁高位珊瑚礁森林之幼齡稚樹在2001至2013年間急遽減少	國家公園學報	25(1): 17-23	其它
Shih-Hao Jien, Ming-Hsi Lee Zeng-Yei Hseu, 王相華	Erosion Potential Estimation by Network Measurement of Soil Properties in Coastal Areas after Clearcutting	International Journal of Distributed Sensor Networks	Article ID 281321	SCI
Y.L. Chang, M.H. Tseng W.L. Chiou, 黃曜謀	Effect of temperature on the viability, lifespan, and vigor of chlorophyllous spores of Osmundastrium cinnamomeum (L.) C.Presl (Osmundaceae: Pteridophyta)	The fern Gazette	20(2): 55-64	其它
林群雅、劉怡秀、陳育涵 張資正、陳盈如、鄭森松 張上鎮	臺灣紅檜葉子BVOCs之動態釋出速率及其釋出量之估算	中華林學季刊	48(1): 109-120	其它
曾聰堯、林國銓、杜清澤 林瑞進、鄭智馨、邱祈榮 王亞男	臺灣東部闊葉樹造林地土壤與腐植質碳含量之比較—以花蓮平地造林地為例	嘉大農林學報	12(2): 61-81	其它

其他學術期刊

作者	題目	書名期刊	卷(期)、頁碼、審查編號	TCCC/SCI/EI
洪昆源、吳芯慧、邱秀芸 沈勇強、范義彬	超高速真空模組附加創新連接器對精油萃取之研究	博物館學刊	68(2)	其它
Chun-Yi Lin, 吳孟玲 Tang-Long Shen, Hsin-Hung Yeh Ting-Hsuan Hung	Multiplex detection, distribution, and genetic diversity of Hop stunt viroid and Citrus exocortis viroid infecting citrus in Taiwan	Virology Journal	12: 11	SCI
Han Chien Lin, Po-Kuang Chen Ying-Jang Lai, She-Ching Wu 黃國雄, Noboru Fujimoto	Safety Evaluation and Antimutagenic Activity of Bamboo/Wood Vinegars Collected at Different Temperatures	J. Fac. Agr. Kyushu Univ.	59(2): 359-368	其它
王玉婷、林奐宇、陳建文 王相華	由館藏標本探討溫度變化對臺灣熱帶及溫帶植物花期之影響	台灣生物多樣性研究	17 (1): 15-27	其它
Chen, Y.H Yeh, T.F. Chu, F.H. 許富蘭 Chang, S.T.	Proteomics investigation reveals cell death-associated proteins of Basidiomycete Fungus Trametes versicolor treated with ferruginol	Journal of Agricultural and Food Chemistry	63: 85-91	SCI
張惠婷、Ting-Feng Yeh 許富蘭、黃玲瓏、李金梅 黃彥三、張上鎮	Profiling the Chemical Composition and Growth Strain of Giant Bamboo (Dendrocalamus giganteus Munro)	BioResaurces	10(1): 1260-1270	SCI
陳盈如 Lin, Chun-Ya, Cheng, Sen-Sung Chang, Shang-Tzen	Rapid Discrimination and Feature Extraction of Three Chamaecyparis Species by Static-HS/GC-MS	Journal of Agricultural and Food Chemistry	63(3): 810-20	SCI
Chun-Lin Huang, Jui-Hung Chen Ming-Hsuan Tsang, 鍾振德 Chung-Te Chang, Shih-Ying Hwang	Influences of environmentaland spatialfactorsongenetic and epigenetic variations in Rhododendron oldhamii (Ericaceae)	Tree Genetics & Genomes	11: 39-56	SCI
陳舜英、Yu-Han Tsai Carol C. Baskin Jerry M. Baskin 簡慶德	Seed dormancy and germination of the three tropical medicinal species Gomphandra luzoniensis (Stemonuraceae), Nothapodytes nimmoniana (Icacinaceae) and Goniothalamus amuyon (Annonaceae)	Seed Science Research	25: 57-63	SCI

其他學術期刊

作者	題目	書名期刊	卷(期)、頁碼、審查編號	TCCC/SCI/EI
黃曜謀 Victor B. Amoroso Kathlen S. Paraguas Chia Wen Ko, Tzu Tong Kao Wen Liang Chiou John Rey Callado	Reproductive biology of Aglaomorpha cornucopia (Copel.) M.C. Roos, a rare and endemic fern from the Philippines	American Fern Journal	105(1): 31-44	SCI
Ya Lan Chang, Wen Liang Chiou 黃曜謀	The soil spore bank of Isoetes taiwanensis DeVol (Isoetaceae)	The International Journal of Plant Reproductive Biology	7(1): 1-7	其它
蘇聲欣、鍾智昕、唐盛林 林謙佑、邱志明	柳杉人工林行列疏伐異齡混合林經營研究	北京林業大學學報	37(3): 44-54	其它
Sen-Sung Cheng Chun-Ya Lin Chih-Kai Yang 陳盈如 Min-Jay Chung Shzng-Tzen Chang	Chemical Polymorphism and Composition of Leaf Essential Oils of Cinnamomum kanehirae Using Gas Chromatography/ Mass Spectrometry, Cluster Analysis, and Principal Component Analysis	Journal of Wood Chemistry and Technology	35(3): 207-219	SCI

林業研究專訊

作者	題目	卷(期):頁碼
徐嘉君	臺灣山地霧林的分布與型態	22(1): 5-8
王巧萍、顏睦歆、吳文哲	著生植物靠什麼維生？—福山亞熱帶雨林中臺灣山蘇花的氮源	22(1): 40-42
徐嘉君	我國山蘇產業的現況觀察與願景	22(1): 43-46
陳盈如、鄭森松、林群雅、張上鎮	快速鑑別臺灣扁柏屬植物之新利器—靜態頂空萃取分析	22(1): 47-50
黃裕星	紙與生活	22(2): 1-2
陳佳琦、徐健國	臺灣手工紙的過去、現在與未來	22(2): 3-6
何振隆、徐光平、王益真、蘇裕昌	臺灣造紙產業之介紹	22(2): 13-18
彭元興、徐健國	甚麼是好紙—談鈔票用紙與書畫用紙性質要求	22(2): 23-28
沈純意、徐健國、謝宜君	質樸與風華—紙張樣品陳列室	22(2): 29-35
何振隆、徐光平、王益真、蘇裕昌 彭元興	特種紙的簡介及未來展望	22(2): 36-39
李金梅、黃國雄	認識木材—都市林中姿態優美的小葉欖仁	22(2): 445-46
林俊成、陳溢宏	近10年木纖產品進出口價值分析	22(2): 47-51
陳財輝、王仁	健康麻竹苗的培育技術	22(2): 52-55
林俊成、陳溢宏、陳宗明、蔡清榮	菇類栽培之木屑使用量及來源推估	22(2): 56-60
黃瓊璡、周富三、林照松	扇平一號橋上下游災害復建之探討	22(2): 61-67
黃裕星	森林共和國—森林中的共生現象	22(3): 1
傅春旭、陳韻婷、蔡景株、姚瑞禎	臺灣地區植物和共生微生物之研究現況	22(3): 2-6
張東柱	樹木和真菌的共生現象—森林菌根菌	22(3): 11-14
陸聲山、葉文琪	蜾蠃的保鏢—共存共榮的攜播螨	22(3): 15-18
董景生、潘亮瑜、楊曼妙	蟲癭內複雜的共生關係—以真菌為食的喜楠癭蚋	22(3): 19-21
施欣慧、林清山、陳啟予、陸聲山	菌蠹蟲之生態及其對森林之危害	22(3): 22-25

