Oxford Plant Systematics

With news from Oxford University Herbaria (OXF and FHO), Department of Plant Sciences, Oxford

OPS 17 **May 2011**

Cloud forest plants on the Eastern slopes of the Andes

Foreword

This issue of OPS highlights the roles of botanical exploration, herbarium and laboratory work for systematics research in some of the world's biodiversity hotspots. Robert Scotland emphasises the importance of herbaria in the global species discovery process. Caroline Pannell, John Wood and Steven Heathcote highlight the value of fieldwork for research on *Aglaia* in Papua New Guinea, Bolivian cerrado plants and Andean bromeliads. Elizabeth Cooke and John Wood use chloroplast DNA sequences to identify a mysterious plant collected in the Bolivian cerrado. Detailed field and laboratory work enable Marcelo Simon and Colin Hughes to investigate the evolution of the Cerrado biome.

From our eighteenth-century archives, a collection of John Sibthorp's undergraduate botany lectures is showcased, and Johann Dillenius's 'missing' German lichens rediscovered. John Wood 'finds' Conan Doyle's 'Lost World' in Bolivia.

Stephen A. Harris
Curator of Oxford University Herbaria

Cover images:
Plants from the Eastern slopes of the Andes including bromeliads like the spectacular *Tillandsia rubella* Baker (top right) in an isolated patch of mossy forest at the tree line; the colourful *Guzmania squarrosa* (Mez & Sodiro) L.B.Sm. & Pittendr. (bottom left); and the bright green flowers of *Puya membranacea* L.B.Sm. (bottom right). It is not just bromeliads, but the cloud forest is full of beautiful plants, for example *Eccremis coarctata* (Ruiz & Pav.) Baker, an endemic species of Hemerocallidaceae (top left).
All photographs on front cover by Steven Heathcote, see article on pages 9-11.

Typesetting and layout of this issue of OPS *by Serena Marner*

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Oxford University Herbaria database at:
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Back issues of OPS can be viewed at:
http://herbaria.plants.ox.ac.uk/OPS.html

Contents

News items

At the end of 2009 **Dr Colin Hughes** took up a position as an assistant professor in the Institute of Systematic Botany at the University of Zurich where he will continue work on legume systematics and evolution. He retains a part-time link to the Department of Plant Sciences in Oxford working on the Global Hotspot Initiative.

In 2009 **Marcelo Simon** was awarded the Brian Thomas Styles Memorial Prize in recognition of his D.Phil. thesis on the *Systematics and evolution of Mimosa (Leguminosae) and the assembly of a Neotropical plant diversity hotspot*. This prize is awarded from time to time for an outstanding D.Phil. thesis in the subject area of tropical or subtropical plant taxonomy.

Colin Hughes visited Bolivia in November to December 2009 in association with the Darwin Initiative project - *Conservation of the Cerrados of Eastern Bolivia* – to deliver a training course on legume taxonomy and identification and work with Margoth Atahuachi on Bolivian *Mimosa*.

Rosemary Wise undertook a third trip to Bolivia with **John Wood** in October 2009. Besides painting 30 plants to be incorporated in new 'Cerrado vegetation posters', Rosemary had three botanical illustrators with her, two from Bolivia and one from Argentina, to learn techniques of water colour painting.

Oxford University Herbaria was awarded Accredited Status by the Museums, Libraries & Archives Council in April 2010. This demonstrates the commitment of the Herbaria to manage its collections to nationally agreed standards, and builds on the previous Registered Status of the Herbaria.

The artist **Sarah Simblet**, who has been working in the herbaria, has published *Botany for the Artist* (2010, Dorling Kindersley; ISBN-10 1405332271) which features over 350 botanical illustrations by Sarah. Many of Sarah's models were drawn from collections in either Oxford University Herbaria or the Oxford Botanic Garden.

Improving 'hotspot' conservation

Knowledge of the world's species and ecosystems – global biodiversity – is woefully incomplete. We already know that plant diversity is unevenly distributed and that some areas of the world have more endangered species than others. However, this apparent pattern at the global level disguises a very poor level of detail at the local level. Even within global hotspot regions, whether the Peruvian Andes, Sumatra or the Cape region of South Africa, there are long horizons of botanically uniform vegetation that is poor in rarities. Perhaps these regions should be where urban or agricultural developments are directed in order to reduce species' extinction. Conversely, between the global hotspot regions there are isolated pockets of endangered plant-life, as yet undocumented or too small to appear on world maps, but all the more important to conserve because of their isolation and tenuous existence.

Knowledge of hotspots at all scales facilitates selection of areas and methods for conservation or sustainable economic development. But, even when the global significance of small areas is well known to scientists, the detailed information and analytical tools that are crucial for sound stewardship and practical management, or for minimizing environmental impacts, are often unavailable locally.

The research programme is an innovative global research project to explore, discover and publicise hotspots of plant diversity at local and national levels coupled with a biodiversity awareness programme. Our project will deploy and develop analytical tools, rigorous reports and user-friendly promotional products to publicise facts, figures, maps and field guides at different scales, showing where hotspots of biodiversity are located and how to recognize them. The study areas focus on the tropics and sub-tropics where major hotspots occur. In each priority area, one or more regional surveys will address conservation priorities and threats at various levels. Alongside the many practical and applied benefits and impacts, the programme will help answer more fundamental questions about why biodiversity is so unevenly distributed; how hotspots of diversity are assembled and distributed; and how they might respond to global environmental changes.

New data will be gathered from selected countries using Rapid Botanical Survey (RBS) methods and combining these with existing and new BRAHMS herbarium datasets. Collaborative links are being enhanced in countries where substantial volumes of high quality data are already available for analysis.

Our research activities have received an enormous boost through involvement with Plants for the 21st Century Institute (P21C; http://www.oxfordmartin.ox.ac.uk/institutes/plants/), a translational research institute that is embedded within the Oxford Plant Sciences Department and is affiliated with the Oxford Martin 21st Century School, and generous support from InterContinental Hotels Group.

Denis Filer
Research Associate

A new Taxonomy Library for Oxford

As part of the next stage in the creation of an integrated library service for Oxford University, the main collections from the existing Plant Sciences Library were successfully transferred to the Radcliffe Science Library (RSL), the nearby central science library in autumn 2010. The collections were merged with the RSL's from the 1st October, in time for the new academic year. All existing services (including lending of books) continue to be available at the RSL. The Oxford Forest Information Service was also relocated to the RSL, and continues to collect world forestry materials in conjunction with CAB International. At the same time, Oxford University Library Services was rebranded as 'Bodleian Libraries'.

Taxonomic materials, which need to be used in the Herbaria alongside botanical specimens, have however remained in the Department of Plant Sciences, creating a new collection which is now known formally as the 'Sherardian Library of Plant Taxonomy – one of the Bodleian Libraries of the University of Oxford'. The Sherardian Library is housed partly in the Herbaria and associated stack; a Reading Room for study (accessed by swipe card) has also been redeveloped in an area which was originally part of the existing Plant Sciences Library space. This new Sherardian Library continues to be open to any member of the university, holders of a Bodleian Libraries reader's card and visitors by appointment.

With these moves there have been some library staff changes. Anne Marie Catterall (formerly Anne Marie Townsend) is in charge of the new Sherardian Library and remains in the Department of Plant Sciences based in the Fielding-Druce Herbarium; other library staff are now based in the Radcliffe Science Library, but help out in the Sherardian Library on a rota basis. Roger Mills (Head of Science Liaison and Specialist Services) retired on the 31st October 2010 after nearly 30 years in Oxford. He was appointed Librarian at the Forestry Library in 1981 and had a fulfilling career during tenure at various Oxford libraries; his last accomplishment included helping to plan and oversee the move of Plant Sciences and Zoology libraries into the Radcliffe Science Library. Roger personifies the Oxford librarian; knowledgeable, helpful, creative, encouraging and supportive and we wish him very best wishes on his retirement.

The move has made more efficient use of space, and has also brought together all the university's collections in botany, forestry and plant taxonomy – the first two at the RSL, and taxonomy in Plant Sciences. Materials at the RSL, including all books and bulletin material are on open access. In-

demand print journals which are not available electronically are available at the RSL; others have been transferred to the Bodleian Book Storage Facility (BSF) which has recently been built in the neighbouring town of Swindon, and was opened in October 2010. Materials held in the BSF can be ordered online and are delivered to the Radcliffe Science Library via a twice-daily van service.

We hope that Oxford's historic and modern collections in Plant Sciences continue to serve an ever-expanding clientele with maximum efficiency and accessibility.

Anne Marie Catterall
Sherardian Librarian of Plant Taxonomy
One of the Bodleian Libraries of the University of Oxford

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Abstract of systematics thesis submitted in 2010

The following D.Phil. thesis was submitted and successfully defended in 2010:

Historical assembly of seasonally dry tropical forest diversity in the Tropical Andes

Tiina E. Särkinen
St. Catherine's College

Supervisors: Dr Colin Hughes (Oxford) and Dr Toby Pennington (Royal Botanic Garden Edinburgh).

