

SCIENCE IN THE GARDENS

Inspiring the appreciation & conservation of plants through exciting, innovative and relevant research

1999–2000 Annual Report
of the Plant Sciences Branch,
Royal Botanic Gardens Sydney



Plant Sciences Branch

Royal Botanic Gardens Sydney

Mrs Macquaries Road, Sydney 2000

Tel (02) 9231 8111 Fax (02) 9251 4403

Web Site Address:<http://www.rbgsyd.nsw.gov.au>

Gardens Offices

8.30 am to 5 pm Monday to Friday

Mount Annan Botanic Garden

Mount Annan Drive, Mount Annan NSW 2567

Tel (02) 4648 2477 Fax (02) 4648 2465

The Garden is open all year except Christmas Day.

Hours 10 am–4 pm April to September;

10 am–6 pm October to March.

Mount Tomah Botanic Garden

Bells Line of Road via Bilpin NSW 2758

Tel (02) 4567 2154 Fax (02) 4567 2037

The Garden is open all year except Christmas Day.

Hours 10 am–4 pm March to September;

10 am–6 pm October to February.

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Senior Technical Officers Sue Bullock and Linda Gunn, part of the Gardens' Plant Disease Diagnostic Unit, examine fungal plates in our Plant Pathology Laboratory.

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1999–00

Our Mission

To work with the community to increase the knowledge and appreciation of plants and their critical role in the sustainability of our natural and urban environments, and to manage our open spaces as inspirational places for recreation, cultural events and celebration.

Royal Botanic Gardens Sydney

SYDNEY • DOMAIN • MOUNT ANNAN • MOUNT TOMAH • NATIONAL HERBARIUM

Our Vision

To be recognised by the community, the Government and our peers as a centre of excellence in:

- Management of public open space of high cultural, heritage and aesthetic significance
- Botanical and horticultural research
- Community botanical and horticultural education, information and outreach programs
- Horticultural practice, display and training
- Plant biodiversity and conservation research and programs
- Through these, to be one of the top five botanic gardens in the world.

Our Values

- Botanical Learning and Knowledge
- Plant Conservation
- Heritage Conservation
- Horticultural Excellence
- Environmental Responsibility
- Community and Visitor Satisfaction
- Staff Safety, Skill, Satisfaction and Dedication
- Ethical Management
- Cost Effectiveness
- Land Custodianship

Our Corporate Themes

- Controlling our Destiny: What Do We Want the RBG to be like in 10 to 20 years?
- Conserving Plant Diversity: Playing our part in influencing plant conservation in NSW, Australia and across the world
- The Millennium Events: Showcasing our gardens to the world while managing the threats and taking advantage of the opportunities
- Our Commercial Activities: Enhancing our core business, while providing services people want
- Staff, Friends, Volunteers and Visitors: Keeping all of us safe and healthy
- Customers, Visitors and Clients: More than meeting their needs
- The Royal Botanic Gardens and Domain Trust: Good corporate governance
- Botanic Gardens: Sites of excellence in horticulture, conservation and heritage at the Sydney, Mount Tomah and Mount Annan Gardens
- Plant Sciences: Researching, understanding, conserving and communicating the diversity of plants
- Community Education: The whole community, inside and outside the walls
- The Sydney Domain: A special place for recreation, festivities, protest, culture and heritage
- Corporate Services: Our people, our money, our businesses, our information technology, our image and our market

**Plants
= Life**

Highlights of the Year

- Detailed vegetation map for the Guyra area of the New England Bioregion
- Taxonomic revision of the Aroid genus *Schismatoglottis* in Malesia, including 90 species, 32 of them new to science
- First teaching contributions to the new Bachelor of Science in Biosystematics course at University of New England
- Major funding through Australian Research Council to study the biology and ecology of *Persoonia* species
- Publication of two volumes of selected proceedings from the 1998 Monocots II conference
- Launch of PlantNET, our plant information portal on the internet

Part 1: Introduction

The Plant Sciences Annual Report is structured around the Vision Document prepared in response to the 1999 Review of Plant Sciences. The following introductory material is taken from that document.

Our Environment

The Plant Sciences Branch of the Royal Botanic Gardens Sydney is:

- Obligated first and foremost to the Royal Botanic Gardens and Domain Trust through the RBG Mission and Corporate Plan
- Funded primarily by the State Government of NSW and its programs must contribute to that government's policies and goals
- Obligated under all treaties and strategies to which the State and Federal governments are signatories (e.g. NSW Biodiversity Strategy, National Strategy for the Conservation of Australia's Biological Diversity, Convention for Biological Diversity)
- The oldest and one of the most highly respected scientific units in Australia. (Science in Australia began at the Royal Botanic Gardens, and Sydney has always been a strong focus for the discovery, documentation and study of Australian plants.)
- Recognised and valued internationally, nationally and within the State for its science programs (with different programs relevant at different levels)
- A critical component if RBG Sydney is one of the leading world botanic gardens
- Accepted as a leading organisation in the conservation and management of NSW's plant biodiversity
- Part of a national and international collection of herbaria and botanic gardens (and other organisations) contributing to the understanding, appreciation and conservation of Australia's flora.

Vision for Plant Sciences

The Royal Botanic Gardens Sydney will have exciting, innovative and relevant scientific research programs. It will be recognised throughout New South Wales, Australia and the world as making a major contribution to the discovery and conservation of biodiversity. It will work with the horticultural industry and botanic gardens in plant development and disease diagnosis. Research results and biodiversity data will be communicated using the best available means. The Gardens will work in partnership with government agencies, universities, botanic gardens and herbaria to achieve these aims. By 2002, all scientific programs will be widely recognised within New South Wales as important and appropriate, with no reduction in the Gardens' international reputation for high quality, progressive science.

Objectives for Plant Sciences

- To undertake original research on the plants of New South Wales and neighbouring areas
- To effectively disseminate the results of research through publications, products and services
- To play a leading role in the conservation of biodiversity in New South Wales and neighbouring areas
- To be the primary source of plant diversity information in New South Wales
- To lead and contribute to the understanding and appreciation of plant diversity
- To assist in the sustainable management of the botanic gardens and the horticultural industry
- To contribute to the development of State, national and international policies and legislation

Priority-setting Criteria

All new programs and projects must be evaluated against the following criteria. Some criteria are deliberately open to interpretation and should be used as a starting point for discussion about a particular program/project. The geographical focus for any program will usually be New South Wales or 'neighbouring' regions (in a scientific, geographic or economic-political sense).

The program or project should:

- Be consistent with the implicit and explicit directions and policies of the State Government of New South Wales
- Be of scientific merit: i.e. methodologically sound and scientific in approach. The research should 'change the way we do or think about things'
- Contribute to a sense of wonder and excitement about plants and their biology
- Be innovative and/or use the best available methodology
- Result in better conservation and management of biodiversity
- Provide a service or knowledge not readily available elsewhere (may be part of a coordinated interagency program)
- Make best use of our resources, including people, facilities, and preserved and living collections
- Contribute to, complement, or initiate other programs in the Royal Botanic Gardens
- Effectively communicate outcomes to the appropriate audience
- Raise or maintain the profile of the Royal Botanic Gardens
- Preferably attract external funding or result in income to the Royal Botanic Gardens
- If consistent with the above criteria, be targeted to meet the greatest needs of the identified stakeholders.

Management Structure

Director Plant Sciences

Executive Assistant

Administrative Assistant

Coordinator, Centre for Plant Conservation (vacant)

Manager Conservation & Horticultural Research

New South Wales Vegetation Theme

Horticultural Research and Development Theme

Fungi and Plants Theme (incl. Plant Disease Diagnostic Unit)

Manager Plant Diversity

Plant Diversity Theme research

National Herbarium of New South Wales

PlantNET and Botanical Information Service

Manager Resources

Library

Botanical Illustration

Herbarium Specimen Preparation Facility

Volunteer Programs

Laboratories

Building and Business Issues

Vehicles and Field Work Equipment

Program Structure

New South Wales Vegetation: Contributing to the management & conservation of biodiversity

- **Community, Species and Population Ecology** – understanding plants to help them survive
- **Vegetation Survey Research & Development** – providing the expertise to map the State
- **Communication and Services** – scientific and popular publications; vegetation maps; policy advice

(IF FUNDED EXTERNALLY: Additional Vegetation Survey – mapping the vegetation of New South Wales)

Horticultural Research and Development: Selecting the best plants for conservation & commerce

- **Conservation Horticulture** – growing plants for conservation
- **Horticultural Development** – benefiting from the botanic gardens brand
- **Communication and Services** – scientific and industry publications; RBG brand plants

Fungi and Plants: Beneficial and harmful relationships

- **Fungi** – pathogens and partners of native and amenity plants
- **Communication and Services** – scientific, industry and general publications; disease diagnosis

Plant Diversity: The discovery and application of biodiversity data

- **Flora of Australia** – documenting Australia's vascular plants, bryophytes, lichens and algae
- **Origins and Evolution** – unravelling the history and relationships of Australia's biota
- **Asia-Pacific Taxonomic Initiative** – collaborating with neighbouring countries
- **Management of Preserved Collections** – maintaining a comprehensive and accurate biodiversity record
- **Communication and Services** – scientific and popular publications; botanical information; electronic products and services

(IF FUNDED EXTERNALLY: Fungal Systematics – the great unknown)

Part 2: Conservation and Horticultural Research Section

This new section brings together a wealth of expertise in ecology, horticulture and plant pathology. The new administrative unit will create opportunities for multidisciplinary projects and collaboration, and facilitate our contribution to the *NSW Biodiversity Strategy*. Existing programs, grouped under three broad themes, will be retained and an experimental ecologist will be added to staff in mid-2001.

New South Wales Vegetation Theme

The three programs included under this theme are combined here. Firstly, an understanding of the ecology of individual species, and how they interact with other species, complements our plant diversity and community mapping programs work in providing baseline data for biodiversity management. Our species ecology work is currently focussed on the Sydney area but will be expanded to all of New South Wales as part of the PlantNET project. The new experimental ecology program, to commence midway through 2001, will focus on issues of high conservation and scientific importance. Aquatic ecology will also be expanded in coming years.

The Gardens is also a contributor to the survey, mapping and classification of plant communities in New South Wales. A thorough knowledge of the composition and distribution of vegetation communities is critical for the management and conservation of biodiversity at paddock, catchment or bioregion level. The target and scope of projects has been driven by gaps in State coverage and the needs of stakeholders. We are currently reviewing our priorities, but over the next three years the development and implementation of validation routines will be part of our contribution to Native Vegetation Mapping Program. Other new directions may include vegetation modelling, testing of conservation reserves, habitat fragmentation, and the inclusion of cryptogam (e.g. bryophyte and lichen) data.

The third program focuses on the communication of botanical knowledge, particularly through the publication of books about the vegetation of the Sydney region. A larger publication project on the vegetation of New South Wales will be initiated in the coming year.

Classification and Status Assessment of the Vegetation of NSW

Ecologist John Benson and Project Officer Chris Togher are reviewing the literature and all vegetation mapping and surveys in NSW with the aim of deriving an authoritative typology of the vegetation of the State. This a large, complex project that will take several years. It mirrors similar work in the United States, Canada and Europe.

A database with 55 fields has been established to store information on each listed plant community. These fields include scientific name, common name, characteristic species, distribution by various regional boundaries, physiography, estimated or measured areas for pre-European and current extents, threat codes based on IUCN criteria, reservation

codes, photograph and a general description. Standard reports from the database will provide summaries of the status of each community. Over the longer term this data will form part of the proposed publication on the vegetation of NSW.

Conservation Committees

Staff had input to a number of key committees that deal with issues relating to legislation or issues about the conservation of species or habitats. Three important statutory committees that Gardens' staff are represented on are the NSW Scientific Committee, the NSW Fisheries Scientific Committee, and the Native Vegetation Advisory Council (see above). The Gardens also contributes to two major implementation groups, the Biodiversity Strategy Implementation Group (as chair) and the Native Vegetation Implementation Group (invited onto committee in June 2000).

Cunninghamia

Cunninghamia: a journal of Plant Ecology for eastern Australia continues to be an important vehicle for the publication of ecological research in New South Wales and other eastern States. Highlights of volume 6, number 2, include:

- The first published plant lists for remnant sites in the South Western Slopes (including 470 native species). The remnants in the western half of the area studied were smaller, more intensively grazed, and with more exotic weed species, and therefore warrant higher priority in conservation management
- New data to improve the management of native vegetation in conservation reserves at Tenterfield (Demon Nature Reserve) and Ashford (Kwiambal National Park)
- The rediscovery on the north coast of a tree orchid thought to be extinct in NSW
- A preliminary study of the response to grazing of a rare grass from the Liverpool Plains. Grazing may encourage growth of this particular species
- The seventh instalment of the Ecology of Sydney Plant Species.

Ecology of Sydney Plant Species

The seventh instalment (Part 7a) of the popular series documenting the ecology of plants in the Sydney region was published in *Cunninghamia*. Included are families Nyctaginaceae to Primulaceae (150 species), highlighting notorious weeds such as Privets, ecologically important species such as Sweet Pittosporum and Blackthorn, and the endangered herb *Lysimachia vulgaris*. Part 7b Proteaceae to Rubiaceae (250 species) is currently being compiled and is due for publication in late 2000.

Ecological Monitoring

The Gardens has contributed over the years to a number of long-term monitoring projects, providing information of importance to vegetation management and conservation. Ecologists Doug Benson and Jocelyn Howell have been monitoring Cumberland Plain communities at Mt Annan, as well as seasonal variation in wetland communities and riparian vegetation of the Hawkesbury-Nepean floodplain.

Freshwater Macroalgal Ecology

Lucy Nairn commenced a PhD on algal ecology at the Gardens in January 2000. The project is funded as part of a large ARC grant held by co-supervisors Dr Barbara Downes, The University of Melbourne, and Dr Tim Entwisle. Lucy is investigating the influence of various environmental variables, including water temperature and depth; nutrients; riparian vegetation; flow velocity; light availability and substratum, on macroalgal communities. Macroalgae are likely to act as good indicators of water quality. However before they can be confidently used in this way we need a better understanding of the natural processes that influence the structure and composition of these communities. Work is currently being conducted in the Southern Highlands and Kangaroo Valley, with later work likely to include sites in the Barrington Tops and Kuring-gai Chase National Parks.

General Publications

Rare Bushland Plants of Western Sydney: A completely revised version of this popular book was published in July 1999. The authors of the revised edition are Teresa James, Lyn McDougall and Doug Benson.

Missing Jigsaw Pieces: the Bushplants of the Cooks River Valley: This new book on the plants and their importance in a very suburban part of Sydney was prepared by ecologist Doug Benson with co-authors Danie Ondinea and Virginia Bear. Funding was provided by the Cooks River Foreshores Working Group and the book was launched in the presence of a large local crowd in November 1999.

Sydney's Bushland: More than meets the eye: In response to the need for a general guide to the plant-life of Sydney for the Olympics, Jocelyn Howell and Doug Benson prepared this magnificent new publication for publication in August 2000. The book was edited by Penny Farrant and beautifully designed by Helen Stevensen in the Design and Editorial Section of Corporate Services Branch. Staff photographer Jaime Plaza provided most of the colour photographs.

Native Vegetation Conservation Strategy for New South Wales

Ecologist John Benson, representing the Gardens and the Ecological Society of Australia on the Native Vegetation Advisory Council (NVAC), contributed to the preparation of a draft *Native Vegetation Conservation Strategy for NSW*. This Strategy contains over 90 actions under six themes aimed at protecting native vegetation. The rationale for these proposed actions is contained in seven 50 page background papers. The first background paper, prepared by John Benson, is titled *Setting the Scene: the Native Vegetation of New South Wales*. It was published in 1999 and is available on the Gardens and Department of Land and Water Conservation web sites. The other six papers, which have recently been released, deal with social values, ecological values, Aboriginal values, economic values, greenhouse impacts and climate change and existing and proposed opportunities for protecting native vegetation. The draft Strategy will be available for public comment in late 2000.

Northern Tablelands Vegetation

A map of the vegetation communities of the Guyra 1:100 000 map sheet accompanied by a 130-page scientific paper will be published in *Cunninghamia* in September 2000.

This is one of the most detailed regional vegetation surveys undertaken and maps published in Australia. It depicts vegetation remnants down to one hectare in size, digitised onto a geographical information system at 1:25 000 scale. Each vegetation remnant is coded for floristic composition, structure and degree of disturbance in the GIS. This survey and mapping exercise sets standards for the type of vegetation survey and mapping required for regional vegetation planning in rural New South Wales.

Population Studies on *Persoonia* (Proteaceae)

Postgraduate student Chris Nancarrow, co-supervised by Dr Peter Weston, continued to investigate the pollination biology and population ecology of a group of sympatric *Persoonia* species and their hybrids in the Blue Mountains. Chris has been looking at processes that influence interspecific hybridisation in this genus. His results suggest that degree of overlap in flowering time may be one of the most important factors influencing the degree of reproductive isolation between different species. He has also been asking whether hybrids may form a 'conduit' for genetic introgression between some species.

In 1999 Dr Weston, in collaboration with Professors Rob Whelan and David Ayre (University of Wollongong) and Dr Tony Auld (NPWS), was awarded a ARC-SPIRT grant. This grant has funded two PhD students, Paul Rymer and David McKenna, both of whom enrolled early in 2000. They will be working on the population genetics and population ecology, respectively, of rare, fire-sensitive *Persoonia* species and their more common and widespread relatives. Paul's project will look at mating systems, gene flow and selection in several species. These taxa will also be the subject of David's investigations of fire responses, reproductive success, seed dispersal and seed predation. Results should be directly applicable to recovery planning by predicting site persistence of the threatened species and assessing management options.