林業研究專訊

作者	題目	卷(期):頁碼
林清山、吳文哲、陳啟予、陸聲山 施欣慧	日月潭環潭區常見食菌性小蠹蟲之初探	22(3): 26-31
陳科廷	藻菌共生的生物—臺灣的膠衣科地衣研究	22(3): 32-36
伍淑惠	這是種子嗎？談竹節蟲的海漂傳播	22(3): 40-43
林文智、周富三	津田氏大頭竹節蟲的「津田氏」到底是指誰呢？	22(3): 42-43
林裕仁、姚聖潔	應用「藍色經濟」概念創造林業新價值	22(3): 44-48
林淵霖、林國銓	森林集水區伐木作業與河川流量	22(3): 49-52
許富蘭、黃裕星、徐光平、楊正釧	談食安風暴下的新風潮—自己榨油？	22(4): 1-5
吳家禎、陳芬蕙、許俊凱	苦茶油—滴滴精純的秘密	22(4): 6-10
簡慶德、陳舜英、許俊凱	小果油茶和鳳凰山茶種子發芽育苗	22(4): 21-23
汪澤宏、吳家禎、許俊凱、陳芬蕙 吳孟玲	臺灣油茶害蟲的調查現況及兩種臺灣新發現的油茶蛀果性害蟲	22(4): 24-27
顧文君、馬復京	烏油脂成分之性質與應用	22(4): 34-36
林仁瀚	重要木本油料植物—千年桐	22(4): 37-41
許俊凱、李雅琳	富含Omega-3脂肪酸的多年生油料植物—星果藤	22(4): 42-45
沈勇強、孫銘源、周富三	臺灣山茶研究史	22(4): 50-52
王培蓉、吳孟珊	茶與樹的兩難—林農為什麼不造林？	22(4): 53-57
鄧書麟、黃正良、江友仁、黃瓊逸	海岸林下藏伏兵—濱海樹種在木麻黃林下直播造林之角色	22(4): 58-61
陳正豐、葉定宏	搶救明星老樹—罹病銀葉板根緊急醫療成功	22(4): 62-64
林國銓	涓滴成河、百川入海— 一個森林學家的生態研究生涯散記	22(5): 1-6
吳俊賢	永續森林經營與保育利用	22(5): 7-12
王培蓉	利用乎？保育乎？科學林業的興起與轉向	22(5):13-18
董景生、林奐宇	內陸國的林業教育	22(5):35-40

林業研究專訊

作者	題目	卷(期):頁碼
趙榮台	何謂「里山地景」？	22(5): 41-43
林俊成、邱祈榮、陶子婕、林幸樺	如何定義木材合法性	22(5): 44-48
黃瓊璡	從極端降雨環境再談集水區經營	22(5): 49-54
邱志明、鍾智昕	屏東地區平地造林重要樹種生長與枯死	22(5): 55-58
謝漢欽、成瑋	探討極端氣候下農林山村地區之社會經濟脆弱度	22(5): 59-64
陳芬蕙、何政坤、林欣德、蘇德忠 何可蕙	木本植物根系分布與經營管理作業關係之初探	22(5): 65-70
陳財輝、王仁	臺灣綠竹筍的產銷模式及市場運作初步分析	22(5): 71-74
葛兆年	2015年國際教育人員講習會紀實	22(5): 75-78
黃裕星	所長的話	22(6): 1
伍淑惠	灘梳—談臺灣海漂種實	22(6): 2-8
鄧書麟、呂福原	臺灣與鄰近島嶼海漂植物之遺傳多樣性	22(6): 17-21
江俊廷、伍淑惠	踏浪來的一抹綠—東沙植物淺談	22(6): 29-33
林奐宇、董景生	斯洛伐克植物園的域外保育	22(6): 42-47
鍾振德、李玉珍、葉翠華	臺灣肖楠全光量與林下栽植生長之差異	22(6): 48-51
陸象豫	恆春半島氣候特性及其變遷趨勢	22(6): 52-56
黃俊元、謝漢欽、朱木生	運用凹地效應改善木麻黃種子直播作業	22(6): 57-59
王相華、洪聖峰	港口苗圃環境教育活動及解說主題規劃	22(6): 60-63
張勵婉	林業專門圖書館參加2015年國際圖書館協會聯盟(IFLA)年會	22(6): 64-67
趙榮台	養毛毛蟲的男人	22(6): 71-72
周富三	勇敢的強者	22(6): 77-78
鄧書麟	念茲在茲都是蛾	22(6): 79-80

研討會報告

作者	研討會名稱	論文題目	主辦單位
何政坤	海峽兩岸珍貴樹種培育學術研討會	紅豆杉之品種選拔與檢定研究	福建農林大學
吳家禎、何政坤、張淑華	海峽兩岸珍貴樹種培育學術研討會	臺灣特有種牛樟基因體學研究與其分子標誌開發	福建農林大學
Dirk Nikolaus Karger Michael Kessler、Jurgen Kluge Takayuki Tanaka、Li-Yaung Kuo 張藝翰、Samuli Lehtonen Hanna Tuomisto	Next Gerneration Pteridology (12th Symposium of the International Organization of Plant Biosystematists)	Patterns of speciation along elevational gradients of fern communities in Asia	National Museum of Natural History & United States Botanic Garden
楊正釧	中華林學會104年度學術論文發表會	評估暗色隔膜內生菌應用在牛樟育苗之效益	中華林學會
楊正釧	第10屆環境保護林經營管理研討會	林木種源的保存基地－種子庫的建構與管理	林業試驗所中埔研究中心
張勵婉、李沛軒、黃正良 羅士福	第九屆海峽兩岸森林動態樣區研討會	影響蓮華池動態樣區地被植物分布之環境因子與各地被植物及上層喬木相互關係之研究	東華大學、東海大學
Chiung-Feng Liou、許富蘭 Sheng-Yang Wang Shen-Shih Chiang	台灣食品科學技術學會第45次會員大會	Amelioration of metabolism syndrome by Camellia brevistyla (Hayata) Coh. Stuart fruit oil in L-NAME treated mice	台灣食品科學技術學會
董景生	博物館聚落與文化景觀國際論壇	台北植物園－從域外保育、科學典藏到環境教育	國立歷史博物館
張靖、葛兆年	中華林學會104年度學術論文發表會	鳥類取食對低海拔造林木上昆蟲危害的影響	中華林學會
朱汶偵、林彥博、邱玉娟 徐翰慈、黃志堅、方懷聖	2015動物行為暨生態學研討會	我們在合歡山 10 年－蝴蝶群聚的長期監測	嘉義大學生命科學院
Ching-Chu Tsai、Li-fen Hung Shiang-Jiuun Chen、鍾振德 Ling-long Kuo-Huang	2015 植物學年會－轉譯植物科學研討會	Cambial phenology and leaf dynamics of Cinnamomum kanehirae Hayata (Lauraceae)	台灣植物學會
Yan San Huang、李金梅 Hung L.F.、許富蘭 Chang H.T.、Kuo-Huang L.L.	8th Plant Biomechanics International Conference	Biomechanical aspect of stem movement and the growth strains in monocotyledonous palm and bamboo	Plant Biomechanics International Conference committee
傅春旭	認識都市樹木褐根病與樹木管護研討會	臺灣樹木褐根病的發生及現況	澳門民政總署
陳芬蕙、何政坤	海峽兩岸珍貴樹種培育學術研討會	以混農林業混植珍貴樹種發展地方特色	福建農林大學