The relative contributions of biome history and geological setting to historical assembly of species richness in biodiversity hotspots remain poorly understood. The tropical Andes is one of the world's top biodiversity hotspots, and with its diverse biomes and the relatively recent but dramatic uplift, the Andes provides an ideal study system to address these questions. To gain insights into the historical species assembly of the tropical Andes, this study focuses on studying patterns of plant species diversification in the Andean seasonally dry tropical forest (SDTF) biome.

Three plant genera are used as study groups: *Amicia* (Leguminosae, Papilionoideae), *Tecoma* (Bignoniaceae), and *Mimosa* (Leguminosae, Mimosoideae). Species limits are re-evaluated to enable dense sampling of species and intraspecific diversity for phylogeny reconstruction for each group. Time-calibrated phylogenies for *Amicia* and *Mimosa* are presented and used to determine patterns of species diversification in time and space. For *Tecoma*, incongruence between nuclear and chloroplast gene trees precludes straightforward estimation of a species tree and this incongruence is attributed to possible reticulation caused by hybridization.

Divergence time estimates and patterns of diversification for *Amicia* and *Mimosa* are compared with other Andean SDTF groups (*Cyathostegia*, *Coursetia*, *Poissonia*; Leguminosae) using isolation by distance and phylogenetic geographic structure analyses. Consistently deep divergences between sister species and high geographic structure across all five groups suggest that Andean SDTF lineages have persisted over the past 10 Ma with high endemism driven by dispersal limitation caused by geographic isolation following the most recent episode of rapid mountain uplift 5-10 Ma. This prolonged stasis of the Andean SDTF biome is in line with Miocene fossil and paleoclimate evidence. Finally, wider analyses of the contrasting evolutionary timescales of older SDTF and more recent high-altitude grassland diversity suggest that the exceptional plant species diversity in the Andes is the outcome of highly heterogeneous evolutionary histories reflecting the great physiographical heterogeneity of the Andean biodiversity hotspot.

Student reports

Elizabeth Cooke (M.Sc., 2nd year) Systematics and Phylogeography of *Cardamine hirsuta* L.

Supervised by Dr Robert Scotland (Oxford), Dr Mark Carine (Natural History Museum) and Professor Miltos Tsiantis (Oxford). BBSRC funded.

Cardamine hirsuta (Brassicaceae) is an emerging model organism in developmental genetics (Canales *et al*. 2009) but the phylogeography and level of morphological variation within *C. hirsuta* are poorly understood.

Cardamine hirsuta is a diploid, self-fertile, winter annual with a cosmopolitan distribution in temperate regions of the world. It is considered native to Europe, Western Asia and North Africa and has been introduced by humans across the rest of the temperate world. The closest relatives of *C. hirsuta* are unknown due to the lack of phylogenetic resolution and paucity of taxon sampling within *Cardamine*, a large genus of some 200 species. *C. hirsuta* is highly variable for a number of morphological traits. Accordingly several intra-specific taxa have been recognised and named since the last comprehensive taxonomic treatment in 1903.

The aims of this project are first, to describe the geographic and phylogenetic structure of molecular variation in *C. hirsuta*, in order to construct a phylogeographic hypothesis for *C. hirsuta*. Second, to use phylogenetic methods to identify the closest relatives of *C. hirsuta*.

Previous studies of *Cardamine hirsuta* using ITS, *trnL* intron and *trnL-trnF* spacer have found little haplotype diversity and only limited geographical structure despite range-wide sampling, apart from a distinct Ethiopian clade within an ITS phylogeny (Lihová *et al.* 2006). This is perhaps unsurprising given that the species is a garden weed and thus there is potential for human mediated dispersal to have obscured or destroyed any phylogeographic structure. However, identifying chloroplast regions with suitable levels of intraspecific variation and sampling widely from across the range of *C. hirsuta*, primarily using DNA extracted from herbarium specimens, has revealed geographic structuring of genetic variation in *C. hirsuta*. Sampling is on-going with the focus on underrepresented areas of the native range.

The close relatives of *C. hirsuta* are being investigated by re-analysing existing data in addition to increased character, individual and taxon sampling.

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Tom Flynn (D.Phil., 3rd year) The evolutionary ecology of nickel hyperaccumulation in *Alyssum* L. and related species

Supervised by Professor Andrew Smith (Oxford), Dr Stephen Harris (Oxford) and Dr Colin Hughes (Institute for Systematic Botany, University of Zurich). NERC funded.

I am now half way through the third year of my D.Phil. project. I am constructing a phylogeny for the large genus *Alyssum* (Brassicaceae), along with twelve smaller closely related genera within the tribe Alysseae. Fifty-four species in two of these genera (*Alyssum* and *Bornmuellera*) are able to hyperaccumulate the heavy metal nickel. A well sampled and resolved phylogeny will help to answer the question 'how many times has this trait evolved in the tribe?'.

In my first year I carried out a pilot study to screen genetic loci, in the hope of finding highly variable (and hence phylogenetically informative) regions, which are also reasonably straightforward to amplify and sequence for Alysseae species. I screened twelve chloroplast and three nuclear regions, and decided to use four for my study (*trn*L-*trn*F, *trn*D-*trn*T, rps16-*trn*K and

part of *mat*K). In my second year I concentrated my efforts on obtaining plant tissue (from herbarium specimens, and from plants that I have grown from seed), sequencing DNA, and constructing a phylogenetic tree for the tribe. I presented this tree in the form of a poster at my second year assessment in October 2010. Interestingly, this tree indicates a single origin of nickel hyperaccumulation in *Alyssum*, and a separate single origin in *Bornmuellera*. The nickel hyperaccumulator clade in *Alyssum* is characterised by very short branch lengths, suggesting that a rapid and recent species radiation may have accompanied the origin of nickel hyperaccumulation in this genus.

In my third year I have added additional genetic loci (*ndh*F, *rbc*L, and PHYA) to my study, and have widened my sampling to include additional taxa in the Brassicaceae and Brassicales. This will allow me to carry out fossil age-calibrated analyses using the Bayesian phylogenetic software BEAST, in order to build a dated phylogenetic tree of Alysseae. This should allow me to estimate the dates of origin of nickel hyperaccumulation in this tribe. It will also allow me to investigate whether the evolution of this trait is accompanied by shifts in species diversification rate.

Evolution of the Cerrado

The Cerrado is the world's most species-rich tropical savanna. Covering two million km^2 in central Brazil, eastern Bolivia and parts of Paraguay in South America, the Cerrado is home to more than 10,000 plant species about 44% of which are thought to be endemic. The open, fire-prone Cerrado habitats thus have a very distinctive flora with limited species overlap with adjacent closed, fire-free forests and other biomes.

Despite the floristic and global conservation importance of the Cerrado, ideas about the origins and diversification of its flora have varied widely. On the one hand the Cerrado has been viewed as an ancient (early Cretaceous) biome with Cerrado lineages suggested as possible precursors of the adjacent Amazon and Mata Atlântica rain forests. On the other hand, others have suggested much more recent origins, even as late as the Holocene. In a paper published last year, we investigated these alternatives in the first comparative phylogenetic study of the Cerrado (Simon et al., 2009). In this study we used time-calibrated phylogenies for plant groups that include a significant number of endemic Cerrado lineages and species to reconstruct a picture of the historical assembly of species diversity in the Cerrado. These phylogenies are based on new empirical data including a new time-calibrated phylogeny for the legume family and a phylogeny for the important species-rich plant genus *Mimosa*. The results suggest a recent origin of the Cerrado biome coinciding with the emergence to dominance of C-4 grasses, in contrast to earlier ideas that the Cerrado is much older and a possible precursor of adjacent Amazonian and Atlantic rain forests.

Fire adaptations are the hallmark of the Cerrado flora. Amongst these are plants that switch from being woody shrubs or trees to become functionally herbaceous by shifting their woody biomass underground in the form of subterranean woody stems and large woody structures referred to as lignotubers or xylopodia, and the plants as geoxylic suffrutices. The abundance of such adaptations in African savannas prompted Frank White to describe these woody formations as 'underground forests' (White, 1977). Such adaptations are common in the Cerrado (Fig. 1), occurring repeatedly across diverse plant lineages. For example, within just a single one hectare plot in the southern Cerrado, 301 species spread across 64 genera and 37 families were found to have xylopodia (Gottsberger & Silberbauer-Gottsberger, 2006). These geoxylic suffrutices can rapidly re-sprout after fire. Sometimes, the first structures to appear are flowers (Fig. 1 G, H, L & N), facilitating rapid seed set and dispersal (Fig. 1 F & I), before the herbaceous ground layer becomes re-established. Other adaptations to fire include thick insulating corky bark (Fig. 1 M), rosulate tree habit where branching is reduced to a smaller number of thicker branches and the leaves are restricted towards shoot tips (Fig. 1 O). Pachycaul treelets of this type are also common in the Cerrado.