Survey of *Waterhousea floribunda*

Under the supervision of John Benson, Lisa Hill is conducting a survey of riparian rainforest dominated by *Waterhousea floribunda* on the lower north coast of New South Wales. This plant community is poorly represented in reserves and mainly occurs on private land. It is threatened by weed invasion, river bank erosion and grazing by cattle. The survey will document the distribution of the community, its conservation status and threats, and make recommendations about management and restoration.

Sydney Region Vegetation

Vegetation mapping of the Wollongong and Southern Highlands area by ecologists Doug Benson and Jocelyn Howell is being incorporated into a major Department of Land and Water Conservation/National Parks and Wildlife Service project covering vegetation of the Illawarra and South Coast. Doug Benson is on a steering committee for this work. Monitoring of Cumberland Plain vegetation in permanent plots at Mount Annan Botanic Garden, begun in 1990, is continuing. This project will provide insights into issues such as weed invasion and fire that are relevant to management of the endangered ecological communities of western Sydney.

Horticultural Research and Development Theme

There are two driving forces behind our horticultural research programs: firstly, the need to provide horticultural solutions to conservation problems; secondly, a desire to increase the number and variety of species available in horticulture. Techniques include the development of biotechnological methods for mass-propagation and ex situ conservation; DNA finger-printing of rare populations and cultivars; and the selection and development of plants, both native and exotic, which are new to commercial Australian horticulture.

In the past priorities have been set by a mix of government and horticultural industry needs. Over the next year we will establish new programs based primarily around conservation and vegetation management in New South Wales, in particular recovery plan priorities and growth requirements and biology of rare species. Alternative directions might include salinity horticulture (including revegetation) and community plant use. The research group will continue to provide advice and expertise for other horticultural development within the Gardens, and assist in the management and development of the seedbank.

Flannel Flowers

The Gardens conducted extensive testing and trials to develop propagation and cultivation techniques for flannel flowers. This program is aimed at encouraging the sustainable development of flannel flowers as an export cut-flower crop and as a pot or garden plant. The results of the scientific research on aspects of cultivation were presented by Horticultural Researchers Lotte von Richter and Cathy Offord at a number of conferences and workshops and published as a major internet report available to all flannel flower growers. As a result of this research the New South Wales Centenary of Federation Committee has adopted the flannel flower as the floral emblem for celebrations in 2001. A number of cultivars have been developed and are being produced by licenced growers for release under the Gardens' new plant label.

Silicon Addition to Potting Mixes

A study was concluded at Mount Annan to examine the effects of adding silicon to potting mixes. It has been suggested that silicon can increase the health of potted plants. The study was run in conjunction with the University of Western Sydney and funded by the Horticultural Research and Development Corporation. Papers are being prepared on this work.

Waratahs

Research Officer Cathy Offord is close to completing her thesis on waratah reproductive biology and genetics for application in the breeding of waratahs. Information on flowering is being generated through a series of experiments including control of bract burn and flower borers, the two major problems experienced with the flowering of waratahs. A large number of tubbed waratahs were prepared for massed displays during the Olympic period.

Weed Assessment

A new program was established to research the weed potential of Australian plants that are being considered for commercialisation. Student Amelia Martyn of the University

of Sydney completed a thesis on this topic, using *Swainsona sejuncta* as a test case. The results will be published over the next year.

Wollemi Pine

Experimental work on seed physiology and requirements for young plant growth were concluded with one paper published and several more in preparation. This research has provided us with insights into how and why the Wollemi Pine is confined to such a small area, and why it is unable to spread under present conditions. A number of plants were sent to one of our partners, the Queensland Forest Research Institute, with the aim of researching and developing the Wollemi Pine for commercial release. This work, in conjunction with our other partner Birkdale Nursery who will market the pine, ensures access to plant material by all and that aspects of cultivation are well understood. Plants in the ground at Mount Annan, Mount Tomah and Sydney Gardens were closely monitored for growth characteristics. Pollen and seed cones were produced on plants propagated from adult material. This is significant because it may allow early cone and seed production. Research into cone, bud and root production continued with various research partners including Professor N. Prakash of the University of New England and Dr G. Burrows of the Charles Sturt University.

Fungi and Plants Theme

Plant health is the major focus of this theme. The research component is now confirmed as the nature, classification and control of fungi, both disease-causing and beneficial. The Plant Disease Diagnostic Unit complements services provided by the Department of Agriculture by focussing on pests and diseases of ornamental plants. It also plays an important role in the Gardens' integrated pest management programs. Molecular diagnosis is a growing area for research and service delivery.

Priorities are set largely by industry needs. The long-standing program on Fusarium continues to be of relevance to agriculture and horticulture in Australian and overseas. New directions will include a greater emphasis on the fungi associated with native species, linking in with other research programs in the Conservation and Horticultural Research Section.

Armillaria Root Rot

A molecular detection method for *Armillaria* has been developed by PhD student Jillian Smith-White. This technique not only allows the detection of minute levels of *Armillaria* but also enables differentiation between the different Australian species. Approximately 150 collections were made during the fruiting period in May-June of 2000 of which 57 originated from the Royal Botanic Gardens Sydney location. A molecular study has been initiated using these isolates to investigate population dynamics.

Fungi Causing Leaf-spot Diseases of the Proteaceae

A major study was initiated on documenting and describing the species of fungi causing leaf spot diseases on plants in the family Proteaceae. Professor Pedro Crous, of the University of Stellenbosch in South Africa, spent six weeks at the Gardens as a

visiting research fellow on this project. Many new species of fungi were discovered during Professor Crous' visit, and even more discovered since. Funding for this project has subsequently been provided by the Hermon Slade Foundation, allowing an expansion of this project.

Fusarium

Research on the genetic analysis of the *Fusarium* species causing a wilt disease in the Canary Island Date Palm has shown that in Australia the fungus is more complex genetically than it is where the fungus causes problems in overseas countries. A macromolecular diagnostic tool was adapted for use here and was shown to be reasonably robust, particularly on isolates from fronds of the palm. This technique is now used regularly in the Plant Disease Diagnostic Unit.

The Slade Orchid Fund sponsored research on *Fusarium* species associated with root rot diseases in orchids. This research showed that the *Fusarium* species affecting orchids are a diverse group of fungi and that the development of a diagnostic tool is not practical.

Dr Brett Summerell was a guest lecturer at a Laboratory workshop on *Fusarium* identification held at Kansas State University in June.

Plant Disease Diagnostic Unit

The Plant Disease Diagnostic Unit is a commercial service for the diagnosis of diseases and pests, with an emphasis on the diagnosis of diseases of amenity plants. In 1999/2000 the Plant Disease Diagnostic Unit processed 127 samples for disease diagnosis, 84 from external clients and 43 from the Gardens.

Nearly half (43%) of external enquiries originated from private gardens in the Sydney region with consultants and government bodies such as the Olympic Coordination Authority together contributing another 46% of samples. As we have found in previous years, soil-borne diseases, mainly *Phytophthora* spp (29%) and tree diseases, mainly *Armillaria* and cypress canker (36%) made up the bulk of the diagnoses. A further 10% of samples were from palms, predominantly *Phoenix canariensis*, underlying the importance of our continuing research into *Fusarium oxysporum* f. sp. *canariensis*, the causal organism of *Fusarium* wilt.

Samples from within the Gardens involved the diagnosis of root and trunk rots, foliar pathogens and the identification of fungal fruiting bodies. The development of a molecular-based test to reliably detect *Armillaria* from bark and root samples has helped in mapping the location of the disease in the Gardens and also offers an improved diagnostic test to our external clients.

Waratah Bud Borer

Alex Newman compared seven pesticides of varying degrees of toxicity for the control of *Xylorycta luteotactella* (Waratah bud borer) on semi-mature pot-grown waratah plants over a period of 10 months. Results indicated that the most effective pesticides were maldison, carbaryl, *Bacillus thuringiensis* and cyfluthrin. Two main seasonal peaks of the insect occur in April and August, with a smaller one in February; and the most effective spray interval was two weeks out of a set of 2, 4 and 10 weeks (4 and 10 week intervals were not far behind).

Part 3: Plant Diversity Section

Previously titled 'Systematic Botany', this section includes research on the diversity, classification and relationships of plants, and the management and application of our botanical collections. The custodianship of collections in the National Herbarium of New South Wales and the provision of systematics research and information are two core legislative drivers for the Gardens. Three key research programs were established under the Plant Diversity Theme, and user-friendly access to data has been identified as the major communication objective.

Flora of Australia Program

We do not know what plants, fungi and algae occur in Australia. It is hard to believe such fundamental knowledge is lacking. The biggest gap in our knowledge is the thousands of undiscovered or unnamed microscopic and flower-less plants. We spend billions seeking life on other planets, but we don't even know what grows in our backyard. Even where the gaps are not so big — the flowers and trees we know so well — a discovery like the Wollemi Pine brings us back to earth!

Plant systematists around Australia work together to document our flora. The Gardens is part of this collaborative effort, with a long-standing expertise in flowering plant groups such as eucalypts and wattles, but also a wide range of expertise in other groups well represented in New South Wales.

Priorities are set by the Flora of Australia publication program, stakeholder demands for resolution of taxonomic problems, and nationally recognised knowledge gaps. In consultation with other members of the Council of Heads of Australian Herbaria, the Gardens will focus on bryophytes and algae as its contribution to the gap in cryptogam knowledge (the so-called 'forgotten flora').

Substantial funding would be required to house the fungal collection (currently on long-term loan outside the Gardens) and to establish a critical mass for a fungal research group. We are consolidating our expertise on microfungi through the Fungi and Plants program, but in the short-term there will be no expansion into macrofungi (e.g. toadstools and bracket fungi).

Bryophytes

In February Professor Tamas Pócs visited the herbarium and collected bryophytes in northern New South Wales with Dr Elizabeth Brown and Robert Coveny. The work contributed to his revisionary studies on the genus *Frullania* (Hepaticae) for the *Flora of Australia* but proved fruitful in other areas as well. Whilst looking at Queensland specimens Professor Pócs located a new species of *Radula* in a collection made by staff members in 1995. A paper describing the minute species (200–300 µm wide) has been submitted to *Telopea*. In addition to collecting a range of *Frullania*, the field work (funded through the *NSW Biodiversity Strategy*) resulted in the finding of a new member of the Lejeuneaceae that is likely to be described as a new genus. Elizabeth

Brown undertook further fieldwork on Lord Howe Island in early June. At least one of the taxa collected (a *Frullania*) may be new to Australia and/or science.

Dr Helen Ramsay (Honorary Research Associate), in collaboration with J.R. Spence (Glen Canyon Nature Reserve, Page, USA) and A.J. Shaw (Duke University, Durham USA), continued work on the Bryaceae for *Flora of Australia*. The family contains 11 genera and 69 species in Australia; two new genera and five new species have been described and the *Flora* manuscript was handed to ABRS.

Helen Ramsay made good progress with a revision of the Sematophyllaceae in Australia and Part I (4 genera and 8 species) will be sent for publication soon. The studies are being carried with collaboration with B.C. Tan (Singapore University) and W.B. Schofield (University of British Columbia).

Work on chromosome studies on moss species from Australia, New Zealand and Papua New Guinea is substantially complete. It is expected that several papers will be sent for publication in the next year.

Ericaceae: Epacridoideae

Dr Elizabeth Brown continued her work on the systematics of the subfamily Epacridoideae. During a 3-month visit, Nikola Streiber, a student from Bonn University, collaborated with her on the systematics of the genus *Dracophyllum* in New South Wales. The project resulted this year in the publication in *Telopea* of two new species for the State with a third taxon requiring further work before its status can be established.

Fabaceae: Faboideae

PhD student Peter Jobson (University of Technology Sydney) and his Gardens' supervisor Dr Peter Weston, made further progress on a taxonomic revision of *Dillwynia* (Mirbelieae). *Dillwynia crispia* and *D. palustris*, both rare and threatened species from the Southern Tablelands of New South Wales, were formally named and described in *Telopea*. A paper naming another rare new species from the Northern Tablelands of New South Wales has also been submitted for publication. An updated treatment of the genus was completed for the second edition of volume 2 of the *Flora of New South Wales*. In this, the number of species listed as native to the state is increased from 17 to 25. Molecular systematic work based on *trnL-trnF* plastid DNA sequences has progressed slowly but preliminary analyses are consistent both with the monophyly of *Dillwynia* and of Bentham's two subgenera.

Fabaceae: Mimosoideae

The preparation of the first version of a web-based computerised identification and information system for the *Acacia* species of New South Wales continued. The team working on this project include Dr Barry Conn, Dr Phillip Kodela, Ken Hill and Terry Tame (Honorary Research Associate).

Barry Conn and Terry Tame have begun an evaluation of the morphological variation within the *Acacia decora* group. This variable species is recognised as occurring in eastern Australia, from northern Queensland, New South Wales and extending into Victoria.

Freshwater Algae

Simon Lewis at the Royal Botanic Gardens Melbourne continued to work with Dr Tim Entwisle on an *Australian Biological Resources Study* funded project on the filamentous green algal family Zygnemataceae. An account for the *Algae of Australia* series, including 5 genera and 45 species, is almost complete, and a paper describing a new species of *Spirogyra* has been submitted to *Muelleria*. The Zygnemataceae is a cosmopolitan family of 12 genera and nearly 800 species, with representatives found in lakes, streams and ponds, sometimes producing weedy problem growths in farm dams.

Dr Stephen Skinner has worked through herbarium holdings and collections from several field trips to document new species and new records of macroalgae from freshwater habitats in New South Wales. Three new species have been discovered and 24 new records for New South Wales. Four papers will be submitted to *Telopea* in late 2000.

Honorary Research Associate Mike Dingley has two papers ready for publication documenting five new species and 79 new records of desmids (microalgae) for New South Wales.

Lamiaceae

Field studies of the genus *Ocimum* in Queensland clarified several aspects of the distribution, habitat requirements and morphological variations within this group. This genus is currently being revised for Australia by Dr Barry Conn.

Lichens

Honorary Research Associate Dr Alan Archer continued his studies on Australian taxa in the family Graphidaceae, in particular the genera *Graphis*, *Graphina*, *Phaeographis* and *Phaeographina*. In each genus additional taxa are reported from Australia for the first time and a number of new taxa have been described in papers either published or submitted for publication. The only species in the Australian endemic genus *Gymnographa* Müll. Arg. was found to be based on a degraded specimen of the endemic *Phaeographis eludens* (Stirt.) Shirley. An illustrated talk on the Australian Graphidaceae was given in Melbourne at the 14th Meeting of Australasian Lichenologists. The next meeting, in 2002, is to be held in Sydney.

A specimen of the New Zealand endemic species *Dictyographa cinerea* (C. Knight) Müll. Arg. was found near Sydney, the first report of this genus in Australia.

Marine Algae

Dr Alan Millar discovered 20 new species, three new genera and 20 new records of marine algae in New South Wales. Results from previous years were published in eight floristic papers in international journals. Alan Millar continued to attract funding for marine algal research, including major grants from the *NSW Biodiversity Strategy*, the Hermon Slade Foundation, and (with G.T.Kraft, University of Melbourne) the *Australian Biological Resources Study*, and a smaller grant from NSW Fisheries to survey introduced marine pests in Botany Bay. The marine algae in NSWDATA are now ready for inclusion in PlantNET.

Nick Yee, a research assistant funded through the *NSW Biodiversity Strategy*, is

processing and databasing many of the collections from New South Wales. He has also started a major research project with Alan Millar on the molecular phylogeny of the brown algal order Sporochneales. The entire order is endemic to Australia save for the one New Zealand genus *Perisporochnus*.

Restionaceae and Allied Families

Study of the Restionaceae by Honorary Research Associate Dr Barbara Briggs continued, using both morphological and DNA data. Phylogenies were published, based on DNA sequences of two chloroplast genes (in collaboration with Dr Adam Marchant, Carolyn Porter and former staff member Simon Gilmore) and on morphological data (with Professor Peter Linder, University of Cape Town). A summary of the new classification of the 34 Australian genera and 146 species was presented and a review of their conservation status (with Professor John Pate, University of Western Australia and Dr Kathy Meney and Dr Kingsley Dixon, Kings Park and Botanic Garden, Perth). On the basis of DNA data and morphological studies, *Hopkinsia* and *Lyginia* have been excluded from Restionaceae and two new plant families, Hopkinsiaceae and Lyginiaceae, were described. Papers are being prepared to formally name the many undescribed species now distinguished and further studies are in progress to clarify affinities of Restionaceae to other families, relationships within the family and aspects of their evolution and biogeography.

Rutaceae

New species keep 'popping up' in Wollemi National Park, a large wilderness area north east of Sydney. The latest is a new *Leionema* species that was previously known only from a small scrap collected at Hungryway Creek, a tributary of the Colo River, by bushwalker Rudi Lemberg in the early 1960s. Subsequent searches of this creek failed to relocate it. In April 2000 Tony Rodd rediscovered a healthy population of this species on the banks of the Colo River. He and Dr Peter Weston later collected flowering material for description and illustration.

Origins and Evolution Program

Through the study of plant relationships the Gardens is part of an international effort to unravel the history of Australia's biota. Fossils give us tantalising glimpses of the past but the full story of plant evolution is contained within the morphology and genes of current day species. Over coming years we will consolidate our research in this area to focus on key questions in the history of Australia, before and after the splitting of Gondwana over 80 million years ago.