研討會報告

作者	研討會名稱	論文題目	主辦單位
范義彬	樂活溼地研討會	由生態監測到環境教育—臺北市華江守護聯盟	臺北市動物保護處、臺北市華江守護聯盟
王培蓉	104年度植樹造林期末檢討會	平地造林林產物創新利用之推廣與經營策略	林業試驗所
汪大雄、陳財輝	10th World Bamboo Congress	Prodution and marketing channels on green bamboo shoots (Bambusa oldhami) in Taiwan	World Bamboo Origanization
汪大雄、陳財輝	10th World Bamboo Congress	Bamboo Resources and carbon sequestration in Taiwan	World Bamboo Origanization
Chao-Huan Wang、汪大雄	Proceeding of SFEM 2015	Basic resource information from the most recent forest inventory in Taiwan	National Chiayi University
陳財輝、汪大雄、王仁	第八屆海峽兩岸森林經營學術研討會	綠竹筍產銷形式的成因探討	國立嘉義大學
謝漢欽、鍾智昕、邱志明	因應氣候變遷及糧食安全之農業創新研究104年成果發表暨研討會	從人工林生長監測指標研擬因應氣候變遷造林調適策略	行政院農業委員會農業試驗所
吳孟玲	樹木疫病蟲害之醫療及健檢研討會	臺灣樹保專章之立法及樹木醫學相關專業證照制度之探討	臺灣植物及樹木醫學學會、台灣大學實驗林管理處、行政院農委會林務局、香港園藝專業學會、環境保護學會
黃瓊璁、莊加政	2015第十屆環境保護林經營研討會	四湖海岸植物園環境整建實務之探討	林業試驗所中埔研究中心
林振榮、邱明賜	International Forum on Tea Culture, Creativity & Science TAIWAN 2015	Evaluation of tree age and diameter growth in Camellia brevistyla tree	International Forum on Tea Culture, Creativity& Science TAIWAN committee
趙榮台	里山地景藝術研討會	與自然共生的農村發展	美濃愛鄉協進會
簡慶德	國立臺灣大學實驗林管理處第6屆亞洲實驗林會議森林健康與森林療癒國際學術研討會	Tree seed quality, dormancy and germination-focusing on the *Cinnamomum camphora* and *Cinnamomum kanehirae* (Lauraceae)	國立台灣大學生物資源暨農學院實驗林管理處
謝漢欽、汪大雄	第十屆環境保護林經營管理研討會	森林步道景觀視覺化處理之研究	林業試驗所中埔研究中心

研討會報告

作者	研討會名稱	論文題目	主辦單位
謝漢欽、成瑋、汪大雄 鍾智昕	中華林學會104年度學術論文發表會	探討極端氣候下農林山村地區之社會經濟脆弱度	中華林學會
林朝欽	2015台灣長期生態網年會	長期生態研究的無形資產：資料倉儲管理與分享	台灣長期生態網及東海大學
邱志明、曾璿融、林奐宇 謝漢欽、鍾智昕	中華林學會104年度學術論文發表會	應用無人載具空拍影像推估平地造林蓄積量研究	中華林學會
何振隆、翁月君、花國鋒 蘇裕昌	中華林學會104年度森林資源永續發展研討會	Anti-inflammatory Activity of Essential Oils from Leaves of Four Eucalyptus Species	中華林學會
吳孟玲	2015兩岸林業論壇	都市林生態服務與樹木療癒季規劃	中國林學會
王秋嫻、劉癸君、劉瓊霰 林介龍	第十屆環境保護林經營管理研討會	四種行道樹滯塵能力之比較	林業試驗所中埔研究中心
鄧書麟、傅昭憲 黃瓊逸	中華林學會104年度學術論文發表會	原生樹種於四湖海岸林下直播造林之研究	中華林學會
邱志明	中華林學會104年度森林資源永續發展研討會	應用3D應力波斷層影像技術進行樹木安全性評估以金門木麻黃行道樹為例	中華林學會
Heng Long Wang、Chun Hsien Lu Yo Ching Liu、Yuan Ting Hsu 鍾振德	亞太光生物學國際研討會	Red Light Supplementation Enhanced Spiking of Phalaenopsis	中央研究院
趙榮台、李玲玲	2015都市林管理國際研討會	增加都市樹木多樣性以降低蟲害並提升樹木因應颱風的韌性	臺北市政府工務局、行政院農業委員會林業試驗所
陸聲山、林朝欽、王豫煌	2015都市林管理國際研討會	無人載具應用於都市樹木之調查	臺北市政府工務局、行政院農業委員會林業試驗所
林朝欽、王豫煌、陸聲山	2015都市林管理國際研討會	臺灣都市林之生態分析—先驅計畫	臺北市政府工務局、林業試驗所
王相華、蘇聲欣	2015年第七屆熱帶林業研討會一森林與生物資源的調查技術與發展」	臺灣森林動態樣區調查、研究成果之回顧與展望	行政院農業委員會林務局、國立屏東科技大學森林系、生物資源研究所
林俊成	森林驗證與打擊非法木材貿易研討會	臺灣木材合法保證制度建立之探討	林業試驗所
陳溢宏、林俊成、吳孟珊	中華林學會104年森林資源永續發展研討會學術論文發表會	臺灣主要林產品貿易統計網站建置及需求分析	國立嘉義大學
吳孟玲、葉耕帆、陳昭翰	中華林學會104年度森林資源永續發展研討會	新北市老樹健檢案例分享	中華林學會

研討會報告

作者	研討會名稱	論文題目	主辦單位
吳孟玲、陳昭翰	中華林學會「104年森林資源永續發展研討會」	木棉潰瘍病與苦楝流膠病之病原鑑定分析	中華林學會
陳舜英	2015臺灣農產品特展	極具潛力的保健素材—阿里山五味子	農委會農糧署
林奐宇	2015氣候變遷對生物多樣性的衝擊研討會	從臺灣維管束植物地理分布談氣候變遷之衝擊	林務局
王相華、傅淑瑋、鄧國楨 黃俐雯	濕地生態產業論壇	新豐紅樹林分布的變遷過程及原因探討	台南大學
王玉婷、王相華	中華林學會104年度森林資源永續發展研討會	由館藏標本篩選台灣中低海拔對溫度變化較為敏感之原生指標植物	中華林學會
林奐宇、林謙佑、鍾智昕 葉銘哲	中華林學會104年度森林資源永續發展研討會	從臺南的竹林資源分布談山坡地之利用管理	中華林學會
林振榮、鍾智昕、黃裕星 黃國雄、吳孟玲	2015森林資源永續發展研討會	高空樹木健全性檢查—受保護雨豆樹的個案調查	中華林學會
黃靜宜、鍾智昕、林振榮	2015森林資源永續發展討會	棲蘭野生動物重要息環境之植退化危險度評估	中華林學會
吳家禎、Ho-Ting Wong	中華林學會「104年森林資源永續發展研討會」	What the tree genes sound like?	中華林學會
楊奕、吳家禎、何政坤 張淑華	中華林學會「104年森林資源永續發展研討會」	牛樟近緣物種木材分子鑑定之初探	中華林學會
顧文君、馬復京、陳衣秀 朱紀實、游漢明	中華林學會「104年森林資源永續發展研討會」	石栗種仁油之成分與性質	中華林學會
葉俞欣、曾聰堯	中華林學會「104年森林資源永續發展研討會」	探討*Oidiodendron maius*和*Cryptosporiopsis ericaeericae*利用不同氮源之能力	中華林學會
彭世賢、王相華、陳芬蕙 郭耀綸	中華林學會「104年森林資源永續發展研討會」	墾丁國家公園石珠海岸林銀合歡移除及生態復育	中華林學會
吳家禎、陳芬蕙、簡浩倫	中華林學會「104年森林資源永續發展研討會」	茶油 DNA 分子檢測之初探	中華林學會
簡芝楹、曾聰堯、林瑞進	中華林學會「104年森林資源永續發展研討會」	探討紅星杜鵑之杜鵑類菌根菌生理生化特性	中華林學會
黃俊元、謝漢欽	林業試驗所中埔研究中心第10屆環境保護林經營管理	木麻黃於臺東太麻里海岸林播種穴直播造林之可行性探討	林業試驗所中埔研究中心
鄧書麟、傅昭憲、黃瓊逸	第十屆環境保護林經營管理研討會	樹木移植作業程序之探討—以福木與蘭嶼羅漢松為例	林業試驗所中埔研究中心

