Oxford Plant Systematics

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

OPS 15 **May 2008**



Details from watercolours and sketches made by Ferdinand Bauer for Sibthorp and Smith's *Flora Graeca*. *Ophrys tenthredinifera* (top) and *Hypericum olympicum* (bottom).

Foreword

This year OPS once again reflects the breadth of systematic activity being carried out within the Department of Plant Sciences. From a Darwin project in Bolivia, student reports covering plants in Argentina, Bolivia, Peru, Brazil, a published book on the history of *Flora Graeca*, and a short piece covering Rosemary and Serena's visit to Gotland in Sweden following in the footsteps of Linnaeus. In addition, Mike Hopkins provides an interesting insight into databasing Brazilian herbaria, which includes using a simple and inexpensive system in conjunction with BRAHMS 6 to collect specimen data from the herbaria in Oxford that can be utilized in Brazil. Denis Filer also provides a useful update on recent developments in BRAHMS. I hope you enjoy reading OPS 15.

Robert Scotland
University Reader in Systematic Botany

News items

We are pleased to report that **Rosemary Wise**, Departmental Botanical Artist, has not yet retired and is still illustrating plants for papers and books for the systematics research group in the Department. Rosemary reported on her 42 year career in the Department in the last volume of OPS which was then thought to be on the eve of her retirement, but fortunately for the group she is still here!

A book written by **Dr Stephen Harris**, Curator of Oxford University Herbaria, entitled *'The Magnificent Flora Graeca: How the Mediterranean came to the English Garden'* was published towards the end of 2007. The book, published under the Bodleian Library programme with reference to collections of books and manuscripts found in the Bodleian Library and other OULS libraries, was launched on 13 December 2007 by Dr Shirley Sherwood as special guest speaker. The book proved to be very popular and sold over half the print run in the first five weeks of sales. Stephen Harris was awarded the Sibthorp Medal for his work by the new Head of the Department of Plant Sciences, Professor Jane Langdale. See article on page 7.

We would like to offer our congratulations to **Professor David Mabberley**, a former staff member of Plant Sciences and Acting Curator of the Oxford University Herbaria (1992-4), on his recent appointment as Keeper of the Herbarium at the Royal Botanic Gardens Kew. From 1st May he will also be Visiting Professor of Plant Sciences, University of Oxford.

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New Darwin Project in Bolivia

A new project financed by the Darwin Initiative to identify conservation priorities in the Bolivian cerrados was approved in April 2007. This project is headed in the UK by the Department of Plant Sciences and we have partners in Bolivia, Brazil and in the United Kingdom. Our principal partner is the Museum of Natural History in Santa Cruz which houses the main herbarium in eastern Bolivia. Also involved are three institutions with which we have long-standing links going back many years: The National Herbarium of Bolivia in La Paz, the Universidade de Brasília and the Royal Botanic Gardens at Kew. Each of these institutions can offer specific skills and expertise in particular plant groups or methods to help move the project forward. For the use of project results and their implementation after the project's end, we depend mainly on the Fundación para la Conservación del Bosque Chiquitano, a Bolivian NGO set up in 1999 specifically to promote the conservation in this region.

The Cerrados constitute a large biome centred on Brazil but extending into Bolivia, belatedly recognised as one of the biodiversity hotspots of the world (Myers et al. 2000). Much of it is on the pre-Cambrian shield, which forms the bedrock at the heart of South America. There are reported to be more than 10,000 plant species characteristic of this biome and although it has been relatively well-studied in Brazil it is poorly known and under-collected in Bolivia. Cerrado develops on poor soil with high levels of aluminium in areas with a pronounced dry season. A particular characteristic is that it is subject to periodic natural fire – something that is becoming more frequent as a result of human activity - and adaptation to fire is a key feature of many cerrado plants. Cerrado does not develop on rich soils even when periodically burnt.

Cerrado is a general term applied to a mosaic of vegetation types, broadly similar to the term "savanna" in popular usage. A bewildering range of terms have developed in an attempt to classify numerous subtypes or "physiognomies" ranging from *campo limpo*, a type of treeless grassland, at one extreme to *cerradão*, a closed woodland at the other. Amongst numerous additional terms, *campo rupestre* is used to describe the vegetation of the broken rock outcrops typical of the region and characterised by an abundance of species of Velloziaceae and Eriocaulaceae. Wetlands are also a feature of the region and include flooded grasslands, seasonal pools and areas of bog-like vegetation with *Drosera*, *Xyris* and *Lycopodiella*. In general, herbaceous members of the flora are very numerous and are reported to outnumber woody species by between 3 and 4.5 times (Filgueiras 2002: 122).



Recently burnt cerrado (campo limpo) with campo rupestre behind
Photo J.R.I. Wood

Cerrado is now one of the most threatened biomes in the world. According to Cavalcanti and Joly (2002), at least 67% of the Cerrado region of Brazil had been converted to intensive human use by the early 1990s and doubtless this percentage has risen since. The same process has begun in eastern Bolivia and is likely to accelerate rapidly. The main threat at the moment is the conversion of natural cerrado grassland to pasture seeded with *Brachiaria* and other introduced grass species. Unfortunately this is extremely easy to achieve given the flat topography of most cerrado and the ease by which scrub and scattered trees can be removed by bulldozers. Other threats which are already a devastating reality in neighbouring Brazil include the conversion of cerrado to arable for the cultivation of soya, the use of lime and chemical fertilizers which change the composition of the soil and invasion by exotic species such as *Panicum maximum*, which seems to be encouraged by excessive burning.



*A new **Blepharodon** (Asclepiadaceae) species from the Cerrado*
Photo J.R.I. Wood

Anyone who has seen a diverse cerrado some weeks after it has been burnt will be struck by the colourful diversity of flowers, which recalls an alpine or Himalayan meadow. The vast majority of these are endemic to the biome. Levels of endemism vary throughout the region and across the different physio-gnomies with highest rates of endemism noted in *campo rupeste* (Filgueiras 2002: 123), fortunately the least threatened vegetation subtype because of its rocky nature. Within the biome individual mountain ranges (known as chapadas in Brazil and serranias in Bolivia) often have species narrowly endemic to the particular range. In Bolivia two such ranges are immediately apparent, the Serrania de Huanchaca situated in the Noel Kempff National Park and the long serrania that stretches from Chochis to the east of Santiago. Even at this early stage of the project it is clear that these two serranias are outstanding in their plant diversity and in the presence of species endemic to the particular serrania as well as those with a very restricted distribution within the Cerrado biome as a whole.