Priorities are set by the scientific questions left unanswered, national priorities (such as through the Australian Research Council), and the expertise available within the Gardens and collaborating organisations. The biota is best treated as a whole, and collaboration will be sought with, for example, the Australian Museum.

In addition to telling us more about the country we inhabit, research on relationships, origins and evolution can provide an alternative way to set conservation priorities and discover new species, and a means of understanding (and managing) responses of plants to the environment (e.g. the origin of fire tolerance in the Australian flora).

Dennstaedtiaceae

The first worldwide overview of the bracken ferns (*Pteridium*) for 60 years has now been completed by Honorary Research Associate Professor John Thomson using both morphological data and molecular evidence of relationships amongst these ferns based on DNA fingerprinting using arbitrarily-primed PCR. The DNA evidence suggests that morphotypes in *Pteridium* are determined by specific qualitative and quantitative combinations of a limited number of highly conserved, additively assorted, genomic elements. The taxa *africanum*, *aquilinum*, *arachnoideum*, *decompositum*, *esculentum*, *latiusculum* and *revolutum* — accorded varietal status in Tryon's monographic treatment of the genus — would be better treated as species; *pseudocaudatum* and *pubescens* should be regarded as varieties within *latiusculum*; while *yarrabense* and *caudatum* (at least in part) are respectively South-east Asian and American hybrids between southern and northern hemisphere progenitors. Ancient allopolyploidy followed by one or more rounds of autogamous allohomoploidy can account for the origin, interrelationships and maintenance of these morphotypes within *Pteridium*.

Ericaceae: Epacridoideae

Collaborative work between Dr Elizabeth Brown and Associate Professor C.J. Quinn and his team at the University of New South Wales continued throughout the year. The investigation of generic relationships using morphological and DNA studies is substantially complete and much of the work is in the process of being prepared for publication. Further work may be required to elucidate or confirm relationships within the *Epacris* and *Astroloma-Leucopogon-Styphelia* groups.

Eudicots

DNA sequences of the plastid gene *rbcL* have proved particularly useful in helping to reconstruct phylogenetic relationships amongst families of flowering plants. Interestingly, the greater the diversity of sequences that are added to these analyses, the more robust the results appear. The RBG has contributed sequences of some key taxa to the *rbcL* database, and on the strength of this involvement, Senior Research Scientist Dr Peter Weston was invited to join 16 other international authors in writing up an analysis of relationships amongst families of 'eudicotyledons' based on *rbcL* sequences. The eudicots are a clade characterised by tri-aperturate pollen grains (or further modifications of that pollen morphology) and include the great majority of angiosperm taxa. The results of this analysis were published in the June 2000 issue of *Kew Bulletin* and are almost completely consistent with the revised angiosperm classification proposed in 1998 by the Angiosperm Phylogeny Group.

Fabaceae: Faboideae

Dr Weston's collaboration with Dr Michael Crisp and Simon Gilmore, of the Australian National University, on the molecular systematics of *Pultenaea* and its close relatives, came to fruition as a paper published in *Taxon*. This analysis, based on alignments of *trnL-trnF* plastid DNA and ITS nuclear ribosomal DNA sequences, resulted in the recognition of a new monotypic genus, *Stonesiella*, endemic to Tasmania.

Freshwater Red Algae

A collaborative molecular study of a rare alga known from a single locality in New South Wales (Barren Grounds Nature Reserve), several localities in south-west Tasmania and two sites in northern New Zealand was published. Based on a chloroplast (rbcL) and nuclear (ITS region) genes, three 'genetic races' of *Psilosiphon* were identified, with the race from Tasmania more closely related to the one from New Zealand than to the one from New South Wales. The relationship is thought to represent a Gondwanic relic rather than a recent dispersal event.

The collaboration of Dr Tim Entwisle with Dr Morgan Vis of Ohio University in the USA has continued with a second paper accepted for publication. This study looks more broadly at relationships within the order Batrchospermales (including *Psilosiphon*), identifying a distinctive Australian clade as well as some more widespread taxa. A mix of genetic and morphological studies will be used to tackle various systematic and biogeographic questions in this interesting group of stream inhabiting organisms.

Myrtaceae

A paper on the phylogeny of the family Myrtaceae was presented by Dr Peter Wilson to the International Botanical Congress in August, 1999. This work combined DNA data from collaborative work between the RBG, the University of NSW and the University of Wisconsin, Madison (USA).

A new collaborative project between the RBG and the University of New South Wales has begun. This project has been funded by the Australian Biological Resources Study (ABRS) and is aimed at clarifying generic concepts in *Baeckea* and related genera.

A paper was prepared and submitted transferring a rare species to a new genus. This plant was initially identified as distinct from the other species in the genus in which it had originally been placed on the basis of DNA sequence data. Its distinctness was then confirmed by closer examination of morphological and anatomical characteristics.

A paper on future directions in eucalypt research was presented by Ken Hill to the International Botanical Congress in St Louis (USA) during August, 1999.

Orchidaceae

Dr Peter Weston co-supervised two PhD projects on the phylogeny of orchids in Australia. Postgraduate student Jim Mant has the 'sexiest' project in the Gardens - the co-evolution of *Chiloglottis* orchids and their pollinators. The basis for this claim is not that the orchids are spectacularly beautiful (they're not – they're small and look like insects) but that they engage in sexual deception. They attract their male thynnine wasp pollinators by releasing the same pheromones that female thynnine wasps exude when 'calling' for a mate. One of the most intriguing things about this relationship is that most species of *Chiloglottis* attract their own species of wasp (most of which belong to the genus *Neozeleboria*). The first question asked was how this one-to-one relationship had evolved. Has it evolved gradually by the proliferation of a stable relationship, the orchids having speciated together with their wasps? Or has the relationship been unstable, involving evolutionary 'leaps' by orchid species from one pollinator to another?

These alternatives are being tested by reconstructing the phylogenies of orchids and wasps and comparing them for historical consistency. If orchids and wasps have speciated together then their phylogenies should be mirror-images of each other. Phylogenies for both orchids and insects are being reconstructed by analysing DNA sequences. Preliminary results strongly suggest that co-evolution of these orchids and wasps has involved a number of sudden pollinator shifts. The pollinators form three major lineages. These three groups correspond strongly to emergence time. One group includes all the autumn-emerging wasps (pollinators of autumn-flowering *Chiloglottis* species). The other two groups emerge in the spring and pollinate two distinct groups of spring-flowering *Chiloglottis*. The challenge now is to build a clearer picture of how shifts in orchid flowering time can occur and how the specialisation by *Chiloglottis* on one genus of wasps is maintained.

Postgraduate student Andrew Perkins has been investigating the phylogeny of the Australian native 'beardy orchids', *Calochilus*. Over the last year Andrew Perkins has sequenced nuclear and plastid DNA spacer sequences from almost all species. These data sets have proved to be completely congruent with each other and with Andrew Perkins' earlier morphological work. The aims of this research include reconstruction of the biogeographic history of the genus and in particular, that of the species from New Zealand and New Caledonia. Did seeds of the non-Australian species blow across the Tasman Sea or did they ride out into the Pacific on drifting continental fragments? These questions are being investigated using cladistic biogeographic and molecular clock analyses.

One of the nuclear genes that Andrew Perkins and Peter Weston have found particularly informative is the external transcribed spacer (ETS) of the nuclear 45S ribosomal DNA repeat unit. Andrew designed his own amplification primers for this gene and discovered that they work for the great majority of orchids. No orchid ETS sequences have been published by anyone yet and a number of workers have privately reported difficulties in amplifying this locus. A methodological paper reporting on the efficacy of these primers is in preparation.

Most pollination vectors do not see the world in the same way that we do. The range of wavelengths visible to most insects, for instance, extends far into the ultraviolet. Peter Weston collaborated with James Indsto (Westmead Millenium Institute) to investigate near-ultraviolet reflectance patterns of flowers of the orchid subtribe Dendrobiinae. The first paper resulting from this research was published in *Monocots: Systematics and Evolution*. It showed that near-ultraviolet patterns are more phylogenetically conservative than colour patterns in the human visible range. They correlate to some extent with the scanty published information on pollination vectors in *Dendrobium*, and also more closely with recently published molecular phylogenies than with the existing classification. In 1999 James Indsto and Peter Weston started a similar project on *Diuris*, a genus that is thought to mimic the flowers of bee-pollinated taxa, including 'egg and bacon' peas. Comparison of the near-ultraviolet reflectance patterns of flowers of *Diuris* and co-blooming peas has already uncovered some striking similarities.

The results of Peter Weston's collaboration with Dr Paul Kores, Dr Mia Molvray (both University of Oklahoma, USA) and Dr Mark Chase (Royal Botanic Gardens Kew, UK) on the molecular systematics of the tribe Diurideae, were published in *Monocots*:

Systematics and Evolution. This analysis used plastid DNA *matK* sequences to construct the first detailed phylogenetic analysis of intergeneric relationships in this tribe. It has suggested a number of novel, but strongly supported generic groupings that are neither supported nor refuted by morphological characters. One of the many insights provided by this work is the discovery that sexual mimicry has evolved independently in at least six different diurid lineages. Already this team is working on an improved analysis, based on a combined data set of *matK* and *trnL-trnF* plastid DNA sequences.

Poaceae

Fieldwork in New South Wales completed sampling of Australian species of the grass tribe Stipeae for DNA analysis. Although herbarium material can often be used for DNA analysis there are some species for which fresh material seems to be necessary. The leaves must be placed immediately upon collection in a preservative solution. Dr Surrey Jacobs and Joy Everett are collaborating with an international group to investigate the relationships of this tribe. Scanning Electron Microscope studies with Jane Dalby and Wayne Cherry will be added to the dataset in the coming year.

Proteaceae

Dr Peter Weston and Carolyn Porter have been reconstructing the phylogeny of the genus *Persoonia* and its close relatives, using nuclear and plastid DNA sequences. Results from plastid sequences closely resemble those earlier produced from nuclear sequences, both of which complement morphological variation. This work will have nomenclatural consequences as well as contributing to our knowledge of the biogeographic history of the south-west Pacific. It will also allow a more sophisticated analysis of the evolution of pollination syndromes in *Persoonia*.

Asia-Pacific Taxonomic Initiative Program

The Gardens has contributed for a number of years to the discovery and documentation of plants in the local region outside Australia. As part of our national responsibilities under the United Nations Convention on Biological Diversity, we are assisting neighbouring countries to gain the knowledge to manage and conserve their vegetation. Many countries in this region have been identified as lacking the most fundamental biodiversity information. The Gardens is one of the region's chief providers of the expertise and experience needed to address this gap. Sydney, as Australia's 'gateway to the Pacific', continues to look outward to the Asia-Pacific region.

Our emphasis is on training, knowledge exchange and collaborative projects with the host countries. Priorities will be set by international programs, host country needs and our expertise. Most of our research in this area will be funded externally.

Araceae

Dr Alistair Hay, with the assistance of Clare Herscovitch, completed a revision of *Schismatoglottis* (Araceae) in Malesia, including about 90 species. During Alistair Hay's visit to the Royal Botanic Gardens Kew (UK) he revised other genera in the tribe Schismatoglottideae (namely, *Aridarum*, *Bucephalandra*, *Phymatarum* and *Piptospatha* — including 24 species in all). These revisions are precursors to the forthcoming account of Araceae for *Flora Malesiana*.

Yuzammi from Kebun Raya, Bogor (Indonesia) submitted her thesis entitled 'A taxonomic study of the terrestrial Araceae of Java' for the degree of Master of Science at the University of New South Wales.

Clare Herscovitch continued to prepare, database and distribute to other herbaria, material from the living research collection of Araceae, and to distribute remaining living material from the collection to other botanic gardens.

Building on taxonomic work undertaken at the Gardens, a macromolecular study of *Alocasia* was initiated at Singapore Technological University, as a PhD project by Carol Wong, co-supervised by Alistair Hay. Material from the Gardens' living collection provided an important source of information for this research.

A joint project was negotiated between the Gardens and Kebun Raya, Bogor for Yuzammi, other Kebun Raya staff, and Loraine Perrins and Darcy Orndoff (RBG) to undertake a study of macropropagation methods in *Amorphophallus titanum*. The project will be led by Alistair Hay.

Cycadophyta

Ken Hill completed three weeks field study on the cycads of Vietnam in January 2000. He was assisted by Dr N.T. Hiep of the Vietnam Institute of Ecology and Biological Resources and Professor P.K. Loc of the University of Hanoi. This finalised the study of the cycads of Vietnam, recognising 25 species (9 undescribed). An account of this study has been accepted for publication in the *Memoirs of the New York Botanical Garden*.

Another field study trip to examine the cycads of China was commenced in June 2000. A short trip was also conducted to examine potential new taxa in Thailand in February 2000, resulting in discovery of two new species. A paper describing these has been prepared in collaboration with A. Lindstrom of *Teh Nong Nooch Tropical Garden* in Thailand, and accepted for publication in the *Journal of the Siam Natural History Society*.

Analysis of molecular data continued for data accumulated for the cycad genera and the genus *cycas* in particular, and a paper on the molecular phylogeny of the cycadales is in preparation in collaboration with Dr M.W. Chase of the Royal Botanic Gardens Kew (UK) and Dr D.W. Stevenson of the New York Botanical Garden (USA).

Pteridophyta

Honorary Research Associate Professor Emeritus Carrick Chambers continued his taxonomic investigation of *Blechnum* in the Pacific region. A manuscript (in collaboration with Dr Penny Farrant) on the systematics of the genus in Malesia was submitted for publication. A revision of selected species groups in Africa, Malesia, Australasia, Oceania, Meso and South America is in progress.

Urticaceae

A research group headed by Dr Barry Conn was formed to study the systematics of the Urticaceae for the Malesian region. Julisasi Hadiah (Kebun Raya, Bogor) joined the team as a PhD student studying the systematics of *Elatostema* in the Indonesian Archipelago. Associate Professor Chris Quinn (University of New South Wales) is joint supervisor of this project. Dr Reed Beaman successfully obtained a Post-doctoral

fellowship (funded by the National Science Foundation, USA) to work on automated mapping of plant distributions by parsing locality descriptions on specimen labels using the Urticaceae of the Malesian floristic region as a case study.

Management of Preserved Collections Program

The National Herbarium of New South Wales is where the State holds its reference library of a million preserved plants. The herbarium collection represents a comprehensive and accurate biodiversity record through time (as the flora changes) and space (representing the variation and distribution of species). This vital part of our scientific heritage requires expert scientific and technical curation. A key objective over the next few years is to unlock the rich store of information in the herbarium through databasing the collection information.

Electronic Data Exchange

Electronic data is now automatically exchanged with organisations that receive replicates of our physical collections. We can receive electronic data for all material sent to us, with the Royal Botanic Gardens Melbourne providing the first batches.

With the increased need to share electronic data between other natural resource agencies, a review of the international data interchange protocol HISPID3 was led by Dr Barry Conn (editor). In particular, corrections to the transfer of spatial data elements were completed.

The Gardens was a collaborator with the State Herbarium of South Australia and the Centre for Plant Biodiversity Research, Canberra in developing a prototype distributed web-based database system for presenting distribution maps of *Acacia* species based on vouchered herbarium records. The 'Virtual Herbarium' will be expanded to include all major State and Territory herbaria as an initiate of the Herbarium Information Committee (HISCOM). This is a national subcommittee of the Council of Heads of Australian Herbaria.

Herbarium Specimen Database

A review of electronic information requirements of the Herbarium specimen database (NSWDATA) was undertaken as part of a review of the Garden's accession database requirements. This review was coordinated by the *Collection Data Specifications* Project Team (Dr Barry Conn, Gary Chapple and Chris Ward) and represented the preliminary stages of developing specifications for a new electronic Collection Management System for the RBG.

Methodology to Assess Curatorial Standards

The Gardens again coordinated the annual survey of curation standards in State and Territory herbaria. The data is presented each year to the Council of Heads of Australian Herbaria and used by herbaria to benchmark their own performance. The highest priorities for our National Herbarium of New South Wales are to keep the collection free of insect attack and to database the remaining 75% of specimens.

Communication and Services Program

A major recommendation of the review was to make our research results and expertise more accessible to the general community. Descriptions, illustrations and identification tools will be part of the expanded PlantNET system. Linked to the collections of all State and Territory herbaria through Australia's Virtual Herbarium, PlantNET will provide an up-to-date Flora of New South Wales and a series of interactive keys and information packages. Our commitment to teaching and student supervision is a concrete way for the Gardens to fulfil its legislative objective 'to increase and disseminate knowledge with respect to the plant life of Australia and of New South Wales in particular' and 'to give particular emphasis to encouraging and advancing the study of systematic botany, and to plant conservation'.

The Botanical Information Service now includes electronic delivery of information, through PlantNET, as well as a plant identification service and self-help reference collection. The hardcopy Flora of New South Wales has been updated, continuing to provide a summary of our research on the diversity and classification of the State's plant species. Through a mix of print and electronic products the Gardens will maintain its core role as provider of information on the plant diversity of New South Wales.

Botanical Information Service

Government, non-government and community groups continued to seek botanical information and request plant identifications from the Service during the year. The introduction of a charge for identifications had little impact on the number of inquiries but has resulted in more equitable cost recovery. The integration of the Service and PlantNET will continue in the next year to improve the delivery and accessibility of our services.