研討會報告

作者	研討會名稱	論文題目	主辦單位
蔡景株、黃淑清、傅昭憲 王靖堯、賴芳瑩、蕭宇樂 鄭宇凱	第十屆環境保護林經營管理研討會	淺談社區栽植綠美化—以屏東林區管理處為例	林業試驗所中埔研究中心
陳財輝、鍾欣芸、李宗宜	第十屆環境保護林經營管理研討會	木麻黃等防風林樹種對濁水溪揚塵之攔截效果	林業試驗所中埔研究中心
林裕仁、潘薇如	中華林學會104年森林資源永續發展研討會	南投縣竹山地區竹加工業經營現況與竹廢料之調查分析	中華林學會
何政坤、張淑華	因應氣候變遷及糧食安全之農業創新研究—104年度成果發表暨研討會	氣候變遷與糧食安全：耐逆境牛樟、泡桐與雜交桉品系選拔與利用	行政院農業委員會農業試驗所
蘇聲欣、邱志明	104年森林資源永續發展研討會	不同檜木林經營方式對於地被植物多樣性與林木天然更新之影響	中華林學會
趙榮台	與自然和諧共生的農村發展：生態農業與里山倡議國際研討會	舞鶴茶園：一個社會—生態的生產地景	花蓮區農業改良場、林務局、農村發展基金會、國立東華大學、中華民國自然生態保育協會
潘薇如、林裕仁	2015森林資源保存與利用研討會	亞洲地區木質顆粒市場概況與發展趨勢	行政院農業委員會林業試驗所
顧文君、馬復京、黃國雄 陳衣秀、朱紀實、游漢明	2015森林資源保存與利用研討會	瓊崖海棠油防曬功效之應用研究	行政院農業委員會林業試驗所
胡正恆、陳芬蕙	2015森林資源保存與利用研討會	樟楠闊葉林下遮陰茶的生長表現與野生動物棲息效益	行政院農業委員會林業試驗所
王巧萍	2015森林資源保存與利用研討會	南仁山生態保護區遊客踐踏對土壤硬度之影響	行政院農業委員會林業試驗所
林國銓、杜清澤、黃菊美 李莉莉	2015森林資源保存與利用研討會	棲蘭山檜木林枯落物之碳含量及其分解	行政院農業委員會林業試驗所
洪聖峰、陳右人	2015森林資源保存與利用研討會	毛柿初步大果選種及單偽結果誘導	行政院農業委員會林業試驗所
黃怡菁、陳顥正、卓晨惠 陳瑀芳、陳嘉慧	2015森林資源保存與利用研討會	東方狗脊蕨及長葉腎蕨無性體外培養系統之研究	行政院農業委員會林業試驗所
蔡錦瑩、張淑華、何政坤 陳媜、吳家禎、陳芬蕙	2015森林資源保存與利用研討會	牛樟未成熟胚培養	行政院農業委員會林業試驗所
吳家禎、張淑華、何政坤	2015森林資源保存與利用研討會	Genomics study in Cinnamomum kanehirae Hayata	行政院農業委員會林業試驗所

研討會報告

作者	研討會名稱	論文題目	主辦單位
簡慶德、陳舜英、蔡馨竹 黃玲瓏	2015森林資源保存與利用研討會	5℃層積處理打破臺灣紅榨槭(無患子科)種子的生理休眠及改變植物荷爾蒙、代謝產物和胚細胞的超顯微影像構造	行政院農業委員會林業試驗所
張淑華、陳怡蒨、何政坤 蔡錦瑩、陳媜、黃芷雲 呂汶玲	2015森林資源保存與利用研討會	建立臺灣紅豆杉農桿菌基因轉殖	行政院農業委員會林業試驗所
游漢明、馬復京、張乃航 林元祥、陳國章	2015森林資源保存與利用研討會	福山闊葉林小面積皆伐地的更新動態調查	行政院農業委員會林業試驗所
杜清澤、黃菊美、蘇德忠 葉芝妘	2015森林資源保存與利用研討會	臺灣東部地區三種闊葉樹人工林的細根生產量與周轉	行政院農業委員會林業試驗所
許原瑞、郭幸榮、李思佳	2015森林資源保存與利用研討會	國有林租地造林現況與經營管理芻議	行政院農業委員會林業試驗所
鍾振德、李玉珍、葉翠華	2015森林資源保存與利用研討會	臺灣肖楠種子園後裔之初期生長	行政院農業委員會林業試驗所
陳財輝、邱志郁、王仁 汪大雄	2015森林資源保存與利用研討會	不同海拔高度孟宗竹林分之生長及土壤微生物呼吸作用	行政院農業委員會林業試驗所
陳芬蕙、何政坤、林欣德 蘇德忠、何可薏	2015森林資源保存與利用研討會	經營管理作業對木本植物根系分布影響之初探	行政院農業委員會林業試驗所
邱志明、鍾智昕、劉雯玲	2015森林資源保存與利用研討會	杜英矮林更新試驗	行政院農業委員會林業試驗所
何政坤、張淑華	2015森林資源保存與利用研討會	引種尾巨桉與泡桐造林檢定試驗	行政院農業委員會林業試驗所
陳怡蒨、何政坤、洪聖峰	2015森林資源保存與利用研討會	泡桐種間雜交授粉結果率與種子品質之研究	行政院農業委員會林業試驗所
李金梅、黃國雄、余欣怡 顧文君、夏滄琪	2015森林資源保存與利用研討會	孟宗竹熱處理材之基本性質	行政院農業委員會林業試驗所
許富蘭、黃佳瑩、林佳慧	2015森林資源保存與利用研討會	五種商用木材之密度對加壓防腐處理結果之影響	中華林學會
何振隆、徐光平、蘇裕昌	2015森林資源保存與利用研討會	棕櫚葉稈纖維性質及其製漿適性之評估	行政院農業委員會林業試驗所
何振隆、Yu-Chang Su Kuo-Feng Hua、Tzu-Jung Yang	2015森林資源保存與利用研討會	Chemical Composition and Anti-inflammatory Activity of the Liquidambar formosana Leaf Essential Oil from Taiwan	行政院農業委員會林業試驗所
邱志明、簡慶德、唐盛林	Proceeding of SFEM 2015—The international on sustainable forest ecosystem management	Density-dependent mortality in Taiwania cryptomerioides and Chamaecyparis formosensis stands in Taiwan	國立嘉義大學