One of the most diverse groups with particularly high rates of endemism in the cerrados is the Mimosoid legume genus *Mimosa* (Simon & Proença 2000). While the centre of diversity in this genus lies clearly in the cerrados of central Brazil, as with so many Cerrado genera, the cerrados of Bolivia also harbour a significant cohort of narrowly restricted endemics and there is every prospect that the project will discover others. Bolivian *Mimosa* have recently been examined by Margoth Atahuachi (Cochabamba) with Colin Hughes in Oxford and *Mimosa* is also the focus of new work by Marcelo Simon, from Brazil as part of his D.Phil. in Oxford. The endemics from the San Jose-Santiago serranias include *Mimosa jacobita* Barneby, *M. josephina* Barneby, *M. dalyi* Barneby, *M. orbignyana* Barneby and *M. auriculata* Benth. with two other undescribed species known from this area. From the Sierra de Huanchaca, one new species, *M. suberosa* Atahuachi & Hughes was recently described, to add to *M. huanchacae* Barneby and another as yet undescribed species thought to be endemic there. It is notable that the majority of these species are described within the last 20 years, most of them by Barneby (1991). It is also clear that the other serranias of eastern Bolivia remain extremely poorly known and under-collected botanically. Given the high levels of endemism in *Mimosa* and other Cerrado genera, it is likely that new species will continue to be discovered as these areas are explored during the project.



Mimosa jacobita *Barneby*
Photo Colin Hughes

References

Barneby, R.C. (1991). Sensitivae Censitae: a description of the genus *Mimosa* Linnaeus (Mimosaceae) in the New World. *Memoirs of the New York Botanical Garden* **65**: 1–835.

Cavalcanti, R.B. & Joly, C.A. (2002). Biodiversity and conservation priorities in the cerrado Region. In: Oliveira, P.S. & Marquis, R.J. (eds.) *The Cerrados of Brazil*: 351–367. New York: Columbia University Press.

Filgueiras, T.S. (2002). Herbaceous Plant Communities. In: Oliveira, P.S. & Marquis, R.J. (eds.) *The Cerrados of Brazil*: 121–139. New York: Columbia University Press.

Myers, N., Mittermeir, R.A., Mittermeier, C.G., Fonseca, G.A.B. & Kent, J. (2000). Biodiversity Hotspots for conservation priorities. *Nature* **403**: 853–858.

Simon, M.F. & Proença, C. (2000). Phytogeographic patterns of *Mimosa* (Mimosoideae, Leguminosae) in the *Cerrado* biome of Brazil: an indicator genus of high-altitude centers of endemism? *Biological Conservation* **96**: 279–296.

John Wood
Research Associate

Publications 2007

Bebber, D.P., Marriott, F.H.C., Gaston, K.J., **Harris S.A.** & **Scotland, R.W.** (2007). Predicting unknown species numbers using discovery curves. *Proceedings of the Royal Society of London. Series B*. **274**: 1651–1658.

Bebber, D.P., **Harris, S.A.**, Gaston, K.J. & **Scotland, R.W.** (2007). Ethnobotany, plant discovery and the first written records of UK flowering plants. *Global Ecology and Biogeography* **16**: 103–108.

Elliott, G.N., Chen, W.M., Chou, J.H., Wang, H.C., Sheu, S.Y., Perin, L., Reis, V.M., Moulin, L., **Simon, M.F.**, Bontemps, C., Surtherland, J.M., Bessi, R., Faria, S.M., Trinick, M.J., Prescott, A.R., Sprent, J.I. & James, E.K. (2007). *Burkholderia phymatum* is a highly effective nitrogen-fixing symbiont of *Mimosa* spp. and fixes nitrogen *ex planta*. *New Phytologist* **173**:168–180.

Hawkins, J.A., Boutaoui, N., Cheung, K.Y., van Klinken, R. & **Hughes, C.E.** (2007). Intercontinental dispersal prior to human translocations revealed in a cryptogenic invasive tree. *New Phytologist* **175**: 575–587.

Harris, Stephen, A. (2007). *The Magnificent Flora Graeca: how the Mediterranean came to the English Garden.* Bodleian Library. 189pp.

Hughes, C.E., Rajanikanth, G., Robertson, A., **Filer, D.L.**, **Harris, S.A.** & Bailey, C.D. (2007). Serendipitous backyard hybridization and the origin of crops. *Proceedings of the National Academy of Sciences* **104**: 14389–14394.

Stepkowski, T., **Hughes, C.E.**, Law, I.J., Markiewiez, L., Gurda, D., Chlebicka, A. & Moulin, L. (2007). Diversification of lupin *Bradyrhizobium* strains: evidence from nodulation gene trees. *Applied & Environmental Microbiology* **73**: 3254-3264.

Wood, J.R.I. (2007). The Salvias (Lamiaceae) of Bolivia. *Kew Bulletin* **62**: 177–222.

Wortley, A.H., Harris, D.J. & **Scotland, R.W.** (2007). On the taxonomy and phylogenetic position of *Thomandersia*. *Systematic Botany* 32: 415–444.

Student reports

Systematics of *Amicia* (Leguminosae, Papilionoideae) and plant diversification and endemism in Andean seasonally dry tropical forests

During the past year of my D.Phil. studies, I have been extremely lucky to have had the opportunity to spend three months in the Andes doing field work. This required some stamina but has been key to the success of my first year studies. This short account of my travels and field activities in Argentina, Bolivia and Peru might well be dubbed my *Motorcycle Diary*, not just because I followed in the footsteps of Che Guevara from his birth place in the idyllic city of Rosario in Santa Fe, Argentina, to the area where he was killed near Vallegrande in Bolivia, but also because it felt every bit as adventurous as Che's early journey along the dusty roads of South America.