INQUIRY STATISTICS	1999–2000	1998–1999
Inquiries by mail	1321	1543
Inquiries by telephone	2326	2517
Inquiries in person	375	733
Inquiries by Internet	471	N/A
Requests for Electronic Data	22	N/A
Specimens Identified	5211	6146
Revenue 1999–2000 \$17,786; 1998–1999 \$5738		

Flora of New South Wales

A supplement to *Flora of New South Wales*, Volume 1 was published late February. This 114 page publication incorporated changes that have occurred since the publication of this volume in 1990. These additions and corrections are the result of ongoing research on the Australian flora, as well as changes brought to our attention by users of this volume. Some 85 species were included in this supplement for the first time, an increase of over 5%.

Forensic Identification

Government analysts identified forensic material (*Cannabis*) in 26 cases for the Police Service, resulting in revenue of \$1300.

Monocotyledons Publications

The successful conference *Monocots II*, an international scientific meeting on the systematics of the monocotyledons, led to the publication in May 2000 of two volumes of selected proceedings. The editorial team included Karen Wilson, Dr Surrey Jacobs and Joy Everett from the Gardens, as well as Dr David Morrison from the University of Technology Sydney. *Monocots: Systematics and Evolution* (edited by Wilson and Morrison) and *Grasses: Systematics and Evolution* (edited by Jacobs and Everett) were launched by the Hon Carmel Tebbutt MLC, Minister Assisting the Minister for the Environment.

PlantNET

The electronic presentation of botanical information continued through *PlantNET* via the internet (<http://plantnet.rbgsyd.gov.au>). Two major modules were linked to *PlantNET* during the year. *Cycad Pages* presents the latest information on the cycads of the world. This module was designed and developed by Ken Hill and is now a joint project with Dr Dennis Stevenson (New York Botanical Garden) and several other collaborators. It provides descriptions, photographs, distribution maps, and other information on cycads, plus an interactive identification tool for assisting users to identify cycad species. The other major addition was *Freshwater Algae*. This module is a master list of the names of freshwater algae that occur in Australia, with State-based distribution of each alga graphically presented together with its conservation status. The data component of this project was compiled and edited by Dr Tim Entwisle and Lucy Nairn. It was a collaborative project between the Royal Botanic Gardens Sydney, Royal Botanic Gardens Melbourne, and the Australian Biological Resources Study.

The feasibility of developing an internet-based interactive guide to the species of *Acacia* occurring in New South Wales culminated in the production of a prototype intranet version of *WattleWeb*. This prototype was developed by Dr Barry Conn, Ken Hill, Dr Phillip Kodela and Terry Tame. Further development of *WattleWeb* is expected to form the first stage of enabling information about the flora of the State available via the *PlantNET* internet site.

Public Reference Collection

Environmental consultants, students, government agencies, and the general community spent more than 200 hours using the Public Reference Collection to identify plants that they had collected. Volunteers continued to update and expand the collection. The identifications of 36 specimens were corrected and 126 additional botanical specimens were added to the collection. The collection is managed by Louisa Murray. Unfortunately, two volunteer staff retired during the year: Janet Bennett after 13 years and Jill Ford after 5 years.

Teaching and Training

The first students in the new BSc (Biosystematics) program at the University of New England enrolled at the beginning of the academic year. This new course is being run as a collaborative effort between the School of Biological Sciences, University of New England, the Australian Museum, and the Royal Botanic Gardens Sydney. Scientists from the Gardens and the Museum contributed to the first two residential schools which both included an intensive five-day series of lectures and practical work.

Telopea

Telopea volume 8, number 3, was published in December. The diverse range of papers in this issue showcases systematics expertise both within and outside the Royal Botanic Gardens Sydney. It included some important new additions to the flora of New South Wales, making a major contribution to our understanding of the biodiversity of this State.

Botanists from the Royal Botanic Gardens described six new flowering plant species for New South Wales. A new species of *Acacia* from the South Coast is closely related to *A. pycnantha*. The species is rare, and restricted to a 30 km area near Bermagui. Two new species in the pea genus *Dillwynia* were discovered in the Southern Tablelands: both species are rare, one considered vulnerable. A rare *Chrysocephalum* species from coastal ranges north of Taree has been grown in the Gardens for over 12 years, forming an attractive ground cover, but was not formally named until now. The number of species of the native heath genus *Dracophyllum* recognised in New South Wales has now doubled: the two new species are from the Lansdowne area of the North Coast, and the Jervis Bay area in the south.

Contributions to the documentation of Australia's flora include a new species in the Lamiaceae from Western Australia and a new species of grass from Queensland and the Northern Territory. The issue also includes three new species of moss, two from New South Wales and one in Queensland and Northern Territory only.

Part 4: Resources Section

The Resources Section provides infrastructural and other support to the Plant Sciences Branch. Within the Section are the Library, the Botanical Illustration Service, the Herbarium Specimen Preparation Facility, the Volunteer Program, and the Electron Microscopy and Molecular Systematics Laboratories. The Resources Section is also responsible for (but not reported here) the management of the Branch's vehicles and field-work equipment, for business services, and, in collaboration with the Gardens' Property Coordinator, for issues relating to the Brown Building, which houses the National Herbarium of New South Wales.

Library

The Gardens' Library houses a collection of botanical literature, ranging from antiquarian volumes that pre-date Linnaeus, to the latest issues of international research journals. The Library also contains the Gardens' archives. The Library also provides users with access to computerised databases, and an inter-library loan service.

The major objectives for the library are:

- To develop and enhance comprehensiveness of the collection through the acquisitions policy, meeting botanical, horticultural and other institutional needs*
- To improve efficiency by means of an automated loans system, barcoding of materials, enhancement of the on-line catalogue and staff training*
- To maintain the collection by monitoring the library environment, the physical condition of the collection, and by arranging conservation of materials where necessary*
- To identify options to improve management of archival materials and develop policies and procedures to ensure a high standard of recording the Gardens' history.*

New Accessions

This year the library accessioned some 2,753 items (717 monographs, 2044 periodical issues), and bound some 165 journal volumes. In addition 5983 items were loaned or circulated, and 1998 inquiries taken and acted on.

Physical Care

Monitoring and maintenance of the library temperature and humidity at optimum levels continued without any serious fluctuations or impediments.

Botanical Illustration

*The Botanical Illustrators provide detailed and scientifically accurate illustrations of new and renamed species to complement taxonomic descriptions. The illustrations are made from pressed and living plants from Gardens and other collections. The drawings are published in scientific journals, including *Telopea* and *Cunninghamia*. Illustrations are also prepared for the revisions of *Flora of New South Wales*, *Flora of Australia*, *field**

guides, popular books and displays. The illustrators also assist botanists in the creation of computer rendered illustrations and diagrams, particularly for modules of PlantNET.

Job Management

A system for prioritising and recording jobs has been implemented. This will provide an accurate record of work undertaken as well as creating a historical reference of which specimens in the collection have been illustrated.

Major Projects

- Illustrating the new and revised species for the second edition of *Flora of New South Wales, vol. 2* was nearly completed
- Three species of *Davidsonia* (Davidsoniaceae)
- A range of illustrations of Araceae species, including over ten plates of *Alocasia* and *Schismatoglottis* (Araceae) species, a colour and black & white plate of a new species *Alocasia nebula* for inclusion in *Curtis' Botanical Magazine*; illustrations, scanning and layout for Masters Thesis on 'A taxonomic revision of the terrestrial and aquatic Aroids (Araceae) in Java'
- Nine plates of *Cycas* for a paper to be published in *The Natural History Bulletin of the Siam Society*
- A selection of bryophytes: eight plates of *Acromastigum* species, ten plates of the moss genera *Sematophyllum*, *Trismegistia* and *Wijkia*
- Illustrations of the new species *Dracophyllum macranthum*, *D. oceanicum* and *Pentachondra dehiscens* (Epacridaceae)
- A new genus, *Anetholea* (Myrtaceae)
- Ongoing work on *Indigofera* (Fabaceae)
- A new species of *Phebalium* (Rutaceae)
- A new species of *Teucrium*, *T. pilbaranum* (Lamiaceae)
- A cover for *Cunninghamia*, and one vegetation profile
- Selected Restionaceae species
- Twelve plates of desmids (freshwater algae)
- Various species in the lichen genera *Phaeographis* and *Phaeographina*
- Several plates of *Dillwynia* (Fabaceae)

Herbarium Specimen Preparation Facility

The Preparation Facility is where new plant specimens coming into the Herbarium are processed and prepared. Specimens collected in the field are pressed and dried in preparation for mounting and then frozen to ensure they are free from pests before they are incorporated into the collection. In-coming and out-going loans and exchanges are also frozen, to ensure that pests are not transmitted between herbaria. The Facility is also a checkpoint where all specimens entering and leaving the Herbarium can be recorded.

AQIS

In 1999/2000, the Preparation Facility was accredited as an approved Australian Quarantine and Inspection Service (AQIS) facility. This enables the Gardens to process specimens received from overseas, and provide a quarantine service for other Australian herbaria. A meeting between national herbarium representatives and AQIS was organised for and held at the Gardens in July 2000. Outcomes included a cessation of gamma-irradiation for treating herbarium specimens coming into Australia, and the formation working parties to develop generic compliance agreements for herbaria and to clarify the situation regarding exemptions for herbarium specimens in the AQIS database 'ICON'.

Staffing

March 2000 saw the farewell of a long-term employee Judy Wood. Judy commenced in 1989 as a Herbarium Assistant in the Plant Sciences Branch and was the sole operator of the Preparation Facility. For the last quarter of the year, the Preparation Facility was operated with the assistance of staff members from other sections within Plant Sciences, particularly from the Plant Diversity Section, on a roster system.

Volunteer Programs

The mounting program has as its central goal to have the pressed plant specimens securely mounted on archival quality materials, clearly and correctly labelled, and catalogued in the computer database. A major priority is to ensure that all out-going loan material is mounted before being sent out. The program relies on a group of dedicated volunteers, who each give one day per week.

Although most volunteers assist in the mounting program, some work with specific research or curation projects, including scanning and databasing type specimens, and curation of the algae and lichen collections.

Specimen Mounting Program

Sixty-eight regular volunteers mounted 25 326 specimens on archival paper. Outgoing loans, incoming exchange and fragile or vulnerable groups within the Herbarium collection were given highest priority. A total of 1579 cryptogram specimens were also mounted, databased and packaged.

Databasing Program

Volunteers databased in excess of 4 300 specimens during the year. They also assisted with the transfer of data from disks to the Herbarium database (NSWDATA) for exchange specimens for which electronic records were provided from other herbaria.

Other Volunteer Programs

Volunteers assisted with limited general curation and research in the Plant Sciences Branch. Projects included the photographing of Type specimens, maintenance of the Public Reference Collection, and assisting with herbarium research for the *Ecology of Sydney Plants Species* series.

Electron Microscopy Laboratory

The Electron Microscopy Laboratory provides facilities for Scanning Electron Microscopy, including freeze and critical-point drying. These techniques are used in research and plant identification.

Major Projects

- Taxonomic studies of *Senecio* (fireweed; Asteraceae) species in collaboration with CSIRO Division of Tropical Agriculture.
- Development of *Telopea* (Proteaceae) stigmas.
- Taxonomy of *Acacia* rusts (with NSW Department of Agriculture).
- Australian Geographic took a photograph of the Scanning Electron Microscope for inclusion in the article on the botanical collector Robert Brown by Professor David Mabberley.
- The SEM was demonstrated on numerous occasions. The theme for Science Week 'Garden Friends and Foes' included an 'up close and personal' look at a *Mycosphaerella* leaf spot fungus. Groups touring the SEM lab included; Gardens' Guides, new Friends of the Gardens, TAFE students, Illustration Workshop participants and the Australian Plant Society.

Molecular Systematics Laboratory

This laboratory provide facilities and expertise for the use of molecular genetic technology in botanical research.

Major Projects

- Investigation of *Persoonia* (Proteaceae) phylogenetics and population genetics, including two PhD studies
- Two PhD studies on orchid systematics: *Calochilus* and *Chiloglottis*
- PhD study of *Dillwynnia* (Fabaceae) systematics
- Cycad systematics
- PhD study of Urticaceae systematics in Indonesia
- PhD study of the tribe Abildgaardieae in Cyperaceae
- Ongoing study of the systematics of Restionaceae and allied families
- Major survey of worldwide genetic diversity in the fern genus *Pteridium*
- Visiting scientist Dr Goro Kokubugata, from the Tsukuba Botanical Gardens in Tokyo, has been using the technique of 'fluorescent *in-situ* hybridization' to investigate chromosome evolution in cycads and *Pteridium*

Part 5: Centre for Plant Conservation

Plant conservation is the central role for botanic gardens at the turn of the century and the development of a Centre for Plant Conservation offers the opportunity and chance to add value to the Royal Botanic Gardens slogan Plants=Life. The Centre will be multifaceted, drawing on all conservation programs in the organisation, including scientific research, horticultural displays and interpretation, plant commercialisation, and both school- and community-based education programs. It will become our focus for discovering, understanding and explaining what makes our environment work, and how plants are an essential part of the equation.

Key elements of the Centre will be:

- Visually stimulating and interactive exhibits in the botanic gardens
- Multimedia products to help people conserve their local environment
- A register of all New South Wales conservation programs and research projects
- Research into the ecology and biology of rare and threatened species and communities in New South Wales
- Maintenance of the State's rare and threatened species seedbank
- Commercialisation of rare and threatened species with horticultural potential to reduce wildharvesting and other threats to natural populations
- Contributions to State, national and international policy and planning relevant to plant conservation
- Coordination of regional gardens and herbaria for plant conservation.

Current Status

Currently existing in concept, this 'virtual centre' will have a full-time coordinator appointed late in 2000, and a management committee representing all parts of the Gardens.

A research profile for the Centre was prepared and is now in draft form (see following pages). This document also includes a revised timetable for establishing the Centre and some priority actions for the Coordinator.

Centre for Plant Conservation, Royal Botanic Gardens Sydney DRAFT Research Profile

Core Research Programs

BIODIVERSITY CONSERVATION

Saving Threatened Plant Communities in New South Wales

Priority areas

- Long-term projects on **Cumberland Plain Woodland**, including study of land at Mt Annan managed by RBG, and collaboration with universities and community groups
- Shorter-term responses to **high priority communities** identified by Vegetation Classification project and Rare and Threatened Community listings. Also determined by funding availability
- The core of this program will be developed further as part of a Conservation and Horticultural Research program. It may include survey, monitoring, relationships with other communities, biology and dynamics of key species (linking to the other two core programs). Remnant vegetation at Mt Annan is to be used as a field site for at least some projects.

CHARISMATIC PLANTS

Research and interpretation of compelling or iconic species

Priority species

- Target groups to be aligned with existing and proposed living collection and research themes, and with plant society/community interests
- Selection of species within priority groups is to be based on their ranking as **high conservation priority** using State, national and/or international criteria; high visibility; and/or funding opportunities
- Geographic focus is currently **New South Wales and Asia-Pacific**

Current Charismatic Species and Groups

- *Amorphophallus titanum*
- Orchids
- Wollemi Pine
- Palms
- Flannel Flowers
- Fungi associated with Proteaceae
- Waratah
- Cycads

RESTORATION ECOLOGY

Retention, recovery and restoration of biodiversity through research

Priorities

- Viable **germplasm storage of rare and threatened species** of New South Wales including links with other germplasm stores in New South Wales, and *ex situ* responsibilities under 'NSW Biodiversity Strategy'
- Research aligned with, and leading to, **recovery plans and listings** for species or communities listed in New South Wales. Conservation biology of species and populations in the **Sydney region**: e.g. *Persoonia* population biology; *in situ* seedbanks
- **Weed species** as threatening processes, from horticultural and environmental perspectives

THE GOLD LIST

Setting priorities for conservation in New South Wales

Lists of rare and threatened plants ('Red Lists') focus on species on the brink of extinction, not necessarily what is most important for conservation of biodiversity. The Gold List will be a list of areas of importance to conservation because they include many endemic species, or individual species that are distinct genetically or phylogenetically (i.e. in an evolutionary sense).

Priorities

- Map key areas of endemism within New South Wales
- Consolidate relationship information on species in New South Wales to identify key nodes in the evolutionary tree
- Investigate Bitter Vine, *Trimenia moorei*, as an example of a plant that could define an area for inclusion in the Gold List
- Investigate how well vegetation communities act as surrogates for biodiversity

ASSOCIATED RESEARCH PROGRAMS

- **Plant Diversity**
- **New South Wales Vegetation**
- **Horticultural Research and Development**
- **Fungi and Plants**
- Links to research in other organisations through **NSW Biodiversity Research Network** (in preparation)

Revised Timeline for establishment

December 1998	Blueprint approved by the Director
January 1999	Blueprint endorsed by the Royal Botanic Gardens and Domain Trust
February 1999	Establishment proposal submitted to Hermon Slade Foundation [unsuccessful]
July 2000	Key research focus for Centre confirmed
December 2000	First coordinator of the Centre for Plant Conservation commences duty
March 2001	Public Launch of Centre

Priority actions for Coordinator

- Coordinate RBG obligations under *NSW Biodiversity Strategy* and Recovery Plans
- Establish and coordinate RBG role and contributions to international conservation agendas
- Identify and involve collaborative partners for Centre programs
- Establish website presence, including Statewide focus for Plant Conservation
- Coordinate role and responsibilities of RBG staff in Recovery Teams
- Oversee priority research programs, including coordination of funding, collaborators, interpretation and promotion
- Assist in updating and maintenance of Seedbank and *ex situ* priority lists
- Contribute to priority setting by NPWS, including use of RBG research
- Contribute to development of conservation of education and interpretation programs for RBG as part of other planning processes

Part 6: NSW Biodiversity Strategy Report

The Gardens is represented on, and chairs, the Biodiversity Strategy Implementation Group (BSIG), which has representatives from most natural resource agencies. This group coordinates and reports on the implementation of *NSW Biodiversity Strategy* and is responsible to National Parks and Wildlife Service as well as the Biological Diversity Advisory Council (BDAC). Implementation of the Strategy has focussed on the achievement of 22 priority actions by 2001; of these the Gardens is listed as a lead agency in four and as a support agency in 10.