研討會報告

作者	研討會名稱	論文題目	主辦單位
邱志明、唐盛林	第八屆海峽兩岸森林經營學術研討會	疏伐與修枝對臺灣扁柏生長效應之研究	國立嘉義大學
張勵婉、徐健國	81st IFLA General Conference and Assembly	Legacy of trees: Repairing and digital archiving of ancient forestry books	IFLA World Library and Information Congress
王培蓉、林俊成、吳孟珊 黃名媛	The 2015 International Symposium on Sustainable Forest Ecosystem Management in Rapid Changing World	A Study on Current Stewardship of Taiwan's Private Forest Lands and on Feasibility of Forest Cooperatives	National Chiayi University
林俊成	國家林業部門溫室氣體清冊編製成果發表會	林業部門清冊不確定性分析成果	林務局
陸象豫	2015森林集水區經營研討會	Using teh technique of flow routing to estimate the underground flow discharge of the upstream Harpen creek	林試所集水區經營組
陸聲山、林朝欽、王豫煌	2015生命科學的跨領域整合與應用研討會	聲景生態學與聲景監測	東海大學生命科學系
陸聲山、林朝欽、王豫煌	2015生命科學的跨領域整合與應用研討會	無人載具在森林生態研究的應用	東海大學生命科學系
胡正恆、陳芬蕙	友善環境社會營造生態城鄉國際學術研討會	在地生態知識：從坪林到新店的茶楠林經營	南華大學建築與景觀學系
胡正恆、陳芬蕙、何可薏 王星哲、王家惠	第六屆台灣濕地生態學研討會	新店生態茶與林下濕地共伴野生動物	國立臺南大學生態科學與技術學系
湯適謙、邱志明、陳瑋旋 潘昱光、葉大裕、黃冠理	2015年第八屆海峽兩岸森林經營學術研討會	應用不連續差數重要度指數原則於臺灣四個林區管理處疏伐作業標準工作量之制定	國立嘉義大學
王培蓉、王相華、何宇睿	自然保護與生態文明建設學術研討會	當代原住民傳統植物知識之社會分布與選擇性差異分析—以泰雅族及魯凱族的兩個部落為例	北京林業大學自然保護區學院
吳孟珊、陳溢宏、林俊成 王培蓉	第八屆海峽兩岸森林經營學術研討會	油茶經營成本效益分析	國立嘉義大學
陳幸君、林俊成、吳孟珊 陳溢宏	第八屆海峽兩岸森林經營學術研討會	林產品進口運輸之碳排放量估算	國立嘉義大學
陶子婕、林俊成、王培蓉 吳孟珊	第八屆海峽兩岸森林經營學術研討會	木材合法性準則與指標建構	國立嘉義大學
何宇睿、林俊成、王培蓉 吳孟珊	第八屆海峽兩岸森林經營學術研討會	森林生態系服務價值評估方法與比較分析	國立嘉義大學
林幸樺、林俊成、王培蓉 吳孟珊、陳溢宏	第八屆海峽兩岸森林經營學術研討會	竹山地區竹產業發展困境與未來策略	國立嘉義大學
吳孟珊、王培蓉、陳溢宏 林俊成	第八屆海峽兩岸森林經營學術研討會	山村居民對氣候變遷議題與因應策略認知之研究	國立嘉義大學

研討會報告

作者	研討會名稱	論文題目	主辦單位
吳孟玲	老樹管理研討會	植物健康照護	高雄市政府農業局、社團法人台灣都市林健康美化協會
劉子銘、盧道杰、董景生	社區保育國際研討會	蘭嶼水芋田ICCA自主營運模式經濟可行性評估	國立臺灣大學
林奐宇、林謙佑、鍾智昕 葉銘哲	第八屆兩岸森林經營學術研討會	航攝影像與立體測繪技術於竹林資源調查之應用—以台灣台南地區為例	國立嘉義大學
謝漢欽、汪大雄、黃俊元	2015臺灣地理資訊學會年會暨學術研討會	應用福衛二號影像及地理空間資訊技術於公私有林地崩塌監測與影響評估—以高雄那瑪夏及茂林地區為例	台灣地理資訊協會
趙榮台、李玲玲	IPSI (International Partnership for the Satoyama Initiative) Case Study Workshop里山倡議國際夥伴關係案例研究小型研討會	Converting pests into allies in tea farming - a case study of SEPL in Hualien, Taiwan	Unite Nations University, International Partnership for the Satoyama Initiative
趙榮台	國際應用昆蟲學研討會—森林、都市及醫學害蟲生態及管理	Forest invasive alien species of Taiwan	科技部、國立臺灣大學昆蟲學系、國立自然科學博物館
何振隆、Wang Eugene I-Chen Su Yu-Chang	International Symposium on Wood Science and Technology 2015	Derivation of Empirical Equations for the Dissolution of Lignin, Cellulose and Hemicelluloses in THFA/HCl Organosolv Pulping of Rice Straw	The Japan Wood Research Society (JWRS)
林奐宇、Wei-Chun Chao Jer-Ming Hu、Chang-Fu Hsieh	2015年國際植群學會年會	Assessing species richness, endemism and phytogeographical affinities of Taiwan based on an integrated vascular plant distribution database	International Association for Vegetation Science
李恩夢、塗三賢、羅盛峰	2015中華林產事業協會學術論文暨研究成果研討會	酚甲醛樹脂含浸處理對孟宗竹合板表面性質的影響	中華林產事業協會
董景生	2014昆蟲多樣性資源保育與永續利用國際研討會	Problems and Prospects of Insect Gall Research in Taiwan臺灣蟲癭學研究面臨的困境與新局	臺灣大學生農學院等
湯適謙、李建霖、王芳 林耿民、黃智雄	2015中華林產事業協會學術論文暨研究成果研討會	國產林產物生產資訊管理系統建置	中華林產事業協會
王培蓉、黃名媛、吳孟珊 孫銘源	21st International Symposium on Society and Resource Management	Using Pruned Twigs as Value-Added Products for Environmental Education	International Association for Society and Natural Resources
陳盈如、林群雅、劉怡秀 葉辰影、張上鎮	2015中華林產事業協會學術論文暨研究成果研討會	臺灣扁柏芬多精之化學組成及其動態釋出量之探討	中華林產事業協會

研討會報告

作者	研討會名稱	論文題目	主辦單位
趙瑞儀、游華萃、彭擁易 夏滄琪、黃國雄	2015中華林產事業協會學術論文暨研究成果研討會	熱處理孟宗竹材抗白蟻性能	中華林產事業協會
顧文君、馬復京、黃國雄 陳衣秀、朱紀實	2015中華林產事業協會學術論文暨研究成果研討會	烏桕油之特性與利用	中華林產事業協會
顧文君、馬復京、黃國雄 陳衣秀、朱紀實	2015中華林產事業協會學術論暨研究成果研討會	瓊崖海棠油抽提物防曬功效之應用研究	中華林產事業協會
林振榮、李佳如、蔡明哲	2015中華林產事業協會學術論研討會	應用非破壞性技術檢測及評估腐朽損害的柳杉立木	中華林產事業協會
鍾智昕、余欣怡、林振榮	2015中華林產事業協會學術論文研討會	光譜非破壞檢測技術應用於商用木材強度性質的評估	中華林產事業協會
林壯沛、林介龍	2015森林集水區經營研討會	臺灣坡地小區與集水區逕流曲線指數	林業試驗所集水區經營組
林壯沛、王秋嫻、林介龍	2015森林集水區經營研討會	山坡地混農林植林的水土流失探討	林業試驗所集水區經營組
許原瑞	2015林木根部菌根菌資源應用研討會	造林苗木品質與培育	行政院農委會林務局、國立臺灣大學植物病理與微生物學系
范義彬	2015昆蟲多樣性資源保育與永續利用國際研討會	昆蟲在環境教育的運用	行政院農委會林務局、中華民國自然生態保育協會
黃祥哲、馮苑琳、劉逸軒 許富蘭、張上鎮、張惠婷	2015中華林產事業協會學術論文暨研究成果研討會	九節木枝葉萃取物美白功效之評估	中華林產事業協會
李羿萱、許富蘭、張益誠 姚忠廷、李鴻麟	2015中華林產事業協會學術論文暨研究成果研討會	精油微膠囊之開發與產品設計應用	中華林產事業協會
陳芬蕙、何政坤、胡正恆 林欣德、黃芷雲	第六屆海峽兩岸森林保育經營學術論壇	林下茶園的生產與環境監測	臺灣森林休憩保育協會
曾俊偉、陳明杰、林介龍 曹崇銘	2015森林集水區經營研討會	農村地區不同土地利用對土壤水資源涵養量之初探	林業試驗所
Cheng Wei Chen、黃曜謀 Chia Wei Li、Wen Liang Chiou	Next Generation Pteridology	Proposing a monographic study on the old world genera of vittarioids	National Museum of National History, Smithsonian Institution, USA
黃瓊璁	2015森林集水區經營研討會	環境倫理與文化宗教發展過程之互動	農委會林業試驗所
黃瓊璁、林照松	2015森林集水區經營研討會	氣候變遷下之水資源調適策略和CDP發展之因應	農委會林業試驗所