The focus of my D.Phil. project is plant diversification in the fragmented seasonally dry tropical forest (SDTF) biome of the New World and during my fieldwork I aimed to visit a set of these disjunct SDTF areas scattered across the Andes from northern Argentina to northern Peru. These SDTFs, although not as species-rich as wet forests, are especially rich in narrowly-restricted endemics, and the origins of this high endemicity remain poorly understood. The markedly disjunct distribution of SDTF with isolated patches of forest scattered from northern Mexico to Argentina and Paraguay suggests that either long-term isolation (dispersal limitation) could have driven species diversification and high endemicity, or that these forests were previously more continuous with subsequent vicariant fragmentation driving diversification. Distinguishing between these hypotheses is the aim of my research.

To tackle this question, the initial focus of my D.Phil. project is to build densely sampled and well-supported time-calibrated species-level phylogenies for a number of SDTF plant genera as one way to test the hypothesis of dispersal limitation. I have selected three genera – *Amicia* (Leguminosae), *Tecoma* and *Delostoma* (both Bignoniaceae) with diverse endemics in the highly disjunct and potentially isolated SDTFs of the Andes but which are manageable in terms of total numbers of species. Such work demands densely sampled phylogenies (all species and multiple accessions of species) and hence good taxonomic knowledge of species limits. Taxonomic accounts are available for *Tecoma* (recently revised by John Wood) and *Delostoma* (revised by Alwyn Gentry). However, this is not the case for *Amicia*, with no recent revision, and I have



Amicia lobbiana *Benth. ex Rusby*
Photo Colin Hughes

undertaken a new taxonomic account of the genus as a prelude to building a phylogeny. By comparing phylogenetic patterns and estimating diversification times for these three genera, and integrating these with what is known for other Andean SDTF plant groups, I aim to assess the tempo and mode of diversification in SDTF taxa.

By early spring 2007, I was heading to South America to start my field work to collect silica-dried leaf material for my study taxa, and to study and collect *Amicia* for the taxonomic revision. In late February, I arrived in Buenos Aires, Argentina to visit the herbarium at the Instituto de Botánica Darwinion. There I had the pleasure of meeting Dr Emilio Ulibarri who is currently revising the large South American genus *Adesmia*, a close relative of *Amicia*. In Rosario, I met up with Dr Darién Prado at the Universidad Nacional de Rosario on the way to the northern parts of this very large country. Accompanied by Darien's colleagues Luis Oakley and Olga Martínez from the Universidad Nacional de Salta, I travelled through the NW Argentinian Andean Departments of Catamarca, Jujuy, Tucuman and Salta, collecting specimens of *Amicia* and *Tecoma* (and of course other taxa on the Christmas wish list of people back at FHO and E!).

The field collecting in Argentina was very successful, and it was a pleasure to work with such extremely enthusiastic and professional field botanists as Luis and Olga. After sad goodbyes, I travelled to the Bolivian border, walked over the frontier with a terrible headache caused by the 4000m altitude, and took the direct train from Villazón to La Paz. In La Paz, I met up with Pablo Duchen from the Herbario Nacional de Bolivia and was joined a few days later by Colin Hughes and Alex Wortley (RBGE, Edinburgh). After a few days of preparations, we headed off into the Yungas and started collecting. Alex had joined us to collect *Calceolaria*, a very species-rich and largely Andean genus of herbs and sub-shrubs in alpine meadows and cloud forests, locally known as *Zapatitas*, 'Little Shoes', due to their beautifully shaped flowers. Colin as always was looking for more Lupins, and on many occasions succeeded in finding them.

Our journey in Bolivia took us to the Yungas in La Paz Department, through Cochabamba to Chuquisaca, and finally south to Tarija and back to the Argentinian border. We were lucky and had plenty to collect, including a magnificent set of multiple collections of all the species of *Amicia* known from Bolivia. After getting stuck in Tarija due to demonstrations and road blocks surrounding the city, we finally started the long two-day drive back to La Paz across the bleak Bolivian Altiplano, stopping in the high cold city of Potosi. From La Paz, Colin and I continued to Peru, Pablo stayed in La Paz, and Alex went back for a flying visit in the UK before leaving to Congo for another field trip!



Plant collecting in Tarija, Bolivia, with Alex Wortley, Pablo Duchen and Colin Hughes pressing a species of ***Lupinus*****.**

In Peru we were joined by Aniceto Daza, and for part of the time Jose Luis Marcelo, from the Universidad Nacional Agraria La Molina, Lima and Maria Baden from Royal Botanic Garden Edinburgh. We set out on the long haul north from Lima along the coast of Peru to spend two weeks in the northern Departaments of Piura, La Libertad, Cajamarca, and Amazonas. We found and collected most of the SDTF valley-specific endemics of *Tecoma*, and it was amazing to see how quickly the local flora changes over very short distances, new endemics popping up over distances as short as 50km. Up in the Maraňon valley in northern Peru we were also collecting other legumes and stopped to collect a white-flowered *Mimosa* on a busy roadside that has proven to be a new species!, adding yet another species to the already long list of species of Maraňon endemics. These exciting collections in this under-collected part of Peru add valuable evidence to my D.Phil. data, and looking back now it makes me feel very lucky to have been there.

The last spell of field work started once we had returned to Lima from the North. I was very keen to include the southern Peruvian dry valleys in my sampling, especially of *Tecoma* and we headed to Cusco, and from there to Arequipa, Moquegua and Tacna where three of the *Tecoma* endemics are found. Returning to the UK at the end of May after three months of strenuous and hectic field work, I was happy to get stuck in the lab and settle in for a while.

Since then, I have done a large chunk of lab work and managed to generate some respectable phylogenies for both *Amicia* and *Tecoma*, with work on *Delostoma* planned for later this year. Using two chloroplast sequence loci and the nuclear ribosomal ITS, I have built a densely sampled and robustly supported phylogeny for *Amicia*. This shows a number of interesting features. First, species are generally deeply reciprocally monophyletic but with very short branch lengths between species. Second, there is a surprisingly large amount of genetic variation found within each species which often seems geographically structured. I am currently running a large legume-wide age estimate analysis with fossil calibrations to estimate divergence times for *Amicia* and looking for ways to quantify the geographic structure across the tree.

For *Tecoma*, I have generated a similarly densely sampled phylogeny using four chloroplast DNA markers and the ITS. Initial results suggest that although the story in *Tecoma* is more complicated, it resembles *Amicia*.

This spring (April-May 2008) I will be heading to the field again – I have not been scared off by my first visit to the Andes! This time I will be focusing more on ecological work, gathering plot-based species abundance data for the second part of my D.Phil. project.