Funding of \$5.3 million was allocated (over three years) by Treasury to enhance the implementation of eight of the nominated priority actions. For each of these actions a working group was formed to assist with their coordination and implementation (the Gardens is represented on five working groups). The Gardens was allocated \$328,000 to implement four projects under these priority actions. All other contributions were achieved within existing recurrent expenditure.

A Centre of Plant Conservation was established in December 1998 to bring together various research, education and display aspects of our conservation programs. A blueprint and research profile for the centre have been prepared, and a coordinator will be appointed by the end of 2000. A key role for the Centre will be to coordinate and facilitate the Garden's contributions to the *NSW Biodiversity Strategy*.

The following Priority Actions from the NSW Biodiversity Strategy list the Gardens as a Lead (L) or Support (S) organisation. Performance targets (in brackets) are to be achieved by 2001. Only those targets relevant to the Gardens are listed.

1. Improve the accessibility of biodiversity information (S)

(Agency databases linked and compatibility enhanced to provide user-friendly computer information systems, with community access to information facilitated through linked Internet sites) FUNDED

The Gardens was allocated \$50 000 to provide a current 'master names index' for plant species in NSW. The 'master names index' for vascular plants was completed in July 2000. Further funding will be sought to extend this index to non-vascular plant.

11. Incorporate biodiversity components into education courses (S)

(Relevant primary school syllabuses and associated curriculum support material enhanced to incorporate components by 2000. Relevant secondary school syllabuses and associated curriculum support material enhanced to incorporate components by 2001. Curriculum resources, including teaching kits and teacher training programs, targeting biodiversity issues relevant to the rural community developed by 2000. Home-study packages focusing on educational opportunities for the rural community developed by 2000)

The Gardens' Community Education Unit continued to incorporate various biodiversity topics in its programs for primary and secondary school students and community groups; especially in relation to rare and threatened plants (e.g. Wollemi Pine), rainforests and the Australian environment.

13. Bioregional planning (S)

(Audit of data and information gaps for western New South Wales completed by 1999. Audit of the conservation status of New South Wales plant communities completed and information accessible by 2000. Statewide map-based GIS system developed and widely accessible by 2000) FUNDED

The Gardens was allocated \$135 000 to audit the conservation status of New South Wales plant communities by June 2001. A project officer was appointed in May 2000, and at June 2000 the database design was finalised and entry of data for a pilot region (south-west New South Wales) commenced.

19. Continued establishment of a comprehensive system of marine parks (S)

(Marine parks at Solitary Islands, Jervis Bay and Lord Howe Island established. Zoning and operational plans prepared for Solitary Islands and Jervis Bay through a comprehensive community consultation process to be completed by the end of 1999 and for Lord Howe Island by the end of 2000. Initial assessment of Julian Rocks, Byron Bay completed by the end of 1999)

The Gardens' phycologist continued to contribute to the establishment of a comprehensive system of marine parks by providing algal diversity information on areas such as Jervis Bay, Byron Bay and Lord Howe Island. Surveys of areas of significance along the New South Wales coast continued.

24. Prepare, implement and review recovery plans (S)

(144 recovery plans prepared by 2001. Critical habitats declared and identified in environmental planning instruments)

Gardens' staff continue to contribute to recovery plans when requested by NPWS. The majority of these are informal (i.e. NPWS seeking advice from staff), but for a growing number, Gardens' staff are members of the Recovery Team.

29. Implement ex situ conservation measures (L)

(Techniques developed for enhancing reproductive output and storage of reproductive tissues, sperm, eggs, embryos and seeds of threatened species and populations)

The seedbank at Mount Annan was upgraded to include a seed drying room (humidity and temperature controlled) and a small seed physiology laboratory. The RBG's Centre for Plant Conservation will include seed viability and storage as a key research focus, as well as prioritising our *ex situ* work.

33. Identify threatening processes and prepare and implement threat abatement plans (S)

(Compliance with the provisions of the TSC Act)

Doug Benson and Dr Alan Millar continued to sit on the NSW Scientific Committee and the NSW Fisheries Scientific Committee respectively. Gardens' scientists continue to provide technical information for the identification of threatening processes and the preparation of abatement plans.

55. Review legislation relevant to biodiversity conservation (S)

(Compliance with the provisions of the TSC Act. Completion of the review within targeted time-frame)

No progress due to the NSW Biological Diversity Advisory Council being in abeyance since May 1999.

56. Develop local biodiversity action plans (S)

(Local Biodiversity Fund established by 1999. Guidelines for the development of biodiversity action plans prepared by 1999. Biodiversity action plans developed and implemented by councils by 2000) FUNDED

The working group formed by BSIG does not include an RBG representative.

122. Enhance taxonomic research (L)

(In addition to ongoing research efforts, an extra 50 new invertebrate species and 25 new non-vascular plant species will be described each year in New South Wales) FUNDED

Dr Winston Ponder (Australian Museum) and Dr Tim Entwisle have a lead role in the interagency working group responsible for this priority action. \$200 000 was allocated to the Gardens over three financial years to research non-vascular plant groups. Two additional staff were employed, and funding was available for field work. The results of the work to June 2000 were:

Group	New species to science in NSW	New records of species for NSW	Progress towards publication
Marine algae	25 (incl. 1 genus)	30	1 ms submitted; other mss to be submitted by June 2001
Lichens	10	9	1 ms submitted; 1 in final draft; other papers possible (not incl. in totals)
Bryophytes	3 (incl. 1 genus)	1	1 ms in final draft; 1 ms in prep.
Freshwater microalgae	5	79	1 ms completed; 1 ms in first draft
Freshwater macroalgae	3	24	2 mss completed; 3 mss in preparation
Total at end of project	46	143	
Number likely without additional funding	15	15	
Number due to additional funding	31	128	

129. Establishment of mechanisms for long-term biodiversity monitoring (L)

(Identify and select standardised, best practice approaches for monitoring biodiversity. Undertake long-term biodiversity monitoring covering a broad range of species and ecosystems)

No progress on Action by Gardens without funding.

130. Implement biodiversity survey program (S)

(Publication of Biodiversity Survey Program Action Plan, detailing a program of prioritised studies and timeframes. Agreed standards, methods and protocols for the collection and management of biodiversity data established. A wider taxonomic range of organisms included in biodiversity studies. Studies and products from the BSP published and widely promoted and disseminated. Greater community involvement in biodiversity studies achieved)

The Gardens is part of an interagency working group for this priority action but no contribution has been sought to date.

135. Develop and implement a biodiversity research strategy (L)

(In consultation with the community, a NSW Biodiversity Research Strategy developed and implementation commenced by 2000)

The Gardens chaired four meetings of the NSW Biodiversity Research Strategy Working Group. A Stage One report including current research, capabilities, mandates, priority setting criteria and gaps was completed in July 2000. The July meeting included representatives of New South Wales universities, in addition to the government agencies already on the working group, and a State-wide network was proposed. To proceed further and take pressure of the agencies (particularly the coordinating agency RBG) a funding proposal for a Project Officer has been included in the draft 2001-2002 Treasury bid.

Part 7: Appendices

Appendix A

STAFF

Director Plant Sciences

Tim Entwisle BSc(Hons)(Melb)PhD(La Trobe)

Executive Assistant

Lynne Munnich BA(Syd)

Administrative Assistant

Kristina McColl BSc(Hons)(UNSW), BushRegenCert

CONSERVATION AND HORTICULTURAL RESEARCH

Manager

Alistair Hay MA, DPhil(Oxon) (Senior Research Scientist)(as Manager 1.1.00)

NSW Vegetation

Senior Research Scientist

Surrey Jacobs, BScAgr, PhD(Syd)

Special Botanists

Doug Benson BSc(Hons)(UNSW)

John Benson BSc(Macq)

Gwen Harden MSc(UNE)

Senior Technical Officers

Jocelyn Howell BPharm(Syd), BSc(Macq)

Liz Ashby BSc(Syd)

Lisa Hill BAppSc, GradDipEd (CSturt)

(22.5.00) (temp)

Technical Officer

Chris Tozher BEnvSc(Wollongong) (6.3.00) (temp)

Technical Assistant

Lyn McDougall BushRegenCert

Fungi and Plants

Senior Research Scientist

Brett Summerell BScAgr(Hons), PhD(Syd)

Senior Technical Officers

Suzanne Bullock NZCS, MSc(UNSW)

Linda Gunn BAgSc(Hons)(Melb)

Technical Officers

Alex Newman CertAmenHort(SA), AdvCertHort(SA), BScAg(Hons)(Adel), BMus(Adel)

Jillian Smith-White BSc(Hons)(Macq) (LDD30.6.99)

Horticultural Research and Development

Horticultural Research Officer

Catherine Offord MScAgr(Syd)

Technical Officers

Patricia Meagher

BScUrbanHort(Hons)(UTS) (temp)

Joanne Tyler HortCert, BScUrbanHort(UTS)

Lotte von Richter MScAgr(Syd)

Horticulturalists

Faye Cairncross AdvCertUrbanHort

Glenn Brooks BScUrbanHort(UTS),

HortCert (14.2.00) (temp)

PLANT DIVERSITY

Manager

Barry Conn BScEd, MSc(Melb), MBA (CSturt), PhD(Adel) (Senior Research Scientist)(as Manager 1.1.00)

Research and Curation

Senior Research Scientists

Ken Hill BSc(Hons), MSc(UNE)

Alan Millar BSc(Hons), PhD(Melb)

Peter Weston BSc(Hons), PhD(Syd)

Special Botanist

Karen Wilson BScAgr(Syd), MSc(UNSW)

Senior Botanists

Joy Everett BioTechCert (Syd TAFE),

BSc(Hons), MSc(Syd)

Peter Wilson BSc(Hons), PhD(UNSW)

Botanists

Elizabeth Brown BSc, MSc(Hons), PhD(Auk)

Stephen Skinner BSc(Hons), MSc,

PhD(Adel), GradDipEd(Sec.)

Postdoctoral Fellow

Reed Beaman BS(Univ. of Michigan), MS(Univ. of Florida), PhD(Univ. of Florida)

(Jan.2000 - Jan.2002)

Senior Technical Officer

Katherine Downs, BA(UNSW),

BSc(Hons)(Syd) (Acting)

Technical Officers

Wayne Cherry BScAgr(Syd),

GradDipBioSc(UNSW) (temp)

Jane Dalby BA(Hons), CBLT(QIT)

Dianne Godden, BSc(Hons)(UNSW)

Clare Herscovitch BSc(Hons)(Syd)

Phillip Kodala BSc(Hons), PhD(UNSW)

(temp)

Natasha Leist BSc(UNSW) (temp)

Hannah McPherson BSc(Hons)(UNSW)

(temp)

Leonie Stanberg BSc(Syd), DipEd(SCAE)

Rachel Wakefield, BSc(Hons)(La Trobe)

Nick Yee BSc(Hons)(Melb) 27.9.99 (temp)

Herbarium Assistant

Zonda Erskine AssDip in FAP(Sydney TAFE)

Botanical Information Service

Botanist

Barbara Wiecek BSc(Syd)(Acting)

Senior Technical Officers

Seanna McCune BAppSc(Hawkes),

BushRegenCert (Acting)

Louisa Murray BAppSc(CCAE)

Technical Officer

Gary Chapple BSc(Syd), DipAg(Hawkes)

Robert Coveny HortCert

Gillian Towler BSc(Macq), AssDipAppSc

(HortParkMgt), TreeSurgCert (temp)

PlantNET Officer

Peter Hind HortCert

RESOURCES

Manager

Anthony Martin, BioTechCert, BioTechHigherCert, BAppSc(Riverina)(as Manager 1.1.00)

Technical Assistant

Judy Wood HortCert (LDD 27.3.00)

Laboratories

Senior Technical Officer

Adam Marchant BSc(Hons), PhD(ANU)

Technical Officer

Carolyn Porter BAppSc(Hons)(UTS)

Library

Senior Librarian

Anna Hallett BA(Syd), DipLib(UNSW)

Library Technician

Miguel Garcia AssocDipLibPrac(STC)

Botanical Illustration

Illustrators

Lesley Elkan BSc(UTS),

PostGradDipIllus(Newc)

Nicola Oram BSc(Macq),

PostGradDipIllus(Newc)(LDD30.6.99)

Catherine Wardrop BA(Vis)(ANU),

PostGradDipIllus(Newc)

HONORARY RESEARCH ASSOCIATES

Alan Archer PhD(City Lond), CChem, FRSC

Peter Bernhardt BA, MA(SUNY),

PhD(Melb)

Don Blaxell BSc(UNSW), DipAgr(Vic)

Barbara Briggs BSc(Hons), PhD(Syd), PSM

Professor Carrick Chambers AM, MSc(NZ &

Melb), PhD(Syd), Hon.LLD(Melb),

Hon.DSc(UNSW) AHRIH

Mike Dingley BioTechCert (STC)

Lionel Gilbert OAM, BA(Hons), PhD(UNE),

LCP(Lond)

Norman Hall BForSc

Peter Michael BAgSc(Hons) PhD(Adel)

Professor David Maberley MA,

PhD(Cambridge), DPhil(Oxon)

Helen Ramsay MSc, PhD(Syd)

Bettye Rees BSc(Hons)(Qld), PhD(UNSW)

Geoffrey Sainty DipAgr(WAC),

GradDipExt(Hawkes)

Terry Tame DipIndArts(STC), DipEd(Syd)

Joy Thompson BScAgr, MSc(Syd)

Professor John Thomson MSc, MAgSc,

PhD(Melb)

Mary Tindale MSc, DSc(Syd)

Elsie Webster Hon.D Litt(Melb)

Appendix B

VOLUNTEERS

Herbarium Volunteer Program Supervisor
Alan Leishman, Photoengraving Etching Cert.

Volunteers

Mike Atkinson, Lydia Bell, Chris Belshaw, Janet Bennett, Carol Bentley, Margaret Beavis, Margaret Bell, Emma Betts, Patricia Bradney, Harry Brian, Dawn Bunce, Lynette Burns, Margaret Carrigg, Kathryn Chapman,

Maja Dakic, Jeffery Drudge, Eleanor Eakins, Gwen Elliott, Helen Flinn, Jill Ford, Gladys Foster, Muriel Gamble, Estelle Geering, Carole Gordon, Mien de Haas, Margaret Hafey, Pat Harris, Jane Helsham, Rachel Hill, Beverley Honey, Abu Ibrahim, William Isbell, Tony Jeans, Helen Jolley, Ian Lewis, Marie Lovett, Ann McCallum, Helen McLachlan, Nell Mackie, Margaret Marsh, Miriam Mathews, Ena Middleton, Joseph Minitier,

Elizabeth Mitchell, Joan Moore, Jill Pain, Edwin Pearson, John van Peer, Kelvin Perks, Aileen Phips, Syd Pinner, David Powys, Dorothy Pye, Elizabeth Radford, Aidan Ruja, Betty Reef, John Richards, Rod Roberts, Betty Ruthven, Jan Smith, Julie Taylor, Betty Thurley, Ruth Toop, Shelagh Trengove, Sybil Unsworth, Rosemary Varley, Minyo Weight, Ann Wilcher.

Appendix C

REPRESENTATION ON EXTERNAL COMMITTEES

Tracey Armstrong

Member, Australian Network for Plant Conservation Inc. Committee; Regional Coordinator (Sydney), Australian Network for Plant Conservation.

Doug Benson

Member, NSW Scientific Committee, Threatened Species Conservation Act; Member, National Trust Bush Management Advisory Committee; Member, Institute of Wildlife Research, University of Sydney; Member, Olympic Coordination Authority Ecology Expert Advisory Panel.

John Benson

Member, Native Vegetation Advisory Council, Native Vegetation Conservation Act; Member, NSW Ecosystems Definition, Listing and Conservation Status: Technical Working Group; Member, Institute of Wildlife Research, University of Sydney; Member, IUCN Species Survival Commission Plant Specialist Group; Member, IUCN Commission for Ecosystem Management; Member, Technical Committee Vegetation Mapping of NSW; Member Steering Committee, Grassy White Box Woodland Protection Area Network; Member, Wollemi Pine Conservation Team.

Dr Barbara B riggs

(Honorary Research Associate)
Member, Editorial Committee *Taxon*; Member; Editorial Advisory Nordic Journal of Botany; Member, Research Scientist Classification Committee of NSW Public Sector Management Office.

Professor Carrick Chambers

(Honorary Research Associate)
Consultant to City of Orange Botanic Garden; Member, Standards Association of Australia Tree Evaluation Committee; Member, Papua New Guinea Biological Foundation; Member, Australia and Pacific Science Foundation

Dr Barry Conn

Editor, Handbooks of the Flora of Papua New Guinea; Editor, 'HISPID - Herbarium Information Standards and Protocols for Interchange of Data', version 3; Regional Secretary (Oceania), International Working Group on Taxonomic Databases for Plant Sciences; Member, Herbarium Information

Systems Committee (HISCOM); Member, NSW Natural Resources Information Management Strategy (NRIMS); Member, NSW Metadata Working Group (NRIMS); President, Australian Systematic Botany Society; Member, NSW Biodiversity Working Group (NRIMS); Board Member, CANRI (NRIMS); Coordinator, Flora Malesiana Urticaceae Working Group; Member, Vegetation Targets Working Group; Committee Member, The Friends of the Royal Botanic Gardens, Sydney.