研討會報告

作者	研討會名稱	論文題目	主辦單位
蔡素芬、李俊彥、林俊成	2015生物產業學術研討會	以AHP分析永續方案—以臺灣國產製材業為例	國立嘉義大學
林奐宇、Tseng Yu-Hsin Hu Jer-Ming	2015年美國植物學會年會	Examining dioecy and the associated ecological correlates in the flora of Taiwan based on an integrated plant distribution database	Botanical Society of America
王巧萍	2015台灣生態研究網年會	臺灣不同海拔下的土壤特質	東海大學生命科學系
邱志明	新竹地區景觀樹木修剪技術研討會	景觀樹木修剪原理應用	新竹市政府
Sheng-Fong Lo 羅盛峰 En-meng Lee 李恩夢 塗三賢	第65回日本木材學會大會	Studies of carbon-fiber sheet reinforced plybamboo	日本木材學會 The Japan Wood Research Society
黃曜謀 Kuei Huei Lin、Yi Jia Huang Ya Lan Chang	Next Generation Pteridology	Detection of cryptochlorophyllous spores of ferns	Smithsonian National Museum of Natural History
何政坤	2015兩岸植物品種保護研討會	紅豆杉之品種檢定技術開發	中華種苗學會、農業委員會種苗改良繁殖場、農業委員會農糧署
胡正恆、徐郁華、郭耀綸 吳家禎	2015動物行為暨生態學研討會	相機記錄下的白鼻心實果習性、墾丁棋盤腳果實受啃與遺傳歧異度	國立嘉義大學生科院
Chen C.W.、Nita J.H. Hsu T.C.、Fanerii M. Yang T.Y.、Pitisopa F. Li C.W.、邱文良	2015 Symposium of plant diversity and systematic	Antrophyum solomonense (Pteridaceae), a New Species from the Solomon Islands, and its Systematic Position Based on Phylogenetic Analysis	Taiwan Society of Plant Systematics
張俊文、林思民	2015動物行為暨生態學研討會	翡翠樹蛙的鳴叫穩定度是否反應雄蛙的品質	國立嘉義大學
邱志明	104臺中市國際樹木醫學管理及維護研討會	危木判定與案例介紹	台灣愛樹保育協會
林俊成	2015民營林業與森林認證研討會	從國內木材供需思考私有林生產策略	林業試驗所
黃曜謀、張正、張藝翰 吳維修、徐昇圓	2015植物多樣性與系統分類研討會	伊藤氏原始觀音座蓮雜交多倍體化	台灣植物分類學會
劉宗穎、謝詠華、吳書平 徐昇圓、黃曜謀	2015年植物多樣性與系統分類研討會	臺灣原生水蕨複合群分子親緣關係	台灣植物分類學會

研討會報告

作者	研討會名稱	論文題目	主辦單位
洪昆源、沈勇強、蔡景株 邱秀芸、吳芯慧	第三十屆生物醫學聯合學術年會	Using ultra high-speed vacuum modules to increase the yield and composition of essential oil	台灣藥理學會、中華民國解剖學學會、台灣生物化學及分子生物學學會、中華民國細胞及分子生物學學會、中華民國臨床生化學會及中華民國毒物學學會、中國生理學會
洪昆源、楊蒼叡、洪州玄 范義彬、吳芯慧、邱秀芸	第三十屆生物醫學聯合學術年會	The toxicity analyzing from Magnolia kachirachirai	台灣藥理學會、中華民國解剖學學會、台灣生物化學及分子生物學學會、中華民國細胞及分子生物學學會、中華民國臨床生化學會及中華民國毒物學學會、中國生理學會
洪昆源、黃俊元、洪州玄 蔡景株、吳芯慧、邱秀芸	第三十屆生物醫學聯合學術年會	Analysis of the active ingredient of Fraxinus formosana and Indian rosewood	台灣藥理學會、中華民國解剖學學會、台灣生物化學及分子生物學學會、中華民國細胞及分子生物學學會、中華民國臨床生化學會及中華民國毒物學學會、中國生理學會
邱志明	樹木安全與植穴改善研討會	樹木安全議題－危木研判與因應	交通部公路總局
陸聲山、葉文琪	2015動物行為暨生態學研討會	陽明山國家公園姬虎頭蜂Vespa ducalis Smith婚飛事件觀察	國立嘉義大學
范義彬	戶外教育高峰論壇	安全是戶外教育最重要的課題	教育部國民及學前教育署
王培蓉	2015民營林業與森林認證研討會	民營林業組織發展、轉型及趨勢	林業試驗所