Tiina Sarkinen (D.Phil., 2nd year)

Supervised by Dr Colin Hughes (Oxford) and Dr Toby Pennington (Royal Botanic Garden Edinburgh). Osk.Huttusen Säätiö and Helsingin Sanomain 100-vuotisjuhlasäätiö scholarships.

Ecological setting and the evolution of Neotropical plants: origins and diversification of the Cerrado flora

Introduction

In my research I'm interested in the patterns of plant diversity in the Neotropics, and particularly in the origins and evolution of the Cerrado. The Cerrado is a floristically diverse and endemic-rich savannah biome with more than 10,000 plant species covering more than two million km^2 of Central Brazil and part of Bolivia. It has been suggested that the Cerrado may have originated as recently as four million years ago, coinciding with the emergence of inflammable C4 grasses as a dominant component of this ecosystem and the consequent onset of regular fires. One way of testing this hypothesis is to use dated molecular phylogenies of biome specific lineages to infer the age of a particular biome. However, to date there are very few phylogenies for Cerrado plant groups that can be used to test this hypothesis. I am aiming to fill this gap by generating a phylogeny for *Mimosa*, a species-rich legume genus. *Mimosa* is an ideal study group to test this hypothesis since it is remarkably rich in fire-adapted narrow

endemics in the Cerrado, but at the same time also highly diverse in other major Neotropical habitats such as seasonally dry tropical forest and rain forest, providing a good basis for comparisons.





Fire adaptations in Cerrado ***Mimosa*** *species. Top:* ***M. splendida****, a pachycaul treelet. Bottom:* ***M. speciosissima*** *growing from a woody xylopodium.*

Results

One critical issue for this type of study is how to establish a time dimension for a phylogeny. A powerful technique to do this is to use the number of nucleotide substitutions on branches of a phylogenetic tree derived from DNA sequence data constraining specific nodes on the tree with an age, normally derived from fossil dates. This allows ages for all nodes of a given phylogenetic tree to be estimated. To do this for *Mimosa* I have re-analysed Lavin *et al*.'s (2005) family-wide *matK* data set for legumes adding 130 sequences for Mimosoid genera using 12 fossils as calibration points. The number and quality of the fossil calibrations that were used as minimum age constraints for particular nodes across the phylogeny, and the improved taxon sampling in this analysis, provided a reasonably good estimate of around 18 million years for the genus *Mimosa* (crown node). Based on this information, I was able to estimate the ages of many nodes of interest in a subsequent phylogenetic analysis of *trnD-trnT* chloroplast sequences for 250 species of *Mimosa*, which included a substantial set of Cerrado endemics. With around 50% taxon sampling, this provides reasonable geographic, ecological and taxonomic coverage of this large, diverse and widespread genus.

Results from these analyses show that Cerrado endemics originated independently several times in *Mimosa.* However, the majority of Cerrado endemics (75% of all Cerrado species of *Mimosa*) fall into two large clades rich in fire-adapted species, suggesting two independent Cerrado species radiations. It is notable that these two independent species-rich lineages diversified at the same time around 3.5 million years ago. These dates also closely match the estimated age of another large endemic Cerrado plant lineage in the tribe Microlicieae (Melastomataceae; Fritsch *et al.* 2004). This relatively recent origin of Cerrado lineages of *Mimosa* and Microlicieae contrasts with recent findings that Neotropical seasonally dry tropical forest lineages are generally older (Pennington *et al.* 2004, Lavin 2006). I am currently testing this further by dating Cerrado lineages in two other legume genera, *Andira* and *Lupinus*.

My initial results suggest a scenario of recent diversification with rapid and successful adaptive radiation of an endemic-rich fire-tolerant flora. If recent diversification is confirmed for other Cerrado plant groups, the question remains as to what type of vegetation was in Central Brazil before the Cerrado, and what biomes contributed with lineages that were able to colonize the Cerrado.

These initial findings were presented at the Biennial Conference of the Systematics Association in Edinburgh last August, supported by a student award from this same organization. This is the last year of my D.Phil. and I am busy analysing data, reading and writing manuscripts and my thesis, which I hope to submit by the end of the year.

Collaboration

During 2007, Dr Rosaura Grether from the Universidad Autónoma Metripolitana (UAM) in Mexico came to visit our group for three months as part of her sabbatical leave. Dr Grether has longstanding interests in legume taxonomy and specifically in the genus *Mimosa* providing excellent scope for collaboration on *Mimosa* phylogenetics. In 2006 I had the opportunity to carry out fieldwork with Rosaura's research group in Mexico and this recent visit to Oxford by Dr Grether focused on laboratory work to generate sequence data for a large cohort of Mexican species of *Mimosa* for phylogenetic analysis. With more than 500 species of *Mimosa* scattered across four continents, any attempts to build a phylogeny depend on effective collaboration of this sort, and are especially effective with someone as knowledgable and enthusiastic about *Mimosa* as Dr Grether.

Collaboration has also continued with Dr Euan James and colleagues at the Universities of Dundee and York under the project "In search of beta-rhizobia: exploring the symbionts of *Mimosa* in Brazil", which aims to gain a better understanding of the symbionts associated with *Mimosa* and especially the unusual beta-rhizobia that have been found to fix nitrogen in root nodules of *Mimosa*. Again, this collaboration provided scope for joint fieldwork to assemble material of *Mimosa* in Brazil in 2006. With parallel plant host and symbiont phylogenies there is an opportunity to gain insights into the evolution of nitrogen fixing symbioses that involve beta-rhizobia. The project team published a paper last year showing that beta-rhizobia are indeed effective symbionts of a broad range of *Mimosa* species, and a suite of other published outputs from this collaboration are expected during the coming year.

References

Fritsch, P.W., Almeda, F., Renner, S.S., Martins, A.B. & Cruz, B.C. (2004). Phylogeny and circumscription of the near-endemic Brazilian tribe Microlicieae (Melastomataceae). *American Journal of Botany* **91**: 1105–1114.

Lavin, M. (2006). Floristic and geographical stability of discontinuous seasonally dry tropical forests explains patterns of plant phylogeny and endemism. In: *Neotropical savannas and seasonally dry forests: plant diversity, biogeography, and conservation*. Pennington, R.T., Lewis, G.P. & Ratter, J.A. (eds.). Systematics Association, Special Volume Series **69**: 433–447. Boca Raton, CRC-Taylor and Francis.