Dr Tim Entwisle

Chair, Biodiversity Strategy Implementation Group; Chair, Australian Systematic Botany Editorial Advisory Committee; President, Australian Systematic Botany Society (to 9.12.99); Councillor, Australasian Society for Phycology and Aquatic Botany; Research Associate, School of Biological Sciences, The University of Sydney; Assembly representative, National Biodiversity Council; Member, Wollemi Pine Conservation Team; Member, International Organising Committee for Eighth International Phycological Congress.

Joy Everett

Member, Animal Care and Ethics Committee, Australian Museum.

Gwen Harden

Member, Council of the Linnean Society of New South Wales; Trustee, Friends of the Royal Botanic Gardens Sydney Trust Fund.

Dr Alistair Hay

Member, Board of the Flora Malesiana Foundation; Coordinator, Australian Flora Malesiana Contributors Working Group; Member, National Living Collections Policy Working Group; Co-chair, Organising Committee of 5th International Flora Malesiana Symposium 2001.

Ken Hill

Member, Cycad Specialist Group, IUCN.

Peter Hind

Member, Management Committee, Vale of Avoca Recreational Reserve Trust; Leader, Society for Growing Australian Plants Fern Study Group.

Dr Surrey Jacobs

Member, Animal Care and Ethics Committee, Australian Museum; Member,

Steering Committee for Wetland Rehabilitation, Department of Land and Water Conservation; Member, Steering Committee and Technical Committee for implementation of wetland assessment, Hawkesbury Nepean Catchment Management Trust; Member, Expert Panels for Woronora and Bega Rivers, Healthy Rivers Commission; Member, Olympic Coordination Authority Ecology Expert Advisory Panel; Member, State Technical Advisory Committee for Integrated Monitoring of Environmental Flows, Department of Land and Water Conservation; Member, State Wetlands Action Group for implementing State Wetland Policy (whole of State policy); CSIRO; Member, informal Ramsar network, National Parks and Wildlife Service.

Alan Leishman

Member, Heritage (Built and Environmental) Advisory Committee, Campbelltown City Council; Public Officer, Australian Bird Study Association.

Professor David Maberley

(Honorary Research Associate)
Chief Executive Officer, Greening Australia (NSW); Member, Faculty of Natural Sciences, University of Leiden, The Netherlands; Honorary Director and member of Management Group, Joseph Banks Archive Project, Royal Society and The Natural History Museum, London; Council Member, International Association for Plant Taxonomy; Member, Editorial Board, *Journal of South Asian Natural History*.

Seanna McCune

Member, Scientific Advisory Panel, Manly Council.

Dr Alan Millar

Member, International Organising Committee, International Phycological Congresses; Member, Nominations Committee, International Phycological Society; Member, Fisheries Scientific Committee, Threatened Species Conservation Act; Associate Editor, morphology and taxonomy – journal *Phycologia*; Judging panel for International Phycological Prize.

Appendix C (cont)

REPRESENTATION ON EXTERNAL COMMITTEES

Cathy Offord

Program Committee member, Flowers 2000 Conference, NSW Cut-Flower Export Forum; Member, NSW NPWS Species Recovery Teams; Member, Wollemi Pine Conservation Management Committee; Research representative, Waratah Industry Network Committee.

Dr Brett Summerell

Regional Councillor, NSW, Australasian Plant Pathology Society; Senior Editor (Mycology) *Australasian Plant Pathology*; Member, International Society of Plant Pathology Committee on *Fusarium*; Member, Executive Committee, International Mycological Association.

Dr Mary Tindale

(Honorary Research Associate) Member, Special Committee for

Pteridophyta, International Association for Plant Taxonomy.

Dr Peter Weston

Member, Council, Australian Systematic Botany Society; Member, Council of the Willi Hennig Society; Member, *Persoonia mollis* subsp. *maxima* species recovery team; Member, editorial board, *Australian Systematic Botany*; Member, Lane Cove Council Bushland Management Advisory Committee.

Karen Wilson

Convener, Global Plant Checklist Committee, International Organization for Plant Information; Vice-President, Linnean Society of New South Wales; Convener, Special Committee on Electronic Publishing, International Association for Plant Taxonomy; Convener, Global Plant Checklist

Network Task Group, CODATA; Member, STABD Commission, CODATA; Member, CODATA Commission on Data Access; Member, National Committee for Scientific Information, Australian Academy of Science; Member, Board of Management, Johnstone Centre Herbarium, Charles Sturt University at Albury; Systematics Agenda 2000 International Steering Committee Diversitas; Member, Executive Committee, International Union of Biological Sciences; Member, National Committee for Animal Sciences, Australian Academy of Science; Member, Project Management Team, Species 2000.

Dr Peter Wilson

Member, International Advisory Board, *Candollea* (Geneva) and *Boissiera*.

Appendix D

SCIENTIFIC PUBLICATIONS AVAILABLE FROM THE GARDENS

Telopea (a journal of systematic research) and *Cunninghamia* (a journal of plant ecology for eastern Australia) are published by the Gardens in March and September (*Telopea*) and July and December (*Cunninghamia*). They are available from the Gardens Shops or by subscription, or on exchange to other organisations. Copies of most back issues are still available for sale from the Gardens Shop in Sydney.

Setting the Scene: the Native Vegetation of NSW (1999) by J.S. Benson, published by the Native Vegetation Advisory Council. \$7.95.

The nature of pre-European native vegetation in south-eastern Australia: a critique of Ryan, D.G., J.R. and Starr, B.J. (1995) *The Australian Landscape—Observations of Explorers and Early Settlers* (1997) by J.S. Benson & P.A. Redpath, offprint from *Cunninghamia* 5(2): 285-329, \$5.

Flora of New South Wales vol 1 (1990) (being reprinted), vol 2 (1991), vol 3 (1992), vol 4 (1993), edited by Gwen Harden (NSW University Press).

Flora of New South Wales supplement to vol 1 (2000) (NSW University Press).

Orchids of New South Wales (1944) by H.M.R. Rupp. This is a 1969 facsimile (with supplement) of the original and is also family 48 in *Flora of New South Wales* \$5.

Collection, Preparation and Preservation of Plant Specimens (Royal Botanic Gardens Sydney 2nd edition, 1995) \$3.

The Names of Acacias of New South Wales with a Guide to Pronunciation of Botanical Names, by N. Hall & L.A.S. Johnson (Royal Botanic Gardens Sydney, 1993) \$4.

A Strategy for the Rehabilitation of the Riparian Vegetation of the Hawkesbury–Nepean River by D. Benson and J. Howell (Royal Botanic Gardens Sydney, 1993) \$15.

Riverside Plants of the Hawkesbury–Nepean by J. Howell, L. McDougall & D. Benson (Royal Botanic Gardens Sydney, 1995) \$9.95.

Rare Bushland Plants of Western Sydney (1999) Revised edition, by Teresa James, Lyn McDougall and Doug Benson (Royal Botanic Gardens Sydney) \$11.95.

Taken for Granted: the Bushland of Sydney and its Suburbs by D. Benson and J. Howell (Kangaroo Press, 1995) \$27.95.

Mountain Devil to Mangrove: a Guide to Natural Vegetation of the Hawkesbury–Nepean Catchment by D. Benson, J. Howell and L. McDougall (Royal Botanic Gardens Sydney, 1996) \$19.95.

Plants of Pooncarie and the Willandra Lakes by M. Porteners and L. Ashby. A guide to the plant species native to Pooncarie and the Willandra Lakes region in south-western New South Wales (Royal Botanic Gardens Sydney, 1996) \$7.95.

Hispid 3 (1996) by Dr B. Conn. Herbarium Information Standards and Protocols for Interchange of Data, Version Three. Also available on Internet <http://www.rbgsyd.gov.au/HISCOM> (booklet, free to participating institutions).

Missing Jigsaw Pieces: the Bushland Plants of the Cooks River Valley by D. Benson, D. Ondinea & V. Bear (Royal Botanic Gardens Sydney, 1999) \$13.15.

Appendix E

RESEARCH GRANTS

Australian Biological Resources Study Dr Alan Millar – Phaeophyceae of New South Wales. \$18,000	Dr Tim Entwisle and Dr Elizabeth Brown – Taxonomy of algae, bryophytes and lichens in NSW. \$50,000	Dr Peter Weston and Jim Mant – Comparative biology of <i>Chiloglottis</i> (Orchidaceae) and its thynnine wasp pollinators (Tiphiiidae). \$27,000
Dr Peter Weston – Taxonomic Revision of <i>Dillwynia</i> (Fabaceae: Faboideae: Mirbelieae). \$18,800	Dr Alan Millar – Taxonomy of marine algae. \$50,000	Rural Industries Research and Development Corporation
Dr Peter Wilson and Dr Chris Quinn – Generic concepts in the <i>Baeckea</i> complex. \$35,000	Australian Research Council Prof R. Whelan, Assoc Prof D. Ayre, Dr T. Auld and Dr P. Weston – SPIRT Grants Scheme: Ecology and genetics of fire-sensitive <i>Persoonia</i> species: threatened species recovery and management. \$21,000 (first 6 months of a 3-year \$126,480 grant).	Cathy Offord – Development of the Flannel Flower as a cut flower crop. \$4,000
Karen Wilson and Dr D. Steane – Unravelling the history of Casuarinaceae. \$55,000	Hermon Slade Foundation Ken Hill – Systematics and evolution of the genus <i>Cycas</i> . \$33,500	New South Wales Centenary of Federation Committee
Karen Wilson and Dr J. Bruhl – Systematic studies in Abildgaardieae (Cyperaceae). \$12,000	Dr Alan Millar – Survey of marine algae in the south-east of NSW. \$30,000	Cathy Offord and Joanne Tyler – Horticultural research on Flannel Flowers. \$15,000
New South Wales Biodiversity Strategy John Benson – Classification of NSW Plant Communities. \$54,500	Dr Brett Summerell – Biosystematics of fungi causing leafspot on Proteaceae. \$27,000	International Plant Genetic Resources Institute (Asia/Pacific/Oceania)
Dr Barry Conn – Master Name Index for NSW vascular plants. \$50,000		Dr A. Hay – Taxonomy of Aroids in Asian germplasm collections. US\$10,000
		Yellow Rock Nurseries Cathy Offord – Waratah research. \$1350

Appendix F

OVERSEAS TRAVEL

Name and Position	Countries/Cities Visited	Purpose of Visit	Duration	Cost	Source of Funds
Karen Wilson, Special Botanist	Tsukuba, Japan	Species 2000 2nd International Workshop; founding meeting of Species 2000 Asia-Oceania	11 – 17 July 99	\$3170	Consolidated Funds; partly externally funded
Karen Wilson, Special Botanist	Harvard and Manassas, USA	Global Plant Checklist and IOPI Council meetings, and TDWG symposium; Species 2000 Team meeting and workshop	25 Oct – 5 Nov 99	\$4585	Consolidated Funds; partly externally funded
Karen Wilson, Special Botanist	Tsukuba, Japan	Species 2000 Asia-Oceania first team meeting and workshop	21 – 25 Mar 00	\$2637	Consolidated Funds; partly externally funded
Karen Wilson, Special Botanist	Amsterdam and Leiden, Netherlands	Team meeting of Species 2000; herbarium research	3 – 8 April 00	\$2949	Consolidated Funds; partly externally funded
Peter Weston, Senior Research Scientist	Oxford, Mississippi, St Louis, Missouri, USA	Research project on Proteaceae; XVI International Botanical Congress	26 July – 11 Aug 99	\$4500	Consolidated Funds
Peter Wilson, Senior Botanist	St Louis, Missouri, USA	XVI International Botanical Congress; Nomenclature Section meetings	26 July – 7 Aug 99	\$5434	Consolidated Funds
Tim Entwisle, Director Plant Sciences	St Louis, Missouri, USA	XVI International Botanical Congress	29 July – 9 Aug 99	\$8054	Consolidated Funds; partly externally funded
Ken Hill, Senior Research Scientist	St Louis, Missouri; Miami USA; Wye, UK	XVI International Botanical Congress; and International Conference in Cycad Biology; International Conifer Conference	1 – 25 Aug 99	\$5500	Consolidated Funds; partly externally funded
Ken Hill, Senior Research Scientist	Hanoi, Vietnam; Thailand	Collaborative botanical field studies	13 Jan – 4 Feb 00	\$8500	Externally funded
Ken Hill, Senior Research Scientist	Bogor, Indonesia; China	Collaborative botanical field studies	19 June – 19 July 00	\$8500	Externally funded
Alan Millar, Senior Research Scientist	Gent, Belgium; Paris, France; Montecatini and Pisa, Italy	Collaborative research on marine flora of Papua New Guinea; herbarium research; European Phycological Congress	9 Sept – 2 Oct 99	\$5685	Consolidated Funds

Appendix F (cont)

OVERSEAS TRAVEL

Name and Position	Countries/Cities Visited	Purpose of Visit	Duration	Cost	Source of Funds
Barry Conn, Senior Research Scientist	Lae, Papua New Guinea	Conference on forestry and botanical information in New Guinea	4 – 10 Oct 99	\$4500	Consolidated Funds; partly externally funded
Barry Conn, Senior Research Scientist	Boston, Washington, Massachusetts, USA	World biodiversity database meetings	28 – 31 Oct 99	\$4235	Consolidated Funds
Alistair Hay, Senior Research Scientist	Bogor, Indonesia	Herbarium research for Flora Malesiana	12 – 24 Jan 00	\$2385	Consolidated Funds
Brett Summerell, Senior Research Scientist	Manhattan, Kansas, USA	Laboratory Workshop on the identification of <i>Fusarium</i> , Kansas State University	6 – 20 June 00	\$3400	Consolidated Funds; partly externally funded

Appendix G

COOPERATIVE RESEARCH

Dr Alan Archer

- Chemotaxonomy of species of the lichen genus *Pertusaria* with Prof. J.A.Elix of the Australian National University.

Doug Benson

- Rehabilitation of Cooks River vegetation with Danie Ondinea, Wildlife Consultant.

John Benson

- Review of classification and status of plant communities in New South Wales with New South Wales National Parks and Wildlife Service.

Dr Barbara Briggs

- Systematics of Australian Veroniceae with Prof. F. Ehrendorfer, University of Vienna, Austria.

- Phylogeny of Restionaceae with Dr H.P. Linder, University of Cape Town, South Africa.

Dr Elizabeth Brown

- Molecular phylogeny and systematics of Epacridaceae with Assoc. Prof. C.J. Quinn, University of New South Wales.
- Systematics of *Epacris* (Epacridaceae) in New South Wales with Dr Yvonne Menadue, University of Tasmania.

Suzanne Bullock

- Leaf anatomy of *Wollemia nobilis* with Dr Geoff Burrows, Charles Sturt University, Wagga Wagga.

Dr Barry Conn

- Leaf volatile oils of *Prostanthera* (Lamiaceae) with Dr A. Hayes, University of Western Sydney, NSW

Dr Tim Entwistle

- Molecular systematics and biogeography of Batrachospermales with Dr Morgan Vis of Ohio University, USA.
- Ecology of algae in mountain streams with Dr Barbara Downes of The University of Melbourne, Victoria.
- Taxonomic revision of Zygnemataceae (Chlorophyta) in Australia with Simon Lewis of the Royal Botanic Gardens, Melbourne.

Joy Everett and Dr Surrey Jacobs

- Continuing studies in the grass tribe Stipeae with the Stipoid Grasses Working

Group, including Dr M. Barkworth, Utah State University, USA; Dr Randall Bayer, CSIRO, Canberra; Cathy Hsiao, USDA, USA; Dr Minta Arriaga, Buenos Aires; Dr Amelia Torres, Buenos Aires and Dr Francisco Vasquez, Spain.

Gwen Harden

- Revision of *Davidsonia* with John Williams, University of New England, Armidale.

Dr Alistair Hay

- Coordinator, Flora Malesiana Araceae Project with P.C. Boyce (Royal Botanic Gardens, Kew), J. Bogner (Munich Botanic Garden), Prof. N. Jacobsen (Royal Agricultural and Veterinary University, Copenhagen), W.L.A. Hettterscheid (Hortus Botanicus, Leiden), Prof. J. Murata (Makino Herbarium, Tokyo Metropolitan University), Dr D.H. Nicolson (Smithsonian Institution, Washington D.C.), Dr M. Sivadasan (University of Calicut), Dr E.A. Widjaja (Herbarium Bogoriense).

- Commentary on Aroids in Curtis's Botanical Magazine with P.C. Boyce (Kew).
- Taxonomy of *Alocasia* in Thailand with D. Sookchaloem, Forest Herbarium, Bangkok.
- Molecular Systematics of *Alocasia*: co-supervisor of Ms C. Wong, PhD candidate at Nanyang Technological University, Singapore.

- Co-supervising (with Assoc. Prof. C.J. Quinn, University of New South Wales) research by Ms Yuzammi (Kebun Raya, Bogor, Indonesia) on terrestrial aroids of Java for the degree of MSc at University of New South Wales.