The independent occurrence of these fire adaptations across many plant families and genera, and across multiple independent lineages within genera as we have demonstrated using phylogenies of *Mimosa* (11 independent Cerrado lineages) and *Andira* (two independent Cerrado lineages), suggests that fire does not pose a significant adaptive barrier. The changes required to thicken bark, redistribute leaves towards the tips of fewer stouter branches, or shift woody biomass to underground structures are all morphological or architectural modifications of potential genetic developmental simplicity compared to more complex plant physiological adaptations, such as tolerance of frost or saline soils, and this is likely to account for this ease and evolutionary lability of fire adaptation.

The emerging picture of the Cerrado is of recent diversification of endemic plant lineages that took place during the late Miocene and early Pliocene, driven by the common trigger of fire adaptation, and facilitated by ease of fire adaptation across plant lineages from the diverse biomes immediately surrounding the Cerrado. The idea that the Cerrado formed essentially *in situ* via recent adaptive shifts to resist fire, rather than via dispersal of lineages already adapted to fire, sheds new light on recent suggestions that phylogenetic niche or biome conservatism plays an important role in the large scale assembly of regional species pools. The idea that dispersal of pre-adapted lineages may occur preferentially over the evolutionary shifts in traits needed to overcome adaptive barriers, was succinctly summed up in the phrase '*it is easier to move than it is to evolve (unless it isn't)*', in a recent essay on the distribution of plant diversity (Donoghue, 2008). The Simon *et al.* (2009) study of the Cerrado provides documentation for an example of the '*unless it isn't*' category. Instead of long-distance dispersal of pre-adapted savanna lineages from elsewhere, we demonstrate large scale historical biome assembly from disparate plant lineages in geographically adjacent biomes via evolution of diverse adaptations to withstand fire.

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Fig. 1. Fire adaptation in the Cerrado. A-K functionally herbaceous Cerrado perennials with woody lignotubers. A. *Mimosa venatorum;* B *M. ulei*; C *M. speciosissima*; D *Indigofera asperata*; E-G *Andira humilis* (all Leguminosae) – E & F branches of the geoxylic suffrutex or 'undergound tree'; F unripe fruits; G flowers at ground level; H-J *Calliandra longipes* (Leguminosae) – H inflorescence on soil surface emerging immediately after fire; I ripe dehisced pods overtopped by shoots two months after fire; J lignotuber; K lignotuber of *Rynchosia burkartii* (Leguminosae); L *Barbacenia* sp. (Velloziaceae) flowering immediately after fire; M thick corky bark of *Machaerium opacum* (Leguminosae); N *Hippeastrum goianum* (Amaryllidaceae) flowering immediately after fire; O *Kielmeyera coriacea* (Clusiaceae) rosulate treelet with leaves crowded at tips of thickened branches. Photos A-C, E & L-O Marcelo Simon; D & I-K Colin Hughes; F-H Darwin Initiative Cerrados Project, Bolivia.

Stryphnodendron fissuratum, a distinctive endangered tree of the South American cerrados

Stryphnodendron fissuratum (Leguminosae, Mimosoideae) is a rare tree of the cerrados of Brazil and Bolivia. It was first described as recently as 1980 by E.M.O. Martins based on a collection from Mato Grosso by G. & L.T. Eiten. There are three additional collections from the same area and perhaps from the same population at Kew. No other Brazilian collections are noted in Dubs (1998) or in Tropicos or the New York Virtual Herbarium. It is thus a very rare plant in Brazil.

Fig. 1 Habit of *Stryphnodendron fissuratum*

Until the Darwin Initiative Project 16-004 "Conservation of the Cerrados of Eastern Bolivia", this species was only known in Bolivia from a single sterile collection (*Killeen* 1909 (MO)). However, since the start of field work in this project, this species has been found on many occasions, usually growing as a single isolated tree in cerrado and, less commonly in cerradão. Within Bolivia it appears to be restricted to the areas around Concepción, Santa Rosa de la Roca and San Ignacio, where it is commonly associated with species such as *Aspidosperma elegans* (Apocynaceae), *Dipteryx alata* (Leguminosae, Mimosoideae) and *Caryocar brasiliense* (Caryocaraceae). It grows on open sandy plain on well-drained soils and is completely absent from hill-top mesetas or mountain slopes. Given its preferred habitat it is unlikely to be present elsewhere in the Bolivian cerrados.

Stryphnodendron fissuratum is a very distinctive tree. It is usually 10-15 m high with a broad, spreading crown (Fig. 1). Older trunks have a greyish, somewhat fissured bark (Fig. 2). Younger stems, both the trunks of immature trees and the branches and branchlets of mature trees, are covered in a yellow-brown, deeply fissured corky bark (Fig. 3). This kind of bark is typical of a number of cerrado species and may provide protection for younger growth during the periodic fires, so characteristic of this habitat. The tree is at least partially deciduous during the dry season and young leaves of a distinct "apple-green" are usually present. The very large leaflets are another unusual feature which is rare or absent in other species of *Stryphnodendron* and related genera. The inflorescence consists of racemes of cream flowers which contrast with the reddish buds and reddish, glandular indumentum of new growth (Fig. 4). The flowers are in fact difficult to spot against the background of reddish twigs and green leaves, which may partly explain why they are so rarely collected. The fruit is also unusual in the genus, consisting of spirally twisted legumes (Fig. 5).

Fig. 2 Greyish fissured bark of an older branch

Fig. 3 Yellow-brown, deeply fissured corky bark of young trunk and branch

Given its distinctive character it seems remarkable that this species was not described until 1980 and was only known from a handful of collections before the current Darwin project. Its rarity is obviously one factor as also are its camouflaged flowers. However, another probable factor is that it is a periodically flowering species. Apart from a single tree at Concepción, we were unable to find any fertile trees in 2007 or 2008. However in 2009 we found trees in flower throughout its range in Bolivia from April through to October. We still have to confirm whether fruits are formed as readily but it is clear that flowering does not take place on a regular annual basis and must be triggered by some kind of environmental event or perhaps by some genetic predisposition. Infrequent flowering would appear to explain the total absence of young plants. To date we have seen no seedlings or plants less than about two metres tall. It will be interesting to see if young plants appear in 2010.

Fig. 4 Inflorescence of *S. fissuratum*

Flowering patterns are a neglected field in South American botany in general and very few studies are available. It is well-known that burning stimulates flowering in many cerrado species, which survive flowerless and perhaps entirely subterranean between the periodic burns which sweep across this biome. However, there are clearly other factors at work. Some of these are obvious, such as the appearance of large numbers of annual species of *Utricularia* (Lentibulariaceae), *Acisanthera* (Melastomataceae) and *Curtia* (Gentianaceae) in between grass tussocks after sufficient rainfall at the appropriate season. But in other cases, such as that of *S. fissuratum* no obvious explanation is available. Clearly further studies of this species are necessary to understand its reproductive behaviour.

This is clearly a matter of some urgency as the areas where *S. fissuratum* grows are under threat. These are close to population centres, flat and easily cleared by bulldozers with the original vegetation grubbed up and replaced by imported grasses to provide pasture for beef cattle. Vast areas have

Fig. 5 Fruit of *S. fissuratum*

already been cleared and it is likely that the number of trees has been significanty reduced. And we are not talking about a lot of trees. We have observed a single tree in the 30 kilometres between San Ignacio and San Miguel and only two or three between San Ignacio and Santa Ana. Even in the largest population lying to the south of Concepción, there are only about 25 trees and these are mostly restricted to a narrow strip of the original vegetation, which survives along the road. Clearly *S. fissuratum* is a vulnerable species within the IUCN classification in Bolivia and there is every reason to think that is equally rare or more so in Brazil.

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Map showing distribution of *S. fissuratum* in Bolivia and Brazil

Andes to Amazon in search of Bromeliads

It was no real surprise, looking up into the canopy of a large *Weinmannia*, to see the mass of plants which had accumulated on the branches. As the fog rolled in, on cue, in the early afternoon, obscuring the furthest reaches of the canopy from view, the reason that the Eastern slope of the Andes supports so many epiphytes became apparent. I was searching for the Bromeliads amongst the mass of ferns, orchid and bryophytes, and the twisting branches of the tree's canopy.

My fieldwork in Manu National Park, one of Peru's biggest National Parks, is aimed at trying to understand how the 60-or-so species of Bromeliaceae are distributed in the 3500m altitudinal transect, which is the focus of a much broader range of research for the Andes Biodiversity and Ecosystem Research Group (a collaboration between Oxford University, Edinburgh University from Britain, Wake Forest University and UCLA in the USA and the San Antonio Abad National University from Cuzco in Peru.). The group as a whole is making exciting progress, key findings so far include:

- First direct evidence of plant migration in the Andes in response to climate change (Feeley *et al*. 2011).
- High carbon storage in cloud forest soils compensate for the smaller trees meaning these forest store as much carbon as lowland tropical rainforest (Girardin *et al.* 2010).
- Termites dramatically increase the turnover of soil in lowland forests compared to montane forests (Palin *et al*. 2011).