Lavin, M., Herendeen, P. & Wojciechowski, M.F. (2005). Evolutionary rates analysis of Leguminosae implicates a rapid diversification of lineages during the Tertiary. *Systematic Biology* **54**: 530-549.

Pennington, R.T., Lavin, M., Prado, D.E., Pendry, C.A., Pell, S.K. & Butterworth, C.A. (2004). Historical climate change and speciation: neotropical seasonally dry forest plants show patterns of both Tertiary and Quaternary diversification. *Philosophical Transactions of the Royal Society of London B-Biological Sciences* **359**: 515-537.

Marcelo Simon (D.Phil., 3rd year)

Supervised by Dr Colin Hughes and Dr Stephen Harris. Clarendon scholarship and Embrapa.

Sibthorp, Bauer and the *Flora Graeca*



Professor John Sibthorp (1758-1796)

In Britain, the late-eighteenth century was an exciting time to be interested in plants. Fortunes had been made exploiting plants, the great and the good were enthusiastic botanical patrons, new regions of the globe were being explored and their botanical treasures returned to Britain's shores. Furthermore, new scientific methods were being used to investigate the botanical world and Carl Linnaeus' classification and naming systems were being widely adopted. In Oxford, John Sibthorp (1758-1796), Third Sherardian Professor of Botany, extolled Linnaeus' virtues in his undergraduate lectures: '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'. However, lecturing was only a minor part of John Sibthorp's short career as an Oxford Professor; he was also responsible for the Botanic Garden and the Herbarium.

John Sibthorp was the only son of Humphrey Sibthorp, Second Sherardian Professor, by his second marriage. Humphrey Sibthorp is reputed to have published nothing and given but one lecture in his 38 years as occuptant of the Sherardian Chair. John Sibthorp was educated as a physician in Edinburgh and came under the intellectual influence of the first teacher of Linnaeus' classification in Britain, John Hope. Sibthorp was to become very wealthy with the premature death of his mother and through the actions of his father to convince the University that his son should benefit from a ten-year Radcliffe Travelling scholarship (worth £300 per year). John promptly set-off to some of the most prominent botanical institutions in Europe and returned to Oxford in 1783, when he convinced his father to resign the Sherardian Chair in his favour. John became Professor in 1784 and promptly departed for another protracted European tour; he returned to Britain in late 1787. It was during this tour that he conceived the idea of the *Flora Graeca* and did the majority of the associated fieldwork.

At the end of the 18th century, major botanical expeditions were being undertaken by botanists from Continental Europe, especially to the New World. John Sibthorp, concerned with his botanical reputation and legacy, decided to explore the relatively unknown western fringe of the Ottoman Empire. The *Flora Graeca* was to contain the botanical results of this exploration. He would be aided by the talents of the phenomenal botanical artist, Ferdinand Bauer (1760-1826), who was engaged for £80 per year (later rising to £100), and his travelling companion John Hawkins (1761-1841). Sibthorp and Bauer set off from Vienna in March 1786, travelled through Italy and passed through the Straits of Messina to collect plants in Crete. During his Cretan trip, gems such as *Teucrium alpestre* and *Staehlina arborea* were collected. From Crete, Sibthorp and Bauer travelled to the Turkish coast and then overland to Constantinople where they overwintered. Here they met Hawkins and, in early 1787, caught the Mediterranean spring as they travelled to Cyprus, where they made the first botanical collections known to western science and found the highly restricted Cypriot endemic sage, *Salvia veneris*. From Cyprus they meandered across the Aegean and arrived in Athens in June 1787. Excursions through Greece followed until September 1787, when Sibthorp and Bauer returned to Britain and Oxford. Throughout his journey Sibthorp had collected vast quantities of herbarium material, seeds, bulbs and animal specimens, whilst Bauer had sketched



Staehlina arborea *from the Flora Graeca.*

hundreds of plants and animals and labelled them with numbers that referred to a specific colour code. In Oxford, Bauer, despite his strained relationship with Sibthorp, used his sketches, together with the herbarium material and, perhaps, living material from the Botanic Garden, to produce 966 magnificent, folio, life-sized botanical watercolours; on average, Bauer produced one watercolour every one and one quarter days. These watercolours would give the *Flora Graeca* its reputation for magnificence and contribute to its extraordinary cost.

Sibthorp returned to the Ottoman Empire for a shorter, more traumatic fieldtrip, without Bauer, in 1794. Sibthorp arrived back in Britain, 'more dead than alive', in late 1795 and died in Bath in February 1796; he never returned to Oxford. In his will, Sibthorp provided the vision, incentives and financial resources to complete his *Flora Graeca* project.

Through the perseverance of John Hawkins and Thomas Platt, Sibthorp's friends and executors, the *Flora Graeca* was eventually completed. James Smith, founder of the Linnean Society, was the first botanist to be employed and was faced with unmounted and unlabelled herbarium specimens, Sibthorp's notes written in an 'execrable hand' and Bauer's largely unlabelled sketches and watercolours; Smith was paid £75 per year for his work. Having brought order to this chaos, Smith became engaged on the laborious task of ensuring that Bauer's watercolours were reproduced to the highest possible standard. Renowned botanical engravers, the Sowerby family, were employed to produce the coloured engravings. The first part of Volume One of the *Flora Graeca* was published in 1806. When Smith died in 1828, his place was briefly taken by Robert Brown, before John Lindley completed the project in 1840, when the final part of the Volume Ten was published. The total project had cost £15,572 6s 10d, and the income had been £15,581 12s. After 54 years the project was complete, the balance, £9 5s 2d, was transferred to the University, and the income from Sibthorp's estate used to establish the Sibthorpian Chair in Rural Economy (now Plant Sciences). Each of the 25 subscribers had paid £254 for their copy of the *Flora Graeca*.

Sibthorp's legacy was the discovery of hundreds of plants new to science and the publication of one of the most costly, rare and magnificent botanical books ever written. Some of the species that Sibthorp introduced to Oxford are still known in British gardens, e.g., *Crocus flavus*, but the fate of the majority of the seeds and living material he returned to Britain is unknown, as the records have been lost. However, the Botanic Garden may contain a living remnant of the Sibthorp's botanical efforts in the shape of the iconic black pine tree. Today, Sibthorp's herbarium specimens are housed in Oxford University Herbaria,

whilst his manuscripts, together with Bauer's original water colours and sketches, are in the Department of Plant Sciences Library.