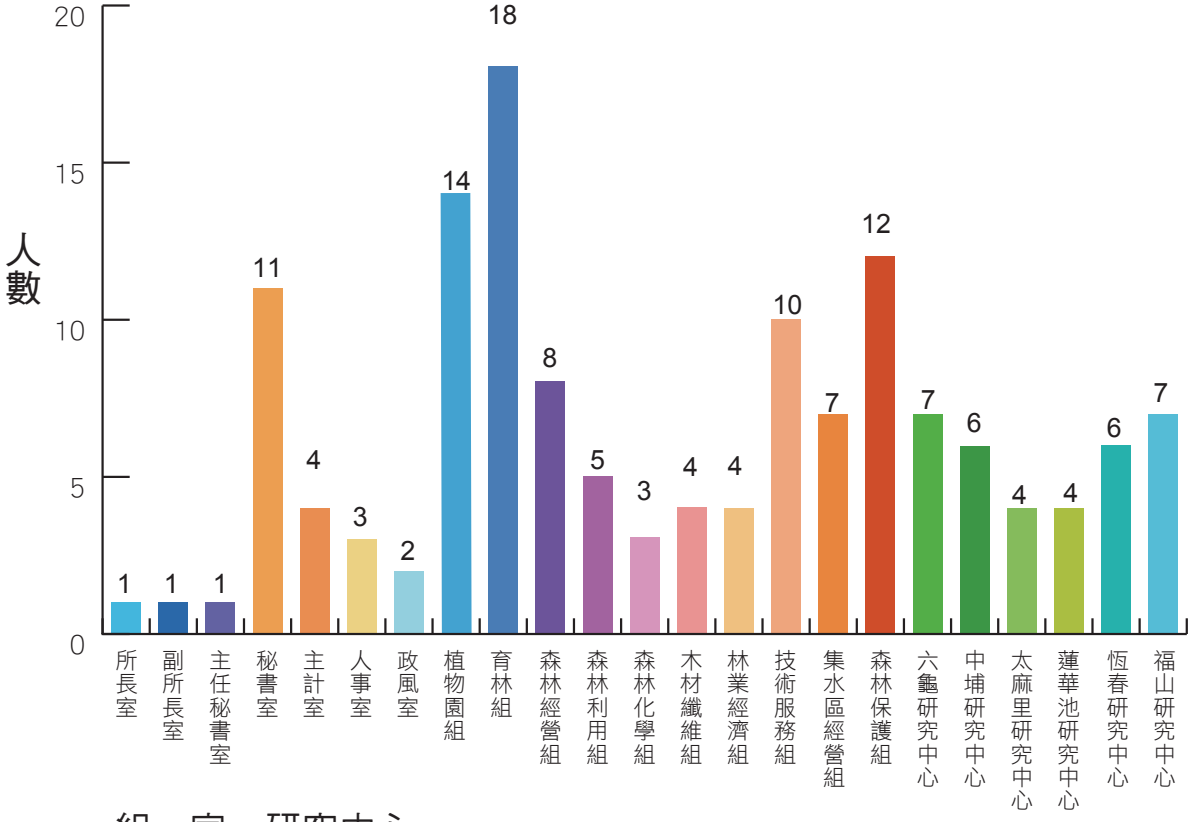
其他推廣刊物

作者	題目	書名期刊	卷(期) 頁碼、審查編號
許原瑞、林文智	租地造林樹種經營管理手冊	同左	全冊
吳憶萍、林文智	手繪回憶—六龜林業老建築	同左	全冊
林俊成、李俊彥 林幸樺	國際主要木材合法性法案實施對全球森林經營環境影響評析	台灣林業	41(6): 41-52
汪澤宏	臺灣的蜻蛉系列介紹—灰蜻蜓屬	農業世界雜誌	388: 52-58
汪大雄	中國第一竹鄉—吉安	台灣竹會電子報	8: 19-22
汪大雄	參與2015年世界竹子博覽會心得分享	台灣竹會電子報	12: 14-19
林俊成、陳溢宏	近10年實木產品進出口價值分析	台灣林業	41(4): 83-88
林振榮	樹木危險性的檢查及診斷建議技術—應力波2D檢測技術	104年度農業創新育成中心研發成果專刊	農委會畜試所專輯第167號
林振榮	古蹟及傳統建築之木質構件劣化的檢查及診斷評估技術	104年度農業創新育成中心研發成果專刊	農委會畜試所專輯第167號
徐健國	第二章—書畫裝裱專題	新視界—東方媒材之跨域整合研究計畫 教材編彙(東海大學美術系)	p: 26-63
黃瓊瑽	海岸的守護者—「四湖海岸植物園」之探索	法務部清流月刊	24(6): 56-50
汪澤宏	臺灣的蜻蛉系列介紹—鼓螋科	農業世界雜誌	387: 52-57
汪澤宏、陳芬蕙	混農林業的蟲害管理探討—牛樟與茶及檳榔混植的例子	農業世界雜誌	385: 26-32
趙榮台	不同的眼光、不同的眼界	瑞秋・卡森—以筆開創環保新天地的鬪士	62-72

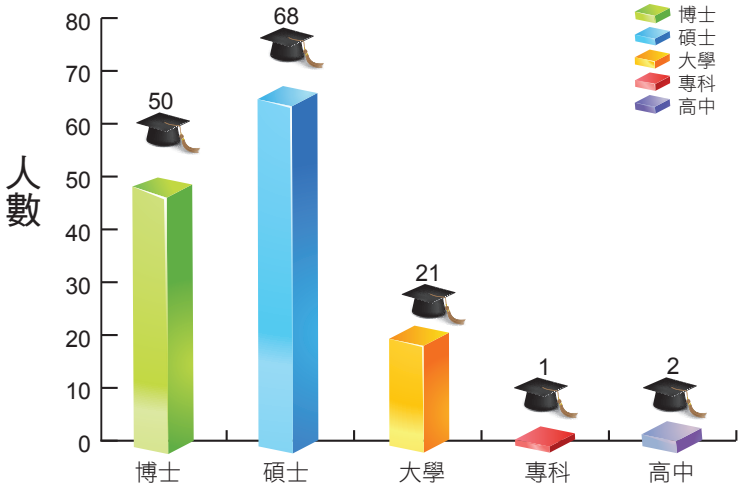
其他推廣刊物

作者	題目	書名期刊	卷(期) 頁碼、審查編號
林振榮	外科處置樹木空洞的概念及原則	林產工業	33(2): 107-112
林壯沛	混農林業經營的水土保持功能	農業世界雜誌	385: 19-25
林振榮	樹藝師使用的樹木風險評估之基本檢查項目	林產工業	32(4): 247-258
徐嘉君	Exploring Treetops in Old-growth Cloud Forests of Taiwan	What's up	21(2-3): 1-2
陳芬蕙	臺灣混農林業的現況與未來	農業世界雜誌	385: 14-18
林振榮、邱明賜	五年生茶樹根部調查個案分享	茶情雙月刊	78: 5-6
許原瑞、郭幸榮 蕭祺暉、胡慧琳	改善育苗作業提昇苗木品質芻議	台灣林業	41(2): 8-15
黃瓊璁	賞楓也可以這麼輕鬆	法務部清流月刊	23(9): 66-67
趙榮台、李玲玲	雅高桑地一壯志未酬的都市實驗室	大自然季刊	127: 66-71
趙榮台	生物多樣性的永續使用與「里山倡議」	台灣林業	41(1): 9-12
王相華、傅淑瑋 鄧國禎、洪西洲 廖學儀	臺灣紅樹林面積變遷及物種組成現況	台灣林業	41(2): 86-90
林振榮	行道樹健康檢查的機器檢測及診斷	行道樹健康診斷培訓專班	興大農業推廣 叢書第104001號
陸聲山、宋一鑫	《昆蟲記》裡蜂臺灣	科學月刊	541: 44-49
范義彬	安全是戶外教育最重要的課題	師友月刊	573: 15-20
王瀛生、張乃航	平地造林木樹皮及小徑幹材之全材利用	家具公會特刊	P.48-51
洪昆源、吳芯慧 邱秀芸、吳素萍	認識植物的腦—快速鑑別常見的植物結晶	台灣林業	47(2): 67-70