Although the epiphytes contribute a small amount of total forest biomass (at most 5%) they are ecologically important, supporting communities of invertebrates, frogs and even specialist birds which feed on the insects in the tanks. They also provide food and water for the Spectacled bear and monkeys which are abundant in the National Park. One of the most exciting aspects of the epiphytes is their distribution, and how the 60-plus species are adapted to their part of this ecosystem.

The transect falls into four major ecological zones, the high-altitude grassland, locally called 'the Puna' (over 3000m). The Puna is home to the large spiny terrestrial bromeliads in the genus *Puya*. *Puya* are a popular food for the Spectacled bear (of Paddington bear fame!). Also in the Puna are isolated patches of trees, and it was here I encountered the enchanting *Tillandsia rubella*, on a bed of red and yellow sphagnum under the *Weinmannia* and *Clethra* trees which tolerate the harsh conditions at high altitude. *T. rubella* has striking green and red foliage, often covered with small spots, and the inflorescence is a vibrant pink, and the flowers purple.

The tropical montane cloud forest extends from the tree line down to 1500m. The cloud part of name is fully deserved, and the frequent immersion in clouds ensures all equipment and clothing is constantly damp. In this zone we find large numbers of species in the genus *Tillandsia* and *Racinaea*. Perhaps most interesting in these forests were a large group of hybrid plants, with morphology suggesting crosses between *Tillandsia complanata*, reknowned for its promiscuity, and *T. rubella*, *T. stenoura* and *T. fendleri*. All these species have the same purple flowers which attract hummingbirds, and cross pollination must be a common occurance. The cloud forests were my personal favourite place to work, the dramatic terrain and high diversity of plant life (with relatively few insects!) make this zone a fascinating place for a botanist to work.

Fig.1 Leaves 8 metres long of a *Bromelia* species, photographed with field assistant Guido Fernandez for scale

The tropical montane forest extending from the base of the cloud zone to the lowland rainforest (mixing occurs between 900m and 600m), is home to some of the most showy plants. The widely plant *T. fendleri* with its 2m high green and red inflorescence is well known from around Machu Picchu. Other species, including *Guzmania squarrosa* and *Mezobromelia pleiosticha* can also flower up to 2m high with red and yellow inflorescences.

The lowland rainforest is home to a very different group of plants, composed predominantly of the spiny genus *Aechmea*. There was also something of a record in my own personal collecting. On the trail to one of the research plots we stumbled across a terrestrial bromeliad, in the genus *Bromelia*, with leaves we measured to be 8m long (and 5-10cm wide, fig 1). The leaves were so long they draped over the surrounding vegetation and simply trailed along the floor in many places!

The diversity of the bromeliads remained constant across the entire altitudinal gradient, only dropping slightly at the highest and lowest altitudes, and the species show a constant rate of turnover. Factors controlling this turnover are complex, but include pollination syndrome, annual rainfall and temperatures and the architecture of the plants. The architecture of the plants has proved especially interesting, as leaf number and angle show significant variation relating to microclimate (Fig. 2).

Fig. 3 The parts of a massive *Tillansia fendleri* in preparation for pressing

Central to the project was collecting and recording morphological traits of these plants, which requires removing the plants from their lofty perches in the canopy. Trained by the Global Canopy Programme in Wytham woods, I found the logistics of climbing into the trees in the wet, remote cloud forest were somewhat more complicated than the dry leafy Beech trees of Wytham Wood. Although my team changed over the two years, I spent over five months hiking through the cloud forests, down muddy, rocky or overgrown trails with Guido Fernandez and Damian Ramos, my assistants from the San Antonio Abad National University in Cuzco, and Andrew Collins, Payden Sra, Liz Ethington and Sally Scudder, volunteers from the USA. I also worked with Aline Horwath of Cambridge University; we shared tree climbing as she studied the epiphytic bryophytes, another essential part of this fragile ecosystem.

Fig. 2 The diverse architecture of bromeliads from the Wayqecha Research Station

The work was made harder because Bromeliads are tricky plants to work with. While collecting the plants we were dealing with the copious spines on some species combined with the myriad of creatures (including biting ants) which make a home in the tanks of many bromeliads, and the constant fear of finding a tree snake which had taken refuge in the plant. The challenge then turned to making an informative herbarium specimen out of the large, fleshy, drying-resistant leaves and delicate, short-lived, colourful flowers (Fig. 3). While a machete made short work of excess material, we often had to carry around over 10kg of newspaper as frequently changing the presses was key to rapid drying. Despite our best efforts more than one set of presses broke under the strain of trying to flatten the plants. Further challenges were created by the ever-wet conditions in the cloud forest, and frequent rainfall in the lowlands. In the end many specimens were preserved in alcohol, using the Schweinfurth method to prevent degradation and pressed back in the project HQ, although at the expense of the vivid colours of many specimens. This was also to the initial amazement of my assistant, who thought I was about to set fire to my specimens! In all a total of 96 plants were collected, pressed, dried and mounted. Of these, 58 were collected with duplicates: these have been expertly mounted by Anne Sing and now reside in the Fielding-Druce Herbarium.

While Manu National Park remains relatively unexplored, another more famous site on equally difficult terrain is much better known. We found time during the course of our research to visit nearby Machu Picchu, the royal hideaway of the Incas. Despite this being a brief holiday, I still located several bromeliads. One plant in particular, growing in a crack in the famous old stones, proved tricky to identify, and after consultation with bromeliad experts its identity still remains uncertain!

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Molecular sequencing solves a taxonomic mystery

Fig. 1 Mystery plant from the Noel Kempff National Park, Bolivia on the Darwin Initiative Project

In November 2008 botanists from the Darwin Initiative Project 16-004 collected a specimen of a small unrecognised plant (Fig. 1) growing in cerrado vegetation on the meseta of the Serranía de Huanchaca in the Noel Kempff National Park in eastern Bolivia. Initial thoughts suggested that it might be a species of Gesneriaceae but this idea was abandoned after receiving a strong negative from an expert in this family. Specimens and photographs were shown to many botanists with experience in the cerrados of Bolivia and Brazil. Some suggested it was an Acanthaceae but the majority opinion was that it belonged to the Scrophulariaceae, in the traditional sense. However, careful search of material in all possible genera proved fruitless.

Given the project´s inability to identify the plant, efforts were made to recollect the plant in 2009. These were successful and the plant was found to be common in sandy hollows between grass in open, dry *campo sujo* vegetation. Photographs were taken of the plant's root system which consists of a relatively stout xylopodium, enabling it to survive fire and drought (Fig. 2). An older unidentified specimen from Las Gamas,

Fig. 2 Photo showing the root system of the mystery plant from the Noel Kempff National Park

Fig. 3 *Casselia chamaedryfolia* photographed in Bolivia
Darwin Initiative Project 16-004

another area of the same meseta, was also found in the Santa Cruz herbarium (USZ) but the plant´s identity remained a mystery.

In order to resolve the matter leaf fragments were passed to Elizabeth Cooke who was asked to identify the plant by molecular methods. This entailed extracting DNA and sequencing common barcoding regions. Universal primers were used to amplify three chloroplast barcoding regions, but only *trnL-trnF* amplified successfully. Thankfully this one region was enough to identify the genus. Blast searching the resultant *trnL-trnF* sequence for the mystery plant revealed it was most similar to species from the genus *Casselia* Nees & Mart. (Verbenaceae). A distance tree of the results gave the mystery plant as being in the *Casselia* clade but its sequence had several differences from those of the three species of *Casselia* that had published sequences for this region (*C. integrifolia*, *C. glaziovii* and *C. confertiflora*). After checking whether the molecular identification of the mystery specimen agreed with morphology by reference to O'Leary and Múlgura's 2010 revision of the genus, it was clear that it was indeed a *Casselia*.

By reference to the New York Starr Virtual Herbarium it was now easy to identify the unknown *Casselia* as *Casselia rosularis* Sandw., a species for which there are no sequences in GenBank. There are five collections of *C. rosularis* in the NY virtual herbarium, three with images. One, without an image, came from a different location on the same meseta in Bolivia as the newly identified plant. All the herbarium specimens of *C. rosularis* show small blackish plants with discoloured flowers, quite unlike the only other species occurring in Bolivia; *Casselia chamaedryfolia* (Fig. 3), which superficially resembles the European *Veronica chamaedrys*. There are no collections of *C. rosularis* in Tropicos and it is evidently a very rare plant, being mainly found in three locations in the Serranía de Huanchaca in Bolivia and three in Mato Grosso State in Brazil. Despite its unattractive appearance as a dried specimen, living plants have large, delicate, short-lived but very attractive flowers.

This narrative serves to show how molecular sequencing can come to the aid of traditional taxonomy; helping to resolve problems of identification in species that cannot readily be assigned to genus or family.