Stephen A. Harris
Curator of Oxford University Herbaria



Fritillaria sibthorpiana *from the Flora Graeca.*

Flora Graeca online

Work has now been completed on digitising the second phase of Sibthorp's *Flora Graeca* materials. For some time the initial pilot project, including selected scans from the *Flora Graeca* original drawings and published engravings, together with the unpublished *Fauna Graeca* and *Mediterranean Scenes*, have been available on the Oxford Digital Library web site at http://www.odl.ox.ac.uk/odlcollections (select *Flora Graeca for the 21st century* from the menu). Now all the original drawings from these series, together with all the plates and accompanying text from the published *Flora Graeca* are available for browsing on http://www.ouls.ox.ac.uk/isbes/taxonomic_collections (select *Flora Graeca in the 21st Century* from the left-hand menu). All 3278 images, plus captions, can be seen here in medium resolution. On this site there is currently no search function, but the files will be added to the Oxford Digital Library site in due course where they can be searched (by name of a species, for example) and also zoomed to a higher magnification.

We also plan to provide hyperlinks to the images from the corresponding entries in the Herbarium BRAHMS database, which will provide more sophisticated searching and links to the digital images of the corresponding herbarium specimens, where available. Meanwhile we hope the browsable collection will whet your appetite and make these wonderful drawings even more widely appreciated.

For publication, high-resolution digital images can be ordered from OULS Imaging Services on http://www.ouls.ox.ac.uk/services/imaging_services. Appropriate reproduction fees are payable. Orders should include the image number which is displayed as a 'tooltip' if you hover over an image with the mouse. For research and private study, the medium-resolution images on the web can be saved to disk as required, provided credit is given to Oxford University Library Services whenever reference is made to them.

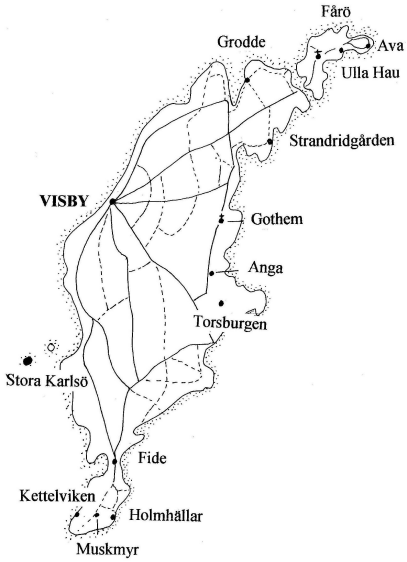
Any queries or comments should be sent to anne.townsend@ouls.ox.ac.uk or roger.mills@ouls.ox.ac.uk, who will be pleased to assist.

Roger Mills
Acting Keeper of Scientific Books,
Oxford University Library Services

Following Linnaeus's journey through Gotland

While here in the United Kingdom it was one of the coldest and wettest summers on record, Serena Marner and I enjoyed continuous hot sunshine in Sweden. As part of the celebrations for the tercentenary of the birth of Linnaeus, in June we attended an excellent symposium in the University of Uppsala, entitled "*Unlocking the Past*" which covered many aspects of Linnaeus's life and times. We visited his house in Uppsala, the botanic gardens, his country estate at Hammarby and paid homage at his tomb in the cathedral, for the occasion beautifully decorated with a border of living plants of *Linnaea borealis*. Following this, 32 of us set off on an expedition to the Baltic island of Gotland, organised and led with perfect precision by Bengt Jonsell, Roland Moberg and Eva Willén of the Swedish Linnaeus Society.

Linnaeus visited the islands of Gotland and Öland in 1741, having been commissioned by the Swedish government to survey the natural resources including medicinal and economic plants, soils, and the commercial possibilities of various minerals and ores. He kept a detailed diary, noting not only strictly scientific items but everything from the construction of gates, local cures for common illnesses, dialects, runic stones, folklore and what the inhabitants wore. We visited many of the places that he had found particularly interesting, not just to look at plants, but geological features, bird colonies and ancient buildings. There were too many locations and plants seen for me to mention them all.



Map of Gotland showing places visited by Linnaeus in 1741 and the Linnean Society party in 2007

Our base was in the city of Visby, possibly the best-preserved medieval city in Scandinavia and now a UNESCO World Heritage Site. Excavations show that there was a settlement here as early as the Stone Age, benefited by the natural harbour and sources of fresh water. The 3.4 km defensive stone wall around the town was originally built in the 12th century with towers added at various times during the next three centuries. Midsummer light in Scandinavia is legendary. With such a busy schedule, I spent a couple of happy hours drawing and painting before breakfast each day!

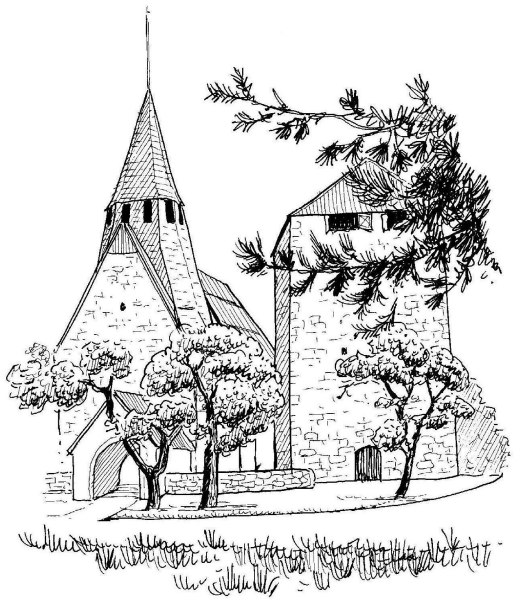
In June the plants were at their best. Gotland conserves many extremely lush and species-rich parish meadows and we saw several, including those of Anga and Fide. Linnaeus said that these meadows looked more like gardens than meadows, so colourful were the flowers, and it was very difficult to walk, and more especially to take photographs, without flattening any. Many species of orchids thrive in such areas, including Common spotted (*Dactylorhiza sambucina*), Early purple (*Orchis mascula*), Military (*O. militaris*), Burnt (*O. ustulata*) Twayblades (*Listera ovata*), Frog (*Coeloglossum viride*) and Lesser butterfly (*Platanthera bifolia*). Also abundant were plants such as Meadowsweet (*Filipendula ulmaria*), Yellow rattle (*Rhinanthus serotinus*), Common rock rose (*Helianthemum nummularium*), Bloody cranesbill (*Geranium sanguineum*), Great burnet (*Sanguisorba officinalis*), Herb-Paris (*Paris quadrifolia*) and the leaves of Lily-of-the-valley – and many, many others.