Ken Hill

- Cycad nomenclature with Dr D. Stevenson, New York Botanic Garden, USA.
- The Cycad Pages internet site with Dr D. Stevenson, New York Botanic Garden, USA.
- Taxonomy of Asian Cycads with Dr C.J. Chen, Beijing Herbarium, Beijing, China, Dr N.T. Hiep, Hanoi Herbarium, Hanoi, Vietnam and A. Lindstrom, Nong Nooch Tropical Garden, Sattahip, Thailand.
- Molecular Phylogeny of the Cycadophyta

with M. Chase, Jodrell Laboratories, Royal Botanic Gardens Kew, UK and D.W. Stevenson, New York Botanic Garden, USA.

Jocelyn Howell

- Attributes of rare and abundant species with Dr Brad Murray, Australian National University.

Dr Surrey Jacobs

- Effects of fire on managing small reserves with Dr J. Pickard, Macquarie University. Macromolecular studies of the Stipeae (Poaceae) with C.Hsiao, USDA and M. Barkworth, Utah State University, USA. Macromolecular studies of the Poaceae with C.Hsiao, USDA.

- Macrophytes as indicators of stream health with G. Sainty, Sainty and Associates.
- Aponogetonaceae with C.B. Hellquist, North Adams, Massachusetts, USA.
- Nymphaeaceae with Dr T. Borsch, Germany, Khidir Hilm, Virginia, USA and C.B. Hellquist, North Adams, Massachusetts, USA.

Professor David Mabberley

- Molecular systematics of Labiatae (Viticoideae, Teucroideae), with Dr R.J.P. de Kok (CSIRO, Canberra), Dr D.L. Steane (Dept. Plant Science, University of Tasmania), Dr A. Paton (Royal Botanic Gardens, Kew), Dr S.J. Wagstaff and Dr R.G. Olmstead (University of Colorado).
- Revision of Labiatae of New Caledonia, with Dr R.J.P. de Kok (CSIRO, Canberra)
- Ecology and systematics of *Vitex* (Labiatae) in Sri Lanka with Dr B.M.P. Singhakumara (University of Jayawardanapura, Colombo).
- Revisions of *Faradaya* and *Oxera* (Labiatae), with Dr R.J.P. de Kok (CSIRO, Canberra).
- Reproductive biology of *Dysoxylum* (Meliaceae) with Dr J. Braggins (University of Auckland) and Dr M. F. Large (Massey University, Palmerston North).
- Systematics of Malesian Meliaceae, with Dr C.M. Pannell (Oxford, UK).
- Nomenclature of apples, with Dr B.E. Juniper (Dept. Plant Sciences, University of

Appendix G (cont)

COOPERATIVE RESEARCH

Oxford) and Dr C.E. Jarvis (Natural History Museum, London).

- Catalogue of the Australian plant drawings and cognate materials in the Natural History Museum, London, with D.T. Moore (formerly Natural History Museum, London).

- Revision of *Grewia* in Madagascar with Prof. P. Morat (Natural History Museum, Paris)

- Study of Ferdinand Bauer's colour-code for plant illustration with Dr E. Pignatti-Wikus, Trieste and Dr C. Riedl-Dorn, Vienna.

Dr Peter Michael

- SEM studies on achenes of *Senecio* with Dr I. Radford, CSIRO, Townsville.

Dr Alan Millar

- DNA research on sporochytriales with Dr G. Saunders and Dr G.T. Kraft, University of Melbourne.

- Taxonomy and ecotoxicity of *Caulerpa taxifolia* with Prof. A. Meinesz and O. Jousson.

- Systematics of coralline algae of the east coast of Australia with Dr Wm J.

Woelkerling, La Trobe University, Victoria.

- Isolation and extraction of secondary metabolites of marine algae towards antifouling compounds with Dr Rocky de Nys, University of NSW.

- New Zealand representatives of the red algal family Delesseriaceae with Dr Wendy Nelson, Museum of New Zealand, Wellington.

- Marine floristics of Papua New Guinea and East African coast with Prof. Eric Coppejens, University of Gent, Belgium.

- Marine algae of the Philippines with Dr Lawrence Liao and Dr Jason Young, University of San Carlos, Cebu City, Philippines.

Cathy Offord

- Potting mix amendments with Dr Sally Muir, University of Western Sydney Macarthur.

- Genetics of the Wollemi Pine with Dr Rod Peakall, Australian National University.

- Reproductive biology and breeding of *Telopea* with Prof. Don Marshall and Dr Peter Sharp of the University of Sydney.

- Weediness of *Swainsona sejuncta* (Fabaceae) with Dr Robyn McConkey, University of Sydney.

- Bud anatomy of the Wollemi Pine with Dr

Geoff Burrows, Charles Sturt University.

- Pollination and seed set in *Wollemia nobilis* (Araucariaceae) with Prof. N. Prakash, University of New England.

Dr Helen Ramsay

- Study of Bryaceae with Dr J.R. Spence, National Park Service, Page, Arizona, USA.

- Australian Sematophyllaceae with Dr B.C. Tan, Farlow Herbarium, Harvard University, USA and Dr W.B. Schofield, University of British Columbia, Canada.

Dr Brett Summerell

- Ecology and taxonomy of *Fusarium* and related fungi, soilborne diseases of plants caused by fungi, and fungal diseases in Vietnam with Professor Lester Burgess, University of Sydney.

- Ecology and taxonomy of *Fusarium* with Dr David Backhouse, University of New England.

- Genetics of *Fusarium* with Prof. John Leslie, Kansas State University.

- Mycotoxins produced by *Fusarium* with Assoc. Prof. Wayne Bryden, University of Sydney.

- Biology of the fig psyllid with Prof. Dinah Hales, Macquarie University.

- Biology of the fig psyllid with Dr Alan Clift, University of Western Sydney.

- Biosystematics of fungi on Proteaceae with Prof. Pedro Crow, University of Stellenbosch.

Dr Mary Tindale

- Cytotaxonomy of Australian Pteridophyta with Dr S.K. Roy Varanasi, India.

Dr Peter Weston

- Cladistic analysis and classification of the Mirbelieae (Fabaceae) with Dr M.D. Crisp, Australian National University, Canberra.

- Molecular systematics of Bracken (*Pteridium*) with Prof. J.A. Thomson and Dr M.-K. Tan (Elizabeth McArthur Agricultural Research Institute, Camden).

- Taxonomic revision of *Macadamia* (Proteaceae) with Dr C.L. Gross, University of New England.

- Phylogeny of the Proteaceae with Dr Nigel Barker, Rhodes University, South Africa, Dr Andrew Douglas, Field Museum of Natural History, USA, and Dr Sarah Hoot, University of Wisconsin, USA.

- A taxonomic revision of *Dillwynia* (Fabaceae: Mirbelieae) with Mr Peter Jobson and Dr David Morrison, University of Technology, Sydney.

- Ecology and genetics of fire-sensitive *Persoonia* species: threatened species

recovery and management with Mr David McKenna, Mr Paul Rymmer, Prof. Robert Whelan, Assoc. Prof. David Ayre, the University of Wollongong and Dr Tony Auld, NSW National Parks and Wildlife Service.

- Reproductive biology of some *Persoonia* species with Mr Christopher Nancarrow, Prof. Robert Whelan and Assoc. Prof. David Ayre, the University of Wollongong.

- Near-ultraviolet reflectance in *Dendrobium* (Orchidaceae) with Mr James Indsto, Westmead Institute of Cancer Research.

- Comparative biology of *Chiloglottis* (Orchidaceae) and its thynnine wasp pollinators (Tiphidae) with Mr Jim Mant and Dr Rod Peakall, Australian National University.

- Phylogenetic systematics of the genus *Calochilus* (Orchidaceae) with Mr Andrew Perkins and Dr Murray Henwood, University of Sydney.

Karen Wilson

- Survey of fungi of Cyperaceae with Mr J. Walker, NSW Agriculture.

- Polygonaceae for Flora of Australia with Mrs G. Perry, Western Australian Herbarium.

- Systematic studies in Abildgaardieae (Cyperaceae) with Dr J. Bruhl, Ms K. Clarke and Mr K. Ghamkhar, University of New England.

- Systematics of *Carpha* (Cyperaceae) with Dr J. Bruhl and Ms Xiufu Zhang, University of New England.

- Systematics of *Lepidosperma laterale* (Cyperaceae) with Dr J. Bruhl and Mr J. Hodgson, University of New England.

- Molecular study of Casuarinaceae with Dr D. Steane, University of Tasmania.

Dr Peter Wilson

- Molecular phylogeny and systematics of Myrtaceae with Assoc. Prof. C.J. Quinn, University of New South Wales.

- Molecular phylogeny of the *Baeckea* suballiance with Assoc. Prof. C.J. Quinn, University of New South Wales.

- Mycorrhizal associations of Myrtaceae with Dr A.E. Ashford, University of New South Wales and Dr W. Allaway, University of Sydney.

Appendix H

STUDENT SUPERVISION*

*Honours,4th year projects, post-graduate;+ external supervisor

Student	Degree	University	Supervisors	Project Title
Abdul Asir Abubaker	MscAgr	University of Sydney	+Professor L. Burgess, Dr B. Summerell	Biology of fungi causing crown rot
Kerri Clarke	PhD	University of New England	+Dr J. Bruhl, +Dr N. Prakash, K. Wilson	Systematic studies in Abildgaardieae (Cyperaceae)
Kioumars Ghamkar	PhD	University of New England	+Dr J. Bruhl, Dr A. Marchant, Mrs K. Wilson	Molecular study of Abildgaardieae (Cyperaceae)
Judi Hadiah	PhD	University of New South Wales	+Assoc. Prof.C.Quinn, Dr B. Conn	Systematics of Elatostema in Indonesian Archipelago
Adele Harvey	PhD	La Trobe University	+Dr Wm J. Woelkerling, Dr A. Millar	The crustose coralline algae of NSW
Ken Hill	PhD	University of Technology	+Dr D. Morrison, Dr P. Weston	Phylogeny and biogeography of the genus <i>Cycas</i> Sydney
John Hodgson	BSc	University of New England	+Dr J. Bruhl, Mrs K. Wilson	Systematics of <i>Lepidosperma laterale</i> complex (Cyperaceae)
Peter Jobson	PhD	University of Technology Sydney	+Dr D. Morrison, Dr P. Weston	A taxonomic revision of <i>Dillwynia</i> (Fabaceae: Faboideae: Mirbelieae)
Aniuska A. Kazandjian	PhD	James Cook University	+Assoc. Prof. Betsy Jackes Dr P. Wilson	Systematics of the <i>Indigofera pratensis</i> complex (Fabaceae): A Morphological and Molecular Approach
Joanne Ling	PhD	University of Western Sydney	+Dr John Bauor, Dr S. Jacobs	Development of a wetland assessment protocol using biological techniques
Rachelle McConville	BSc	University of Wollongong	Dr A. Millar	Macro-algal distribution of southern NSW lakes
David McKenna	PhD	University of Wollongong	+ Professor R. Whelan, +Assoc. Prof. D. Ayre, +Dr T. Auld,Dr P. Weston	Ecology of fire-sensitive <i>Persoonia</i> species:threatened species recovery and management
Jim Mant	PhD	Australian National University	+Dr R. Peakall, Dr P. Weston	Comparative biology of <i>Chiloglottis</i> (Orchidaceae) and its thynnine wasp pollinators (Tiphidae)
Amelia Martyn	BHortSc	University of Sydney	+Dr R. McConchie, Dr S. Jacobs,C.Offord, J. Tyler	Assessment of weediness in <i>Swainsona sejuncta</i>
Lucy Nairn	PhD	University of Melbourne	+Dr B. Downes, Dr T. Entwisle	Ecology of stream algae
Chris Nancarrow	PhD	University of Wollongong	+ Professor R. Whelan, +Assoc. Prof. D. Ayre, Dr P. Weston,C.Offord	Reproductive character displacement and adaptation of three co-occurring <i>Persoonia</i> species
Jenny Nelson	MSc	University of Western Sydney	+Assoc. Prof.Shelly Burgin, Dr T. Entwisle	Desmids of Western Sydney
Melody Neumann	PhD	University of Sydney	+Professor L. Burgess, Dr B. Summerell	Molecular variation in <i>Fusarium</i>
Alex Newman	PhD	Macquarie University	+Assoc. Prof. D. Hales, Dr B. Summerell	Biology of the fig psyllid
Andrew Perkins	PhD	University of Sydney	+Dr M. Henwood, Dr P. Weston	Phylogenetics of the genus <i>Calochilus</i> (Orchidaceae)

Appendix H (cont)

STUDENT SUPERVISION

Chimi Riznin	BScAgr	University of Sydney	+Professor L. Burgess, Dr B. Summerell	<i>Armillaria</i> root rot
Karin Rutten	PhD	University of Wollongong	Dr A. Millar	Macro-algal blooms and management
Paul Rymer	PhD	University of Wollongong	+ Professor R. Whelan, +Assoc. Prof. D. Ayre, +Dr T. Auld, Dr P. Weston	Genetics of fire-sensitive <i>Persoonia</i> species threatened species recovery and management
Jillian Smith-White	PhD	University of Sydney	+Professor L. Burgess, Dr B. Summerell	Molecular biology of <i>Armillaria</i>
Nikola Streiber	BSc	University of New South Wales	+Assoc. Prof. C. Quinn, +Dr E. Fischer, Dr E. Brown	Revision of the genus <i>Astroloma</i> (Epacridaceae)
Song Wang	PhD	University of Sydney	+Dr M. Henwood, Dr S. Jacobs	Taxonomic studies in Australian species of <i>Elymus</i> (Gramineae)
Sabine Wilkins	PhD	University of Berlin	+Prof. Dr W. Greuter, Dr S. Jacobs	Taxonomic studies in the Floating-leaved species of <i>Potamogeton</i> (Potamogetonaceae) in Australia
Nick Yee	MSc	University of New South Wales	Dr A. Millar	Molecular phylogeny of the algal order Sporochneales
Yuzammi	MSc	University of New South Wales	+Assoc. Prof. C. Quinn, Dr A. Hay	Taxonomy of Javan Araceae
Xiufu Zhang	PhD	University of New England	+Dr J. Bruhl, +Dr. N. Prakash, K. Wilson	Systematic studies in Schoeneae (Cyperaceae)

Appendix I

PUBLICATIONS

- *Archer, A.W. & Elix, J.A. (1999) Three new species in the Australian Graphidaceae with novel chemistries: *Phaeographina echinocarpica*, *Phaeographis necopinata* and *Phaeographis nornotatica*. *Mycotaxon* 72:91–96.
- *Archer, A.W. (1999) The lichen genera *Graphis* and *Graphina* (Graphidaceae) in Australia 1. Species based on Australian type specimens. *Telopea* 8:273–295.
- *Archer, A.W. (2000) The lichen genera *Phaeographis* and *Phaeographina* (Graphidaceae) in Australia 1: Species based on Australian type specimens. *Telopea* 8: 461–475.
- *Archer, A.W. (2000) Additional lichen records from Australia 44. *Dictyographa cinerea* (C. Knight) Müll. Arg. *Australasian Lichenology* 47:32.
- Benson, D. & McDougall, L. (1999) Ecology of Sydney Plants Species Part 7(a) Dicotyledon families Nyctaginaceae to Primulaceae. *Cunninghamia* 6:402–509.
- Benson, J.S. (1999) The Native Vegetation of New South Wales. Native Vegetation Advisory Council (Department of Land and Water Conservation: Sydney).
- +Braggins, J.E., +Large, M.F., *Mabberley, D.J. (1999) Sexual arrangements in kohekohe (*Dysoxylum spectabile*, Meliaceae). *Telopea* 8: 315–324.
- *Briggs, B.G. & +Makinson, R.O. (1999) *Derwentia* (Scrophulariaceae) Pp. 507–508 in: N.G. Walsh and T.J. Entwisle (eds), *Flora of Victoria Vol. 4* (Inkata Press: Melbourne).
- *Briggs, B.G. & +Barker, W.R. (1999) *Veronica* (Scrophulariaceae) Pp. 509–516 in: N.G. Walsh and T.J. Entwisle (eds), *Flora of Victoria Vol. 4* (Inkata Press: Melbourne).
- *Briggs, B.G. (1999) The ‘southern rushes’ invade the north: the diaspora of the Restionaceae. Where worlds collide: faunal and floral migrations and evolution in SE Asia–Australasia. Conference abstracts: University of New England. Pp. 9–11.
- *Briggs, B.G. & *Johnson, L.A.S. (1999) A guide to a new classification of Restionaceae and allied families. Pp. 25–56 in: K.A. Meney & J.S. Pate (eds) *Australian Rushes, Biology, Identification and Conservation of Restionaceae and Allied Families*. (University of Western Australian Press: Nedlands).
- *Briggs, B.G. (2000) What is significant – the Wollemi pine or the southern rushes? *Annals of the Missouri Botanical Garden* 87: 72–80.
- *Briggs, B.G., Marchant, A.D., +Gilmore, S. & Porter, C.L. (2000) A molecular phylogeny of Restionaceae and allies. Pp. 661–671 in: Wilson K.L. & Morrison, D. (eds) *Monocots Systematics and Evolution*. (CSIRO: Melbourne).
- Brown, E.A. & #Streiber, N. (1999) Systematic studies in *Dracophyllum* (Epacridaceae) 2. New species of *Dracophyllum* in New South Wales. *Telopea* 8:393–401.
- Brown, E.A. & Coveny, R.G. (1999) *Chonocolea doellingeri* (Nees) Grolle (Chonocoleaceae; Hepaticae); a new record for Australia. *Haussknechtia* 9:57–60.
- +Burgess, L.W. & Summerell, B.A. (2000) Taxonomy of *Fusarium*: *Fusarium acuminatum* stat. & comb. nov. *Mycotaxon* 75:347–348.
- +Burrows, G.E. & Bullock, S. (1999) Leaf anatomy of Wollemi Pine (*Wollemia nobilis*, Araucariaceae). *Australian Journal of Botany* 47:795–806.
- +Crisp, M.D., Gilmore, S.G. & Weston, P.H. (1999) Phylogenetic relationships of two anomalous species of *Pultenaea* (Fabaceae: Mirbelieae), and description of a new genus. *Taxon* 48:701–714.
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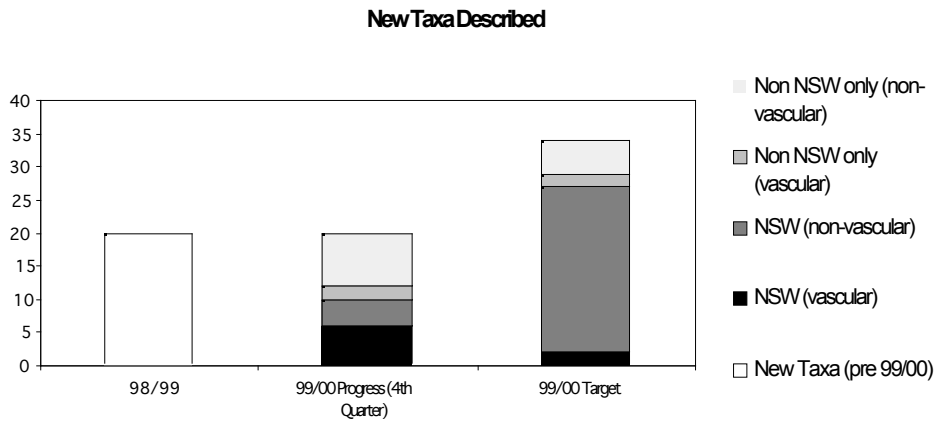
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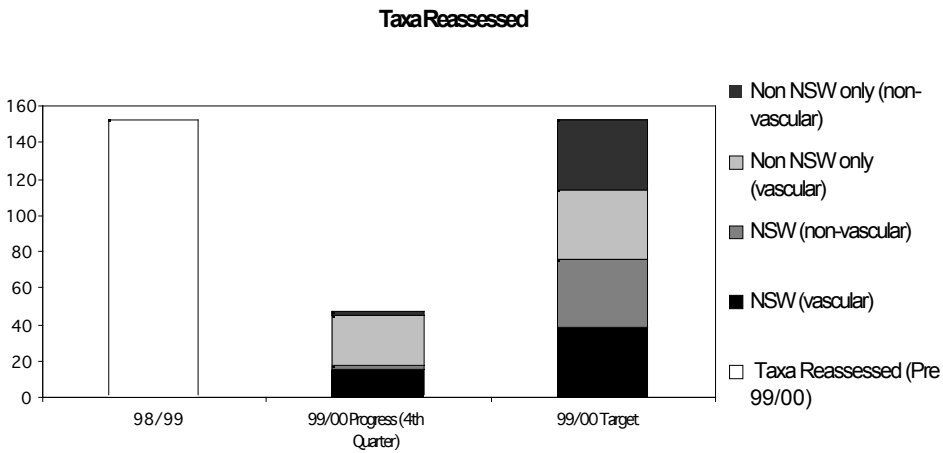
Weston, P.H. (2000) An intriguing case of snotty gobblers. *The Gardens* 44:11.