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Herbaria are the major frontier for species discovery

Upon examining the details of 60 new species of *Strobilanthes* that have been described during the course of a long term monographic study here at Oxford Plant Sciences, I noticed that a sizeable fraction of those species had been first collected over 50 years before. For all 60 species, the mean lag period between the date the first specimen was collected and the species being recognised and published was more that 50 years. This meant that despite the fact that we had been conducting fieldwork over a number of years in Sri Lanka, Southern India, Java, Bhutan and Philippines, most new discoveries were of species that were collected a long time before but had evaded detection thus far. I and my colleague John Wood who had described the majority of those species were keen to establish whether this temporal pattern of species discovery was typical for other groups of plants.

Data were assembled for 3,219 species described during the period 1970-2010, and associated with specimens collected between 1770-2007. We chose this period as it most accurately reflects the contemporary situation and also avoids the complicated taxonomic history and synonymy associated with older species descriptions. The data were gathered from two sources which represent the full range of taxonomic activity and geography: new species (sp. nov.) from six monographic treatments (n = 449 species) and the journal *Kew Bulletin* (n = 2770 species). We selected monographic treatments of taxa with a range of geographical distribution patterns in order to best capture global differences in species occurrence and the history of taxonomic activity, i.e., the pan-tropical Chrysobalanaceae, *Aframomum* from Africa, *Inga* from tropical America, *Strobilanthes* from South and South East Asia, *Agalmyla* from Malesia and *Hypericum* distributed in temperate and subtropical regions of N. America, Europe, Turkey, Russia, India and China. Five of the monographs included fieldwork and examination of large quantities of recently collected specimens. For example, after the first part of the Chrysobalanaceae monograph was published in 1972, 11500 additional herbarium collections were made and then examined by the author. For *Aframomum*, 547 out of 3184 specimens examined were collected post -1990. For *Strobilanthes*, targeted field work was carried out in Sri Lanka, India, Bhutan, Java and the Philippines over a 15-year period. We reasoned that new species described in *Kew Bulletin* provide a representative sample of all new species descriptions included in taxonomic revisions, small monographs and novelties as a result of ongoing collecting activities. The discovery time (*I*) between the date of the earliest specimen collected (*C*) and date the description was published (*D*) was calculated for each species.

The data show that only 16% of new species, between 1970 and 2010 were described within five years of being collected for the first time. The description

Image above shows herbarium specimens of thirty new species of *Strobilanthes* (Acanthaceae) described and published between 1994 and 2009. All species were first collected at least sixty years before publication

of the remaining 84% involved much older specimens, with nearly one quarter of new species descriptions involving specimens more than 50 years old. Extrapolation of these results suggest that, of the estimated 70,000 species still to be described, more than half of these have already been collected and are currently stored in herbaria. Effort, funding and research focus should, therefore, be directed as much to examining extant herbarium material as collecting new material in the field.

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Herbarium specimen of *Strobilanthes frondosa* first collected in 1924 from Burma (*Cooper* 5943A, E), published 70 years later in 1994. Photo: Prashant Awale

Aglaia novelties from Papua New Guinea

Since publication of the monograph of *Aglaia* (Meliaceae) in 1992, three new species of *Aglaia* have been discovered in Papua New Guinea (PNG). All three were novel discoveries for which there was no previously existing material in the collections of any herbarium I have examined. The first emerged from an ingenious Ph.D. study by zoologist, Andy Mack, and the second and third from the intrepid explorations of botanist, Wayne Takeuchi. However, each species is incompletely known, from a single locality and from only one or a few numbered collections (see map below).

In the early 1990s, Andy Mack was researching the diet of the large flightless bird, the Dwarf Cassowary at elevations between 950 and 1200m in the transition zone between mixed evergreen forest and submontane forest in Crater Mountain Reserve, south eastern Chimbu Province. He found that Dwarf Cassowaries swallow whole the enormous arillate seeds of a species of *Aglaia*. The seeds weighed over 100g, up to a maximum of 250g (Andy Mack in litt.), and were large enough for him to hammer numbered nails into the newly fallen seeds. The red aril and large white scar, where the seed had been attached to the fruit, made the seeds conspicuous on the forest floor. The fleshy aril was removed in the gut of the cassowary and the remainder of the seed defaecated. Andy used a metal detector to find some of the now inconspicuous brown seeds in cassowary dung. From the numbered nails, he could tell how far and in which direction the cassowaries had travelled while carrying the seeds internally and whether their movement was downhill or uphill (Mack, 1997 & 1999). He hoped that, by sending me a photograph of the leaves, he would get a routine identification, but a leafy specimen on which the indumentum can be examined is the minimum material for accurate identification of *Aglaia*. When Andy sent me a leafy shoot, together with fragments of the cantaloupe-sized fruit (up to 18 cm in diameter), it was clear that this was a new species. I described and named it *Aglaia mackiana*, in recognition not only of Andy Mack's discovery of the species, but of his invaluable research on the dispersal by Dwarf Cassowaries of its seeds. In addition to description of a new species, his work resulted in the recognition of a new dispersal syndrome for *Aglaia* (Pannell, 1997).

The eponymy in naming new species of *Aglaia* from PNG has been continued by Wayne Takeuchi. He named his first discovery in the genus *Aglaia saxonii*, in recognition of Dr Earl Saxon, the Asia-Pacific regional ecologist for the Nature conservancy (TNC) and senior scientific

Aglaia pannelliana from the southern karst of Papua New Guinea

investigator for the ecological reconnaissance of the Josephstaal Forest Managament Agreement Area (JFMAA). The type collection was made at 160m altitude during a floristic and ethnobotanical exploration of this area, being a site intended for logging operations based on a reduced-impact system known locally as 'ecoforestry'. The bilocular fruit has a lignified pericarp and considerable effort is required to section it with a hacksaw. This is unusual in *Aglaia*. The fresh pericarp in most species is either brittle or tough and fibrous.

The second, he found on limestone, at an elevation of 240m, in PNG's Southern Fold Mountains (Juha North in the Strickland drainage of the Western Province) and named *Aglaia pannelliana* (Takeuchi, 2009). The young fruits of this species are exceeded in size only by the ripe ones of *A. mackiana*. If they dehisce when ripe and belong to section *Amoora*, they may represent a second example of the cassowary dispersal syndrome. The leaves of both *A. saxonii* and *A. pannelliana* are sessile with the basal pair of leaflets smaller than the remaining leaflets. The only other species of *Aglaia* exhibiting this character is *A subsessilis* Pannell from Borneo. None of the existing material for these three species is suitable for DNA extraction, so their position in the phylogeny and infrageneric classification of the genus remains unknown.

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Map showing the three newly discovered species of *Aglaia* from Papua New Guinea, each known from a single locality:

■ *A. mackiana*

● *A. saxonii*

▲ *A. pannelliana*

The Lost World of Sir Arthur Conan Doyle

It is generally believed that Conan Doyle took the idea of the *Lost World* from reports of the tepuis of the Venezuelan-Guyana highlands, a group of remarkable flat-topped steep-sided mountains declared a World Heritage Site by UNESCO in 1994. One of these, Roraima, is often suggested as the inspiration for the novel. This, however, is a frequently repeated myth found in Wikipedia amongst other places. Actually it seems that Conan Doyle derived the idea from reports given to him by the British explorer Colonel Percy Fawcett of a range of flat-topped hills on the Brazil-Bolivia border. I quote from Percy Fawcett's own account published by his son in 1953:

"Above us towered the Ricardo Franco Hills, flat-topped and mysterious, their flanks scoured by deep *quebradas.* Time and the foot of man had not touched these summits. They stood like a lost world, forested to their tops, and the imagination could picture the last vestiges there of an age long vanished. Isolated from the battle with changing conditions, monsters from the dawn of man's existence might still roam these heights unchallenged, imprisoned and protected by unscaleable cliffs. So thought Conan Doyle when later in London I spoke of these hills and showed photographs of them. He mentioned an idea for a novel on Central South America and asked for information, which I told him I should be glad to supply. The fruit of it was his *Lost World* in 1912, appearing as a serial in the *Strand Magazine*, and subsequently in the form of a book that achieved widespread popularity."

Percy Fawcett is a somewhat controversial figure whose own mysterious disappearance in the forests of Mato Grosso in Brazil in 1925 has resulted in various expeditions and much speculation but no satisfactory explanation as to his fate. In the decade before the First World War he was employed as leader of a number of expeditions to designate the borders between Bolivia and Peru and between Bolivia and Brazil. It was during the latter work that he first observed the Ricardo Franco Hills and imagined a lost world of prehistoric animals on which Conan Doyle based his novel.

The hills that Fawcett observed comprise a vast plateau over a hundred kilometers from north to south and up to 40 kilometres east to west. The plateau is roughly 800 metres high at its southern extremity but slightly inclined towards the north. It is cut by two northward-flowing rivers, the Río Verde and the Río Paucerna, the latter falling from the plateau in a spectacular waterfall. The Río Verde forms the border between Brazil and Bolivia and was first mapped by Fawcett in 1909. The area east of the river lying in Brazil is still known as the Serra Ricardo Franco whereas the much larger area lying west of the river in Bolivia is known as the Serranía de Huanchaca, which is the heart of the Noel Kempff Mercado National Park, itself a World Heritage Site.