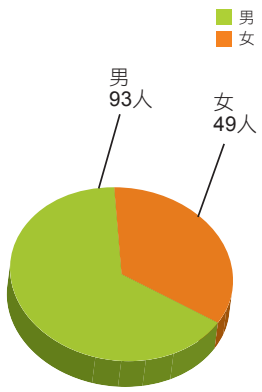
人力資源



組、室、研究中心
共計142人



教育程度



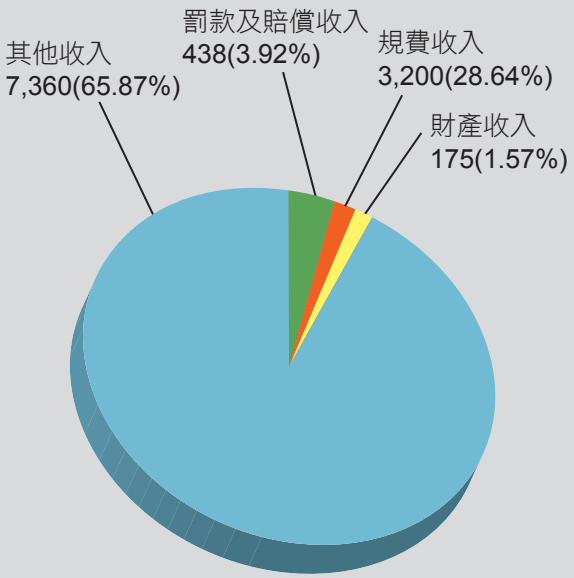
男女人數

財務預決算

(一)104年度預算

1.歲入：本年度歲入預算數11,173千元，較上年度10,185千元增列988千元，其主要內容如圖1。

2.歲出：本年度歲出預算數591,291千元，較上年度601,545千元減列10,254千元，其主要內容如圖2。

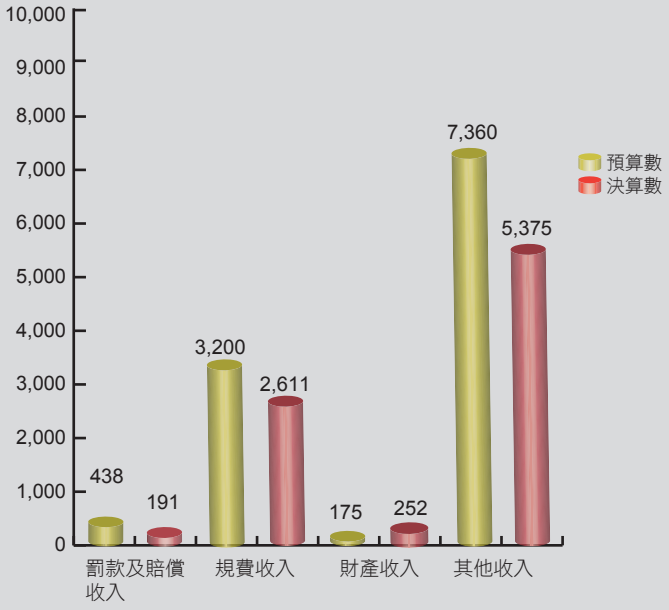


▲ 圖1. 104年度歲入預算主要內容（單位：千元）

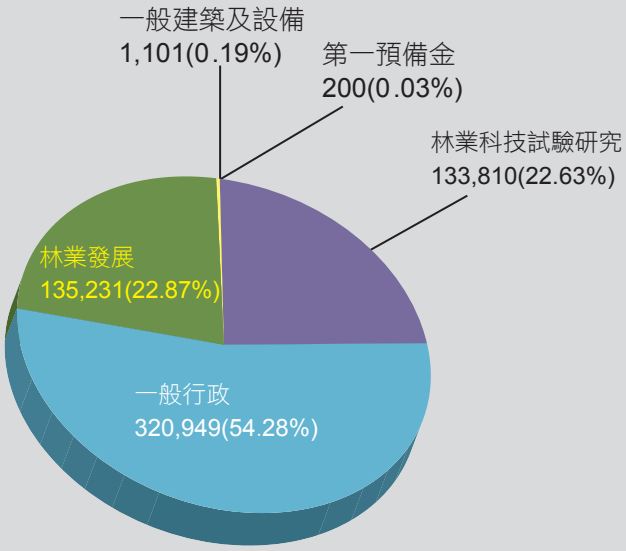
(二)104年度決算

1.歲入：年度歲入預算數11,173千元，決算數8,429千元，執行率75.44%，其主要內容如圖3。

2.歲出：本年度可支用預算數591,291千元，決算數585,668千元，執行率99.05%，其主要內容如圖4。



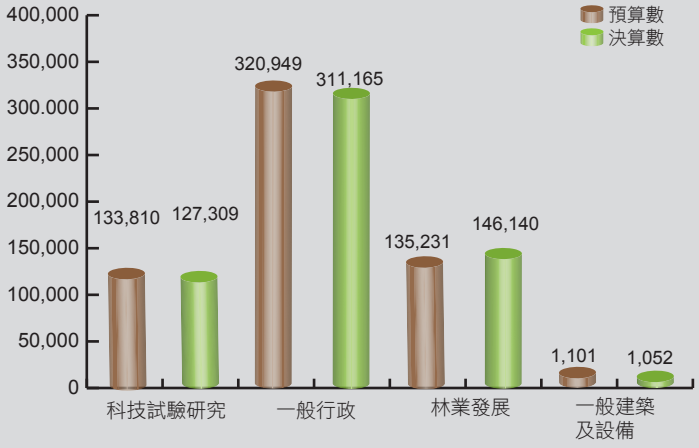
▲ 圖3. 104年度歲入預算執行情形（單位：千元）



▲ 圖2. 104年度歲出預算主要內容（單位：千元）

(三)104年度科技部補助計畫經費

本年度辦理科技部補助計畫經費9,734千元，執行數9,166千元，執行率94.16%。



▲ 圖4. 104年度歲出預算執行情形（單位：千元）

2015 Annual Report

行政院農業委員會
林業試驗所一〇四年度年報

Taiwan Forestry Research Institute Annual Report 2015

發　行　人：黃裕星
編　　審：林業試驗所年報編輯委員會
策　　劃：邱祈榮・吳俊賢
總　編　輯：陳燕章
英文編輯：王益真
編　　輯：董景生・何政坤・吳孟玲・邱志明・林俊成
　　游漢明・林振榮・林照松・許原瑞・傅昭憲
　　陳正豐・陳永修・劉一新
執行編輯：商華光・許明峰・施懿倫
美術編輯：李佩倫・陳盈君
出版單位：行政院農業委員會林業試驗所
地　　址：10066 臺北市中正區南海路53號
電　　話：(02)2303-9978
傳　　真：(02)2314-2234
全球資訊網網址：http://www.tfri.gov.tw
印　　刷：財團法人勝利數位設計印刷中心
展 售 處：國家書店：松江門市
　　10455臺北市松江路209號1樓 02-2518-0207
　　五南文化廣場：臺中總店
　　40042臺中市中區中山路6號 04-2226-0330
出版年月：中華民國105年5月
定　　價：新臺幣200元整

Publisher/ Yue-Hsing star Huang
Advisory/ TFRI Annual Report Editor Board
Planning/ Chyi-Rong Chiou, Chin-Shien Wu
Chief Editor/ Yen-Chang Chen
English Editor/ I-Chen Wang
Editor/ Gene-Sheng Tung, Cheng-Kuen Ho, Meng-Lin Wu, Chih-Ming Chiu, Jiunn-Cheng Lin
　　Han-Ming Yu, Cheng-Jung Lin, Chao-Song Lin, Yen-Ray Hsui, Chao-Hsien Fu
　　Cheng-Fong Chen, Yung-Hsiu Chen, I-Hsin Liu
Executive Editor/ Hwa-Guang Shang, Ming-Feng Hsu, I-Lun Shih
Art Editor/ Pei-Lun Lee, Ying-Jun Chen
Published by/ Taiwan Forestry Research Institute
Address/ 53 Nan-Hai Road, Taipei 10066, Taiwan
Tel/ 886-2-2303-9978
Fax/ 886-2-2314-2234
Web/ http://www.tfri.gov.tw
Printer/ Victory DIGI Print
Published in May 2016
Price/ NT200
ISBN/ 978-986-04-8937-8
GPN/ 1010500906

國家圖書館出版品預行編目(CIP)資料

林業試驗所年報. 一〇四年度 / 陳燕章總編輯--
臺北市 : 農委會林試所, 民105.05
136面 ; 21×29.7公分

ISBN 978-986-04-8937-8 （平裝）

1. 行政院農業委員會林業試驗所　2. 林業管理

436.03　　105010051