Appendix J

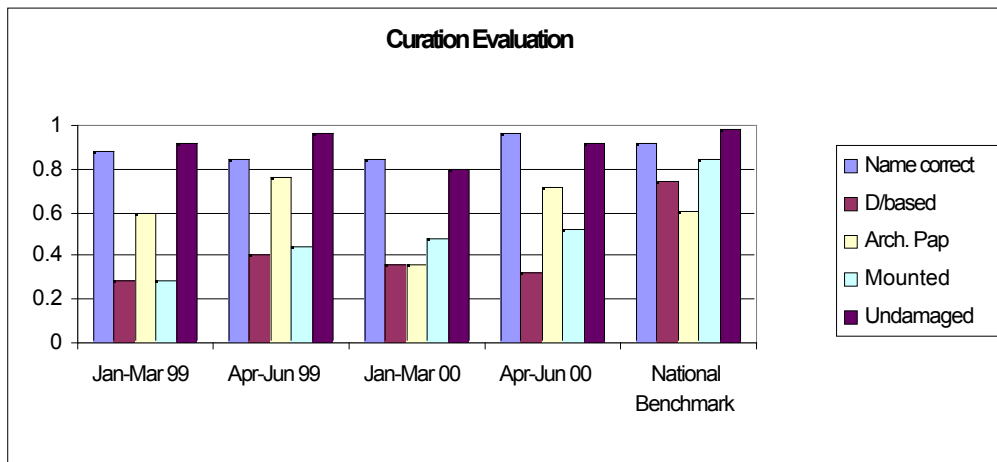
PERFORMANCE INDICATORS



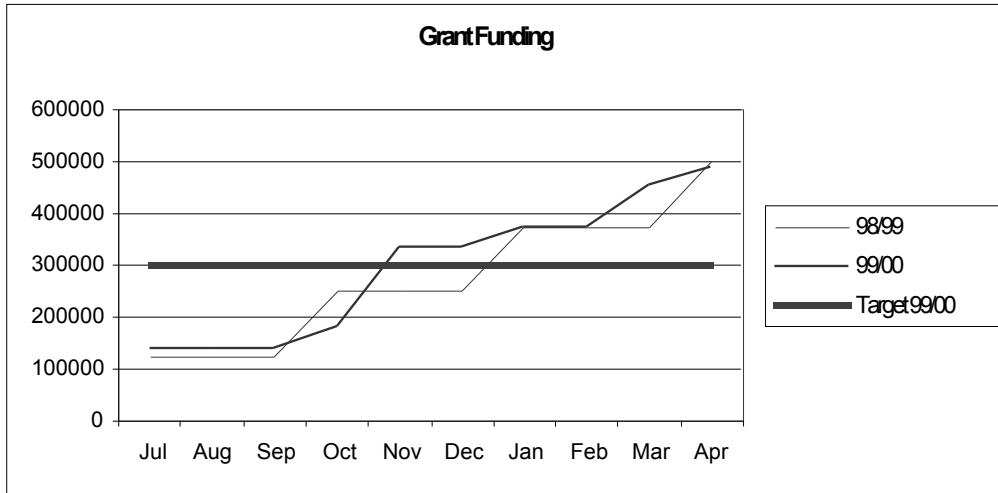
Note: This reports the number of taxa published. A large number of non-vascular plants/cryptogams were discovered and described but formal publication will not occur until next financial year.



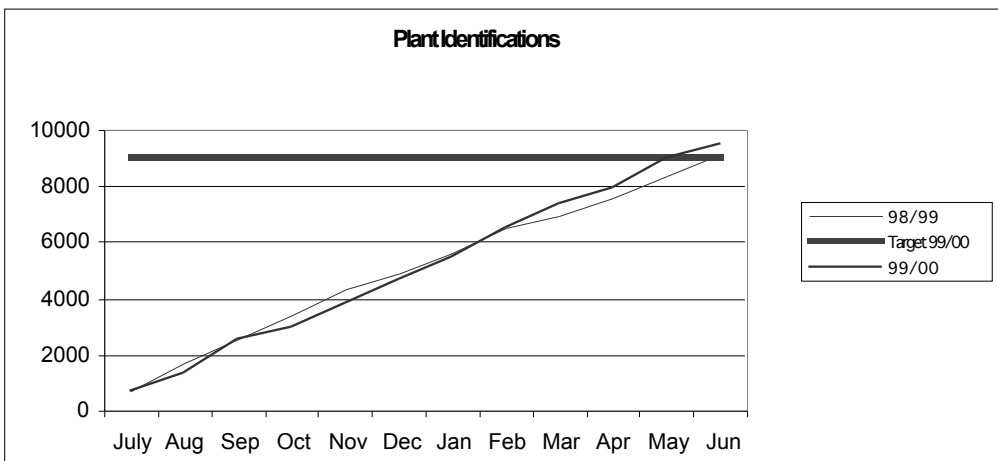
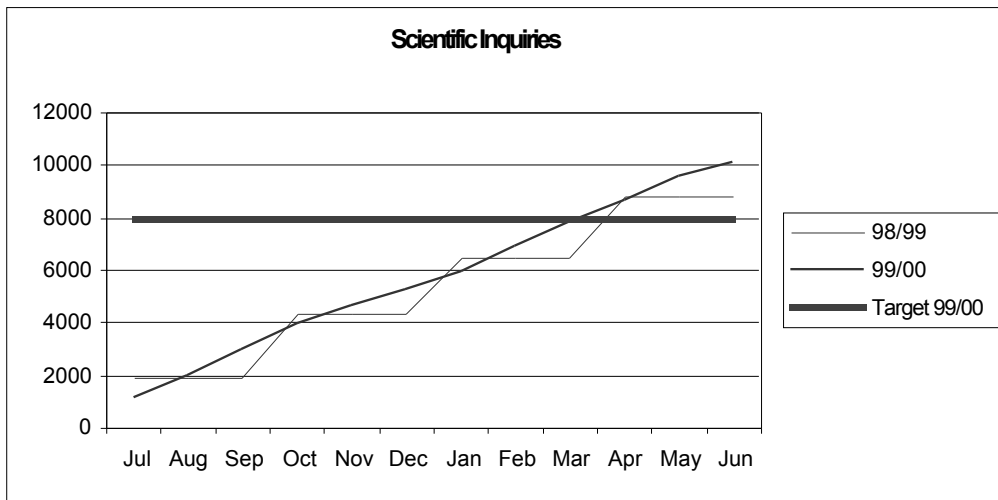
Note: As above.

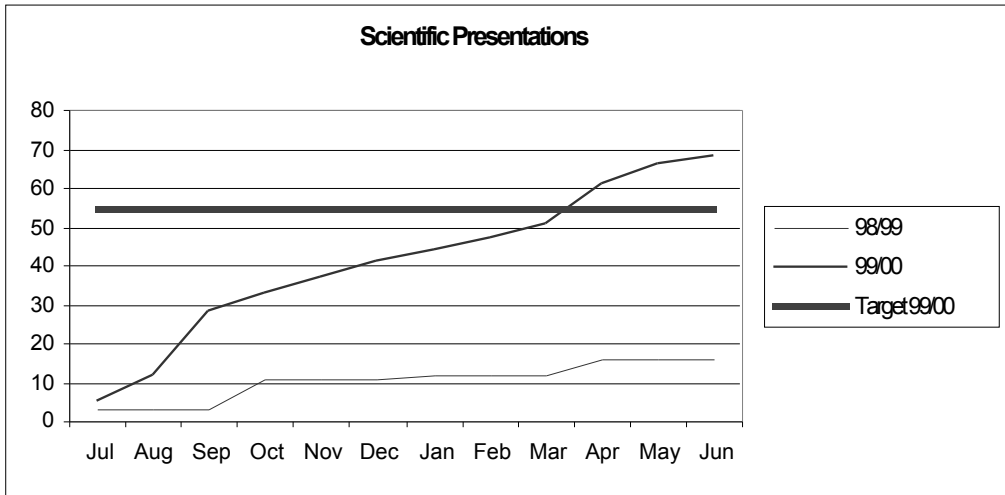


Note: The fluctuations are a reflection of the small sample size rather than real variation and a rolling annual average will be used once sufficient data are available.

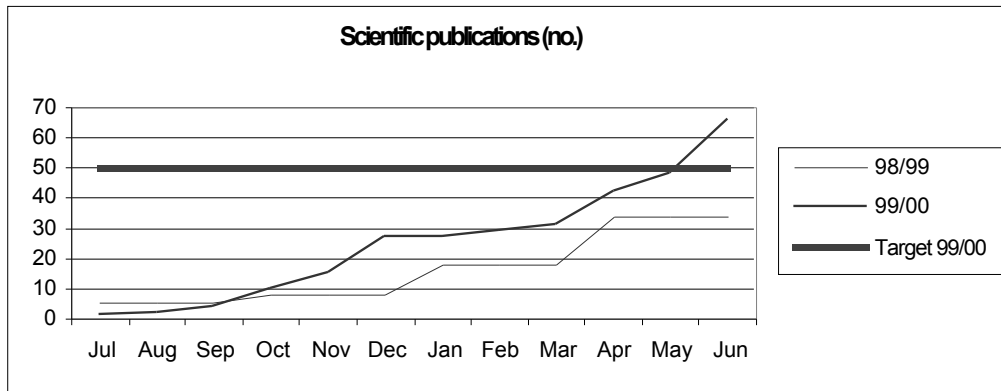
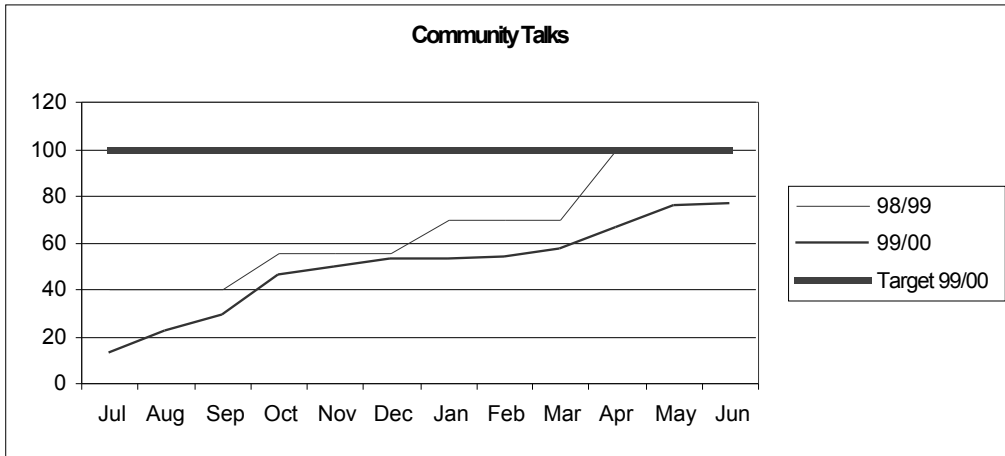


Note: The target for this year was set lower due to the large *NSW Biodiversity Strategy* grant received last year, but we have been able to maintain a very high level of grant success.

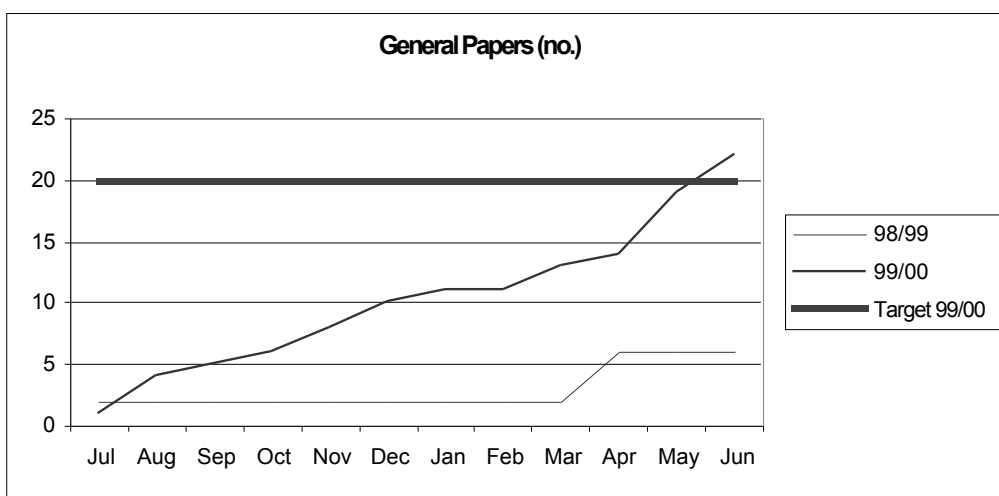
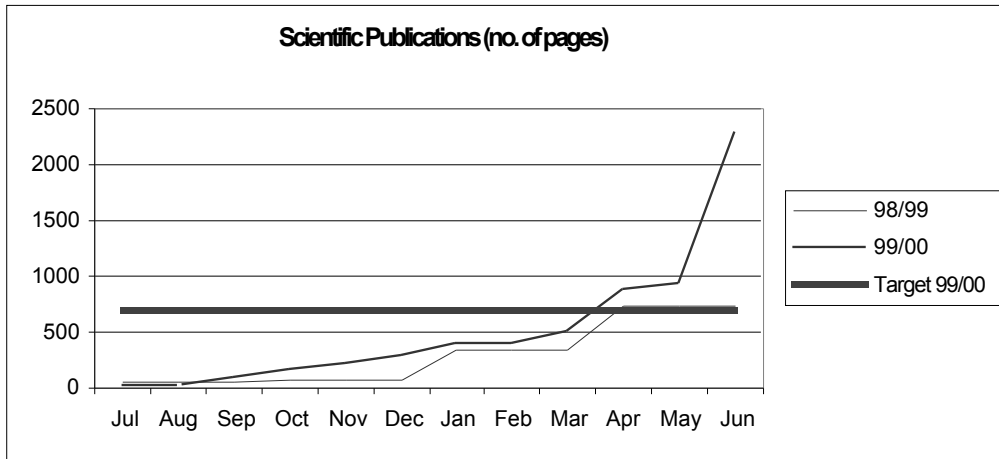




Note: Some major international meetings have contributed to the increase in scientific presentations.



Note: The two *Monocots* volumes contributed to the peak at the end of the financial year.



Note: A major objective for the Plant Sciences Branch is to increase the number of presentations and papers to general audiences.