The plateau is surrounded by tropical rain forest and remains very difficult of access and is rarely visited. It is in virtually pristine condition and constitutes a marvellous refuge for wildlife of all kinds, especially for an astonishing range of insects. It was briefly a location for illicit cocaine processing and a number of clandestine airstrips were established although these are now unusable. The Bolivian naturalist Noel Kempff Mercado was murdered when he stumbled on one of these sites and his name was subsequently given to the National Park. Today access is only by helicopter or, at least from the Bolivian side, by a single steep track.

During the last few years I have been fortunate enough to visit the plateau with Bolivian colleagues on a number of occasions while I have been working on a Darwin Initiative project (16-004) to identify conservation priorities in the cerrados of eastern Bolivia. There are no dinosaurs or large apes but it is a paradise for plants. Unlike the plain at the foot of the hills the plateau is not covered in tropical rainforest. It is a vast undulating plain covered in cerrado, across which fire sweeps every year or two after electric storms in the spring. There are extensive gallery forests but the visitor would be impressed by the openness of the plateau, which extends in every direction to distant horizons. Well over 150 plants are only known within Bolivia only from this area and there are some 20 or more species endemic to the plateau. Almost every time we have climbed there, we have found new species for science in genera such as *Mimosa* (Leguminosae), *Hyptis* (Lamiaceae), *Manihot* (Euphorbiaceae), *Myrcia* and *Psidium* (Myrtaceae), *Paspalum* (Poaceae). Apart from along the arduous single trail onto the plateau and around the abandoned airstrips the whole area remains unexplored, at least botanically, to this day.

Reference

Fawcett, Col. H.P. 1953 Exploration Fawcett. (Ed. Brian Fawcett) Hutchinson & Phoenix Paperback (2001).

John R.I. Wood
Research Associate

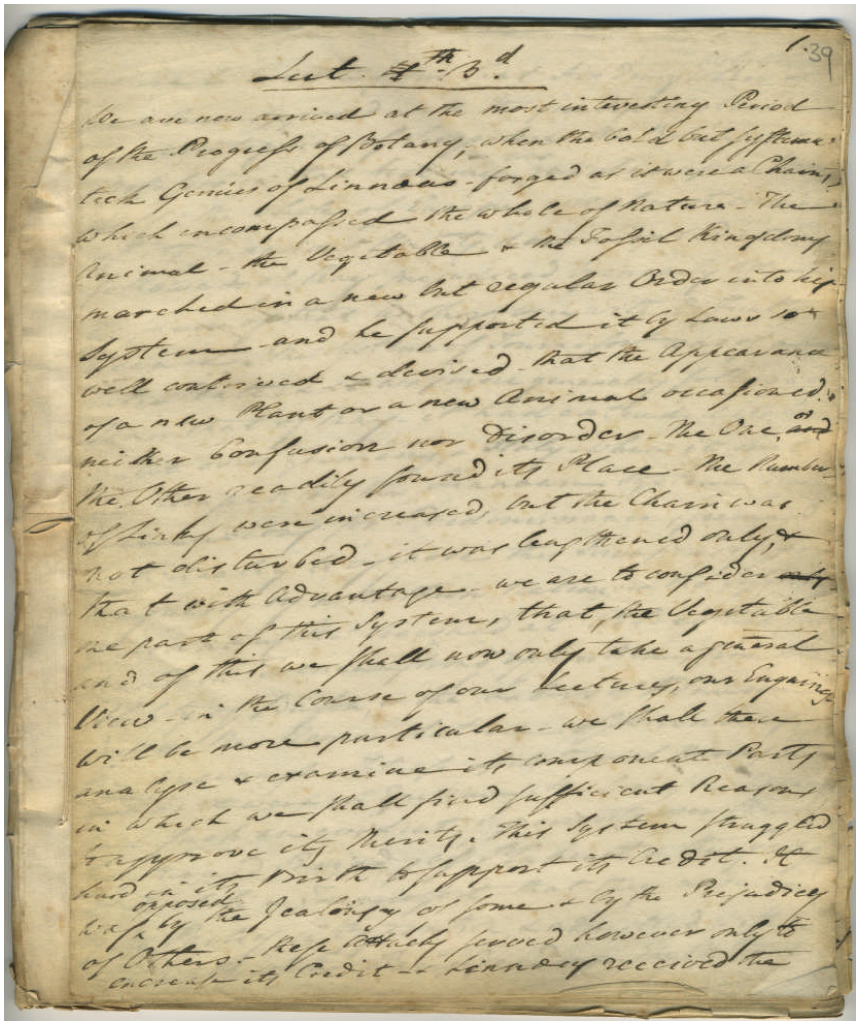
John Sibthorp: teacher of botany

The eighteenth-century botanist John Sibthorp (1758-96) is best known for exploring the eastern Mediterranean, for introducing the artistic talents of the Bauer brothers to the English botanical establishment and for dying young. Besides his travels, research and administrative responsibilities, as the third Sherardian Professor of Botany at the University of Oxford, Sibthorp was expected to teach. Humphrey Sibthorp (1712-97), John's father and the second Sherardian Professor, is credited with being one of the University's least conscientious professors. During the 37 years he had the Chair, Humphrey gave but one, poorly received, lecture and published nothing, although he was a great supporter of the botanic garden and herbarium. Indeed, when a young Joseph Banks (1743-1820) came up to Oxford in 1760, one of his first actions was to send to Cambridge for a tutor in botany – so poorly did he regard Oxford's botanical teaching. In 1783, once Sibthorp had convinced his father to resign the Sherardian Chair in his favour, it looked as though he would follow in his father's footsteps since he left Oxford in 1784 on an extensive European tour and did not return until 1787. Sibthorp left Oxford again in 1794 but never returned. However, for the seven years Sibthorp was in Oxford botanical teaching improved and he evidently gave regular undergraduate lectures.

A record of Sibthorp's lectures is found, in his own hand, in a 583-page manuscript (MS Sherard 219) archived in the library of the Department of Plant Sciences. Sibthorp's lecture course comprised 30 lectures, of which all but three (lectures 14-16) are recorded in the manuscript. The manuscript shows extensive annotation and revision by Sibthorp. Furthermore, the lectures may have been used by Sibthorp's successor, George Williams (1762-1835), for his lectures as some annotations appear to be in Williams' hand. The lecture notes provide a rich source of information about the botanical subjects that were thought important to teach in Oxford, and perhaps English universities more widely, in the late eighteenth century. All quotes in the present article are from this manuscript, and are identified by folio number.

Sibthorp studied medicine in Edinburgh where he became fascinated with botany after he came under the influence of the Professor of Botany, John Hope (1725-86), and Hope's teaching of the then revolutionary Linnaean System. As Sherardian Professor, Sibthorp introduced the teaching of Linnaean botany into Oxford. Sibthorp's enthusiasm for Linnean botany is clear from the opening of his third lecture 'We have now arrived at the most interesting Period of the Progress of Botany, when the bold but systematic Genius of Linnaeus forged as it were a Chain, which encompassed the whole of Nature' (f.39). At Cambridge University, similar enthusiasm for teaching Linnaean botany was expressed by the Professor of Botany, Thomas Martyn (1735-1825). Sibthorp's audience, which comprised young men interested primarily by medicine and agriculture, were told of the benefits of studying botany. Besides the economic and medical value of botany and the discovery of new information, Sibthorp argued that the botanist 'will re-establish his Health deranged by the Confinement of the Closet' (f.72).

Sibthorp appears to have started his lecture course soon after his return to Oxford from his pioneering botanical explorations of the eastern Mediterranean in 1787. Sibthorp's lectures, which took place in the botanic garden, focused on the uses of plants, especially their roles in agriculture and as foods and medicines, which is hardly surprising given the interests of his audience. The order of the lectures will be familiar to many readers of botanical texts. Opening with three lectures on the history of botany from the 'earliest People' through Carolus Linnaeus (1707-78) to Sibthorp's European contemporaries, students were then plunged into three lectures on the details of plant structure. The remaining lectures are devoted to the systematic consideration of the 24 Classes of Linnaeus' Sexual System, although the examples chosen to illustrate the Classes were those likely to hold the students' attentions. Furthermore, Sibthorp populated his lectures with anecdotes from his travels; confirming or refuting the tales of other travellers with whom his students were probably familiar. For example, when discussing the Diandria and *Jasminum officinale*, Sibthorp's students are told 'the Turks are particularly fond of this Tree & greatly esteem the Jessamy Stock for the Tubes of their pipes



Page from MS Sherard 219 – lecture notes of John Sibthorp in his own handwriting

when these are long, straight, & of a good Colour. They are sold at the Enormous Price of a 100. piastres per Stock – about. 10. £ of our Money' (f.137).

Sibthorp used all of the different types of material at his disposal to illustrate his lectures, including books from his personal library, specimens for William Sherard's (1659-1728) herbarium, living plants from the botanic garden and the watercolours completed by the botanical artist Ferdinand Bauer (1760-1826), who was working in Oxford under Sibthorp's direction at the time. The students were shown Bauer's watercolour of *Olea europaea* to illustrate the tree's fruits. This watercolour later formed the model for Plate 3 of the *Flora Graeca*, and its use in student demonstrations may explain why the original watercolour (MS Sherard 244, f.2) is now rather grubbier than most of the other watercolours in the collection.