By contrast, the rocky inland cliffs at Torsburgen, which Linnaeus called a mountain, reach the height of 68m above sea level and presents a far dryer area, prone to fire. There must have been one some years before Linnaeus's visit as he notes that the top of the "mountain" was bare of trees and that he was able to count 30 church towers. The regeneration of fire-resistant plants such as Scorpion senna (*Hippocrepis emerus*) were in evidence following the fire of 1992 but we were not able to see the churches for trees. A few kilometres away is the inland cliff of Östergarnsberget. The typical rock vegetation here includes Juniper, Pine, Herb Robert (*Geranium robertianum*) and Ciliate melick (*Melica ciliata*) the only species colonising the stony ground on the plateau.

At Ulla Hau, north east Fårö (a small island at the northernmost tip of Gotland) another completely different vegetation type is found which Linnaeus said reminded him of Holland. An enormous horseshoe-shaped sand dune started to form in the 18th century following a period of deforestation and over grazing. This was eventually stabilized by the planting of Marram grass (*Ammophila arenaria*) on the seaward side and pine, alder and birch at the western extent. On the dunes, apart from the Marram, the vegetation consists almost solely of the Grey-hair grass (*Corynephorus canescens*). Searching for the dips in the sand inhabited by ant lions and teasing them amused many of us! The composition of the sand in this area is unique to Gotland, completely lacking in calcite and only here, in the wooded area, do we find species common to mainland Sweden. We delighted in our first sighting of Twin-flower, Linnaeus's "own" flower (*Linnaea borealis*), growing in the carpet of Bilberry (*Vaccinium myrtillus*), Cowberry (*V. vitis-idaea*), Crowberry (*Empetrum nigrum*) and various mosses. Linnaeus visited the nearby Ava farm, which he said was "neat and tidy" and rested under an enormous oak which he noted had a trunk diameter of 4.5m and a crown diameter of 28m. The tree is considerably larger now and the owners take very great care of its preservation.



The trunk of the oak at Ava farm



The Parish Church and 12th century defence tower at Gammelgarn. The tower now houses a Linnaean exhibition.

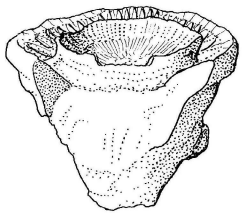
One calm, hot day we went by ferry to the island of Stora Karlsö. Geologically, the island is composed of a core of reef limestone and the power of the sea has gouged out some spectacular caves. One excavated in the nineteenth century revealed continuous evidence of Stone Age occupation from 3000 to 2000 BC. The bones found in the systematic removal of the 4m layer of soil indicate the changes in diet from the end of the Stone Age when sheep, cattle and goats were domesticated back to the earliest inhabitants who lived on birds and seals. (Split human bones suggest there could have been cannibalistic tendencies too). Stora Karlsö is exceptionally interesting to botanists as 560 species of vascular plants, 126 mosses and some 300 species of lichens have been recorded. Linnaeus wrote that the only tree he saw on the island was the ash growing on the Bronze Age burial cairn of Röjsu, the highest point of the island, which was used as a landmark by sailors. On such a hot day we were grateful for the shade provided by the same healthy tree at lunchtime. In this exposed area the predominant plants growing on the limestone shingle were Lesser meadow-rue (*Thalictrum minus)*, Thyme (*Thymus serpyllum)* and Sheep's fescue (*Festuca ovina*). Late afternoon we perhaps lingered too long looking at the flora of the meadows and gazing down on the colonies of guillemots and razorbills on the towering sea cliffs. This necessitated a mad rush down a steep, rocky path through an area of deciduous woodland to catch the ferry.

Grodde nature reserve, north-west Gotland, was a highlight for many of us. A local geologist suggested we took a ten minute walk on the beach and for each of us to bring her two "pebbles" for identification. My two were identified as a rugose coral of the *Palaeocyclys* genus and my second offering contained fossils of many trilobites. We found, as Linnaeus had recorded in his diary, "Each stone was nothing but a coral" and added that there was enough "for every man in the world to get a cartload each". He saw the same series of retreating beach ridges, noticed how the fossils further inland were more weathered and was sure that living material would be evident out in the bay but didn't have time to look. *Vincetoxicum hirundinaria* is one of the only plants to have colonised these nutrient-deficient beach ridges in any number. Its leathery leaves are well adapted to cope with the wind and salt. Occasional patches were seen of Sea campion (*Silene uniflora*), Lady's bedstraw (*Galium verum)*, Thyme (*Thymus serpyllum*), Biting stonecrop (*Sedum acre*) and Carline thistle (*Carlina vulgaris*).

From 1361 until 1645 Gotland was under Danish rule. At this time a great number of churches were built over the island in the Danish architectural style and looking very different from those on mainland Sweden. Many have been restored to their full glory. We visited several. Gothem parish church is home to murals painted around 1300 depicting the farming year, month by month. The German artist also combined dragons, knights, eagles and centaurs alongside the religious themes. Gammelgarn church lies below Östergarnsberget inland cliffs and the defensive tower, built in the twelfth century, is one of the best preserved on the island. In Fårö church, an oil painting and a poem commemorate the amazing story of the 15 local seal-hunters who in 1603 drifted in the Baltic for two weeks when the ice floe they were on broke loose. All survived (on seal meat) and the painting depicts them with hunting equipment and dressed in their best clothes! Another curious painting in the same church shows a vicar of the seventeenth century with his many offspring. Not all had survived childhood but all were included, the deceased painted at the age they had reached, differentiated by the crosses above their heads. Of the four babies in the cradle, the only one to survive is shown with open eyes.