Sibthorp emphasised the scientific importance of the botanic garden in Oxford compared to the fledgling Kew, and made passing remarks about the University authorities, with whom he was battling over funding. 'Academic Gardens tho' greatly inferior in Magnificence & Splendour to those supported by Royal Expenditure may be considered as the more useful Schools of Botany. – not under the Restrictions, of royal or private Collections, they are at all Times open to the Public, & their Object is to inform as well as amuse. Picturesque Beauty is not merely studied, but Method & Order as far as they conduct to a Systematick Arangement must be preserved' (f.19). However, he was well aware of the limitations of the garden for teaching purposes 'in the first Order Monogynia we find the Caper Bush Capparis – but this plant unfortunately I cannot demonstrate as we have it not at present in our Garden' (f.393). Sibthorp was enthusiastic about the changes that were happening in the planting arrangement of the garden, which was coming closer to his ideal for teaching purposes. 'Since we met last we have continued our Arrangement - & we have chosen that Method which we are persuaded from Experience & Conviction is the best. The Quarter now before us contains all the British perennial Plants, whose Situation does not require a particular Position. I mean the Alpine Plants, & such as grew in very moist Situations - these we have contrived under the Cover of a Wall facing the North to place in Such a Situation as they naturally grew in - that we might as much as possible observe their Natural Growth, neither disguised nor distorted by Art' (f.19).

Despite Sibthorp's primary interest in flowering plants, he was keen on mosses and ferns, which 'fortunately for the Botanist … flower at the Season of the year, when there are few other plants to engage his Attention' (f.578). In his lectures, Sibthorp was particularly fascinated by the experimental work of 'ingenious' Johann Hedwig (1730-99) on the sexual reproduction of mosses, and the comparison of Hedwig's ideas about bryophytes to those of Sibthorp's predecessor Johann Dillenius (1684-1747). 'The Obscurity attending the Fructification of the Ferns as well as some other Genera of this Class has lately been in great Measure dispelled by the deep sighted Researches & the indefatigable Industry of the ingenious Hedwig. His physiological Discoveries relative to the Structure of these plants rank among the most interesting Discoveries of this Century. He has observed the most minute Mosses in the very Instant of their Amours, and figured with Fidelity the Anthera in the Discharge of their Pollen. that part which Linnaeus & Dillenius had taken for the male Organ, Hedwig has by undoubted Experiments & clear Relation proved to be the Female & what they termed Antherae He has thereby proved to be Capsulae' (f.570-71).

John Sibthorp left Oxford for his second journey to the eastern Mediterranean in 1794, he returned to England in late-1795 but never got back to Oxford; he died in Bath in early-1796. Sibthorp's role as a botanical teacher was over. However, his reputation as an academic botanist was to be greatly enhanced by the work of others when the *Flora Graecae Prodromus* (1806-16) and the magnificently illustrated *Flora Graeca* (1806-40) were published. As a conscientious teacher, Sibthorp closed his lecture series by stating 'we are now arrived at the last link of the Vegetable Chain - & with this terminate our Lectures but tho' these are finished – my office of a Professor still continues – & the Botanical Student will find me no less ready to assist his Enquiries in the Time of Vacation than in the Hour of Lecture' (f.583).

Stephen A. Harris
Curator of Oxford University Herbaria

On the search for 'missing' lichen collections

I have been interested in old lichen collections from Hesse in Germany for many years. Some of these lichen collections can be found in Hessian museums e.g. in Senckenberg, others appear to be missing or are more difficult to locate. One such collection I was interested in was that collected by Johann Jacob Dillenius (1684-1747) while he was a Professor in Giessen approximately 300 years ago.

A publication by Dillenius dating from 1719 exists with details of the names and the locations of the species he collected. This is *Catalogus Plantarum Sponte Circa Gissam Nascentium*. In this he mentioned approximately 50 lichens (pp. 200-209). Unfortunately, there were no details on the whereabouts of his herbarium. This was regrettable because his names dated from the time before Carl von Linné had developed his "*Systema Naturae*". Therefore the names were in the form of polynomials and no longer valid. My inquiries concerning the whereabouts of the Dillenian herbarium finally led me to Oxford. Dillenius had become the first Sherardian Professor of Botany at Oxford University, taking up the post in 1734. In the spring of 2009 I visited the Fielding-Druce Herbarium (OXF) in order to determine the early eighteenth century lichens there. Thanks to the support of Serena Marner, Manager of the Fielding-Druce Herbarium who gave me the essential indication of the existence of the Dillenian lichens in the Sherardian Herbarium at Oxford, I was able to see the historic collections there. It was astonishing to see that the lichens were in such good condition after 300 years. The lichens were photographed by me and provisional determinations were made. For some of the specimens I was allowed to take tiny pieces for thin layer chromatic (TLC) analyses. With the help of my annotations, the photos and the results of the TLC, definite identifications were finally carried out back in Germany (at the Museum Senckenberg, Frankfurt). Altogether 44 species were determined from the Oxford collection.

It is planned to compare the species composition of 1710 with a further collection dated approximately 1850 and with the present lichen vegetation in the Dillenian collection area of Hesse. With the help of comparison of bioindicators, we hope to acquire information about changes in the air pollution, of the climate and the land use within the last 300 years.

Dr Ulrich Kirschbaum
Wettenberg, Germany

Lichen specimens of *Cladonia pyxidata* collected by Dillenius from the sheet numbered 1829 in the Sherardian Herbarium (OXF)

News from the Herbaria

During 2009 and 2010 many visitors and students passed through the doors of the herbaria. A number of students were given instruction on how to collect plants and record label data before embarking on expeditions, sometimes to rather remote places. We have seen some re-arrangement of space within the herbaria and have now been joined in the Fielding-Druce Herbarium by our colleague Anne Marie Catterall from the former Plant Sciences Library and other library staff on a rota basis (see notes on 'A new taxonomy library for Oxford', page 3). This has given us further opportunities to be able to work together in exhibiting the wealth of herbarium and library special collections that we are so fortunate to hold in Plant Sciences. It is also making it easier for visitors, and us, to view specific historical material from the herbarium and library together in order to carefully interpret the plant material we hold especially from the 17th and 18th centuries. General databasing of material handled for loans, or renamed by visitors, and newly acquired specimens has continued, being recorded in the BRAHMS database.

Visitors

A number of interested groups came to see a display of *Flora Graeca* - the Bobart Group of the Friends of the Oxford Botanic Garden, members of the Ashmolean Natural History Society of Oxfordshire and a group from Merton College Oxford studying 'The History of the Book'. Other more general herbarium tours were given to Oxford Alumni, teachers attending a 'Biodiversity and Botanic Gardens Teachers Day', Oxford University Library Services Sconal trainees and a group of students from the Department of Continuing Education, Oxford University, studying for a Diploma in Environmental Conservation. We were also delighted to welcome many individual visitors. One of our visitors Dr Ulrich Kirschbaum from Germany found some interesting lichens collected in the early part of the 18th century; see the article on page 17. Dr Tony Orchard visited on several occasions, while working as the Australian Botanical Liaison Officer at Kew, to search for all Allan Cunningham (1791-1839) specimens from Australia in OXF. Specimens collected from St Helena were the focus of a couple of visits by Phil Lambdon of the St Helena Nature Conservation Group. Professor John Edgington visited a few times to look at historic fern specimens, especially from the London area. Paul Harmes from Sussex began making visits to search for specimens collected from East and West Sussex for a new flora for those counties, and is continuing this work as time allows. During 2010 Laura Lima from HUEFS, Bahia, Brazil visited to work on the genus *Desmodium* (Fabaceae).

Fielding-Druce (OXF)

New accessions to OXF included a wonderful collection of Bromeliads from Peru collected by Steven Heathcote, D.Phil. student in Plant Sciences (see article on pages 9-11 and front cover). Given the difficulties in pressing and preserving such plants, we are now developing a good collection of Bromeliads in OXF. We were also presented with two isotype specimens of new species of British *Sorbus* hybrids from NMW. 99 miscellaneous species collected in the UK by John Killick were incorporated, this collection includes many interesting records from all over the country. John Killick also presented more material in 2010 and these specimens are now awaiting databasing. A number of lichen and fern specimens were also received.

There has been a steady flow of material being sent out on loan from the collections and a fairly similar number of sheets being returned from loan during the same period. We are again grateful to Dr Bruno Ryves for naming grass specimens for us, the grasses having been collected from various parts of the world including many from South America and from India. The number of 'electronic loans' of images of very specific specimens, often potential types, actually exceeded the number of loans sent in the traditional way, although much fewer specimens were involved in the individual transactions.