Strandridargården was the home of generations of customs officers and is now preserved as a museum. Adjacent is the mysterious and extensive sea-stack field of Kyllaj. Reminiscent of Easter Island, these oddly-shaped monoliths are incongruously sitting in grassland way above the sea. No two look alike and Linnaeus wrote that they

were "Arranged in a row like the ruins of churches and castles" and "From a distance they looked like statues, horses, torsos and I do not know what kind of ghost".



A rugose coral from Grodde, north-west Gotland

On our last day we visited the extreme south of the island and one of Gotland's main tourist attractions, the highly-photogenic stack rocks at Holmhällar. With the extensive sedge fen of Muskmyr and the sandstone grindery at Kettelviken (which provided the stone for the building of the royal palace in Stockholm) yet to explore, time was limited here unfortunately. Just to see these stacks again and to spend a whole day exploring the area would certainly tempt me to return!

Muskmyr is one of the remaining areas of fen land, most of the former wetlands having been drained for agricultural use. The sedge *Cladium mariscus* which fringes the lake was once widely grown over the island for bedding and thatching purposes and was one of its most valuable crops. During the 3 km walk we again saw many species of orchids, and a host of other specialities, including Gotland rock rose (*Fumana procumbens*). We were lucky to be able to see and photograph the Apollo butterfly (*Parnassius apollo*) feeding on sedums.

My main memories will remain associated with the intense colour of Gotland. The roadside verges were unbelievably bright with red poppies, and the intense blue of Viper's bugloss (*Echium vulgare*), thousands of plants en masse in so many places, creates a dominant feature of the Gotlandic landscape.

Rosemary Wise
Botanical Artist

News from the Herbaria

Work continued steadily in all areas of herbarium activity, the databasing and digitisation of the collections, the sending and receiving of loans as requested by various institutes/individuals and for the research activities of the systematics group in the Department. One of the highlights of the year for me was celebrating the tercentenary of the birth of Carl Linnaeus with members of the Linnaean Society of London (in London, Oxford, Uppsala and in Gotland, see page 8) and preparing an exhibit on the theme of *'Celebrating Linnaeus' visit to Oxford'*. This display was prepared for a special meeting of the Linnaean Society of London held in the Oxford Museum of Natural History on 29 September. The exhibit included two plant specimens of *Pedicularis* (Scrophulariaceae) collected by Linnaeus from Lapland, which are now held in OXF. The specimens were originally sent to Professor Johann Jacob Dillenius by Linnaeus himself. A modified version of the display is currently on show in the Department of Plant Sciences Library.

Another highlight of the year was meeting and hosting a visit to the herbaria of Mrs Yasuko Ikenobo, Japanese Senior Vice Minister of Education, Culture, Sports, Science and Technology and five of her colleagues from the Ministry of Education, Higher Education Bureau, the School Curriculum Division of Japan and the Education Attaché from the Embassy of Japan. This was part of a whole day visit on 9 August to the University by the Japanese guests who had also met with the Vice-Chancellor, Dr Hood, and visited the Oxford Botanic Garden and the Oxford Museum of Natural History.

We were delighted to have with us in the herbaria, from September to December 2007, Dr Rosaura Grether from the Universidad Autónoma Metripolitana (UAM) Mexico who came to work with Marcelo Simon (see page 6).

We were also very pleased to welcome back Professor Dr Walter Lack for a day in September and to meet Dr Kräftner, Director of the Liechtenstein Museum in Vienna who came to look at the *Flora* and *Fauna Graeca* and associated materials. Many other visitors came to look at a variety of different collections or to meet with staff.

Fielding-Druce (OXF)

Loans sent out from OXF during 2007 included another consignment of grasses which were sent to K at the request of Dr Bruno Ryves who has kindly offered to name them. Professor Dr Maas, who visited the herbaria in August, also kindly offered to name plants collected by Richard Schomburgk in our indet. folders and a loan of these was then despatched to Utrecht. Increasing numbers of images of specimens were sent as 'internet loans', 16 transactions of this nature were sent during 2007 with determinations for material received in exchange to enable us to update our database records.

A large amount of material was returned to OXF during the year, over 1400 specimens. A large quantity of British *Mentha* (Lamiaceae) was returned from Edinburgh which had been sent to E the year before for a project involved with the 'Hybrid Flora of the British Isles'.

New accessions to OXF included specimens of *Pilosella* and *Heiracium* (Asteraceae) collected in the Shetland Islands by Mr Walter Scott (co-author of the Shetland Flora 1987) and miscellaneous species of British grasses collected by Mr John Killick (co-author of the Flora of Oxfordshire 1998). 71 lichen specimens collected in the UK, Poland, Russia, Finland and the USA were donated by Professor Mark Seaward, University of Bradford, which came from miscellaneous collectors. In addition type material of a new British species of *Taraxacum* (Asteraceae), *T. ronae*, was donated to the Druce Herbarium by Mr L.J. Margetts.

The Fielding Herbarium has recently been providing a resource for researchers in the University's Research Laboratory for Archaeology and the History of Art, on a project studying Egyptian historic chronology being undertaken by Mike Dee and Dr Fiona Brock.

One of our historic collections has received special attention this year and is now databased and with every sheet digitally photographed – this is the collection of 'lower plants' gathered by Johann Jacob Dillenius to illustrate his *Historia Muscorum* published in 1741. There are 176 sheets in the collection and these are associated with 901 taxa. Each entry in the database is linked with an image of the relevant herbarium sheet and related text and plate from the *Historia*. Approximately 16% of the specimens have been annotated as types. The material can be viewed at http://dps.plants.ox.ac.uk/bol/?historiamuscorum

Daubeny (FHO)

New accessions to FHO during 2007 included specimens collected in Sierra Leone by William Hawthorne. This is a substantial collection and the material is still in the process of being mounted and databased. A collection of *Mimosa* (Fabaceae) made by Marcelo Simon in Brazil has been accessed and mounted for FHO. 182 duplicates of *Mimosa* sent as a gift from HUEFS Brazil, for identification by Marcelo, were also received. In addition miscellaneous species collected by Tiina Sarkinen in Bolivia and Peru were accessed and mounted. Other smaller donations included a few duplicates of Meliaceae from S.E. Asia, China, Vietnam and Sarawak, plus a few duplicates of *Lupinus* (Fabaceae) collected in Brazil and a number of sheets