During 2009 we were contacted by staff of the Ashmolean Museum Oxford to provide images of specimens of 'economic plants' collected in the late 17th / early 18th centuries for a display in the redeveloped Museum telling a story of how various cultivated plants crossed the continents between East and West. Edward Lhuyd (1660-1709), a former Keeper of the Ashmolean Museum in 1691, donated a number of plants he collected in Wales to the Oxford Herbarium – he was a friend of Jacob Bobart, Keeper of the Oxford Botanic Garden. In 2009 the National Library of Wales in Aberystwyth asked to borrow a number of the specimens from OXF for an exhibition marking the tercentenary of the death of Edward Lhuyd. On the occasion of the 200th anniversary of the birth of Charles Darwin (12 February 2009), an exhibit of Darwin specimens, a small number of which are held in OXF, and some correspondence of interest was prepared for the Ashmolean Natural History Society of Oxfordshire. This exhibit was shown again for a day in the Oxford University Museum of Natural History in 2010 celebrating the 150th anniversary of the debate on Evolution prompted by Darwin's work on 'The Origin of Species'.

The plant specimens made by John Sibthorp while collecting for his proposed *Flora Graeca* (publ. 1806-1840), have all been databased and digitally photographed. This collection will shortly be available on line. It will include images of over 600 type specimens, the species having been described in the *Flora Graeca* mostly by J.E. Smith. Mark Catesby's plant specimens held in OXF have also now been databased, these sheets found in the Sherardian and Du Bois Collections were collected in the 1720s by the naturalist and artist. Digital images of the Catesby specimens will also soon be available to view on the Oxford University Herbaria website.

Daubeny (FHO)

There was much activity in sending and transferring loans, plus receiving new loans over 2009 and 2010. Over 1500 specimens were received on loan for D.Phil. students and research staff. 1070 specimens of *Cardamine* (Brassicaceae) were received for study by Elizabeth Cooke, 914 specimens of which came in one loan from Berlin. 120 specimens of *Mimosa* (Leguminosae) arrived for study by Tiina Sarkinen. 218 specimens of *Aglaia* (Meliaceae) were received for the attention of Caroline Pannell, some from Kuching, Malaysia, and Kew and over 100 specimens sent for identification from the Sarawak Biodiversity Centre, Malaysia. A few small loans of Acanthaceae and Lamiaceae were also received for study by John Wood and three loans of *Desmodium* (Leguminosae) for study by Laura Lima. Over the same time period 1216 specimens were sent out on loan from FHO to other herbaria. A large proportion of this material was *Lupinus* (Leguminosae) being sent on loan to Colin Hughes at Z.

By far the largest activity in respect of specimens in FHO was the return, or transfer, of material. 1024 specimens were returned in 2009, these mostly consisting of *Strobilanthes* (Acanthaceae) which were sorted and determined by John Wood. These loans were returned to 18 different herbaria. In 2010 the move of Colin Hughes to the Institute of Systematic Botany at the University of Zurich precipitated the transfer of over 3500 specimens of *Lupinus*, originally sent on loan to FHO, to Z, in order for Colin to continue his work on the genus. After written permissions were obtained from 20 different herbaria, most of the *Lupinus* specimens on loan were transferred in August 2010. However 300 further type sheets of *Lupinus* were returned to the lending institutions in the USA as requested by them. Other returned loans after completion of work comprised *Mimosa* (Leguminosae) sent for Marcelo Simon, *Psidium* (Myrtaceae) loaned for illustration by Rosemary Wise and 126 miscellaneous West African collections sent for study by William Hawthorne.

Several hundred specimens were also received as new accessions to FHO from members of the Systematics research group.

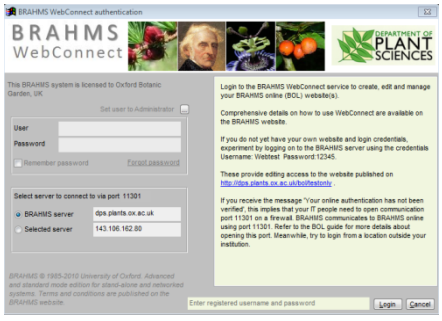
Serena Marner
Herbarium Manager

BRAHMS 6.9 May 2011

BRAHMS Version 6.9 will be available for download in May this year. This upgrade includes new modules for managing living collections and seed banks together with a range of new features for curation, research and website development.

Mapping tools have been extended with new controls to select points to map, set map style and calculate diversity indices. The above raster map of *Callitris preissii* uses Natural Earth II with a shaded relief plotted from BRAHMS to DIVA. Thanks to J. Moat, GIS unit, RBG Kew for locating: http://www.naturalearthdata.com/features/

Maps calculating Extent of Occurrence and Area of Occupancy can be produced using the Geospatial analysis (beta version) **Red List Species Assessment** tool. Select the Conservation Assessment option on the BRAHMS mapper. http://rlat.kew.org/



BRAHMS **WebConnect**, used to develop BRAHMS online (BOL) websites, has been overhauled. Included with a new interface are extended HTML editing features, new data/image upload options and further administrative controls for website owners. This work has been supported by Fundação de Amparo à Pesquisa do Estado de São Paulo, Brasil (FAPESP). For more details:

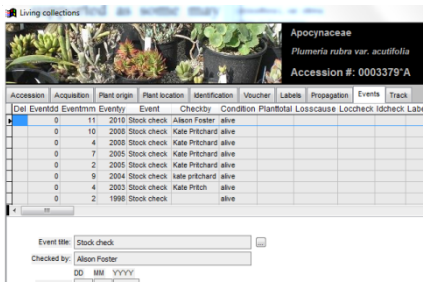
http://dps.plants.ox.ac.uk/bol/content/documentation/BRAHMSWebConnect.pdf

http://dps.plants.ox.ac.uk/bol/ukot

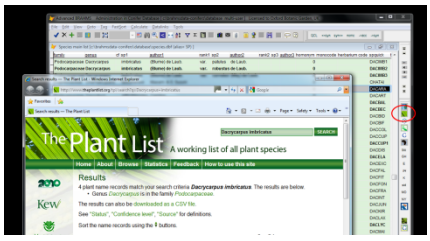
An example BOL website developed at RBG Kew for the UK Overseas Territories (UKOT) projects that takes advantage of **image map features** - click on image areas to visit other UKOT sites. Image map HTML code can be developed quickly using the free image map editor X-Map and then simply pasting the code to WebConnect. http://www.carlosag.net/Tools/XMap/

Image maps are also used on the ***Reflora Amazonica*** BOL site published on an INPA server, Amazonas, Brazil. This prototype site provides access to a series of further, inter-related sites about plant collections in Amazonian Brazil. http://brahms.inpa.gov.br/bol/amazonia

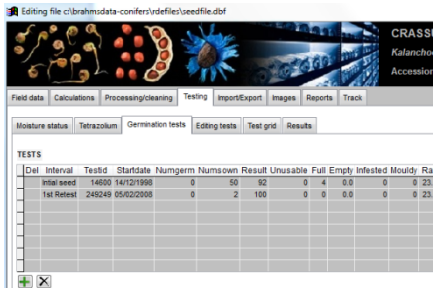
A new version of **BRAHMS online**, in development by Andrew Liddell at Oxford Plant Sciences, will be published in June/July 2011. This version receives data from BRAHMS as XML, can display a greater range of data categories and fields and is generally more versatile. Taxonomic data are more prominent in the new system.



The **Living Collections** module is designed for botanic gardens and other projects that manage living plants. The new module stores data on garden accessions, tracking supplier details; material origin (wild and cultivated); identification and vouchering; garden location; and management events including inventories and stock-checks. Individual projects can extend the standard living collection data structure by editing the living collections linked data file.



New **context sensitive website links** including the recently published 'Plant list' as on http://www.theplantlist.org/ for name checking are available in Version 6.9.



Also in this version is a now upgraded **Seed Management** module developed in collaboration with Kew's Millennium Seed Bank (MSB). This has comprehensive features for seed management including an 'all in one' RDE option to capture and process seed and related viability and germination test data.

BRAHMS 8

The next generation of BRAHMS software is in planning and will be phased in as seamlessly as possible over the next two years by a broader technical development team. BRAHMS 8 will be more closely aligned to BRAHMS online and we will be saying a sad goodbye to Visual FoxPro (VFP) which has served us so well all these years. Further VFP versions will be released as versions 7.x during 2011/2012. The final VFP system will be maintained and supported permanently as some users may prefer to stay put. Databases will be auto-upgradable to V8. BRAHMS 8 will provide comprehensive herbarium management services with power-user research tools as now. Our challenge is to upgrade the software platform yet maintain flexibility, avoid complexity and provide a system equally useful to projects small and large as we now have. More soon on

http://dps.plants.ox.ac.uk/bol/

***Denis Filer**, Research Associate*

Painted by Rosemary Wise

Leaves, inflorescences and corky bark of young trunk of *Stryphnodendron fissuratum* (Leguminosae, Mimosoideae), a distinctive endangered tree of the South American cerrados. Painted by Rosemary Wise during her visit to Bolivia on the Darwin project in 2009. See article on pages 8-9.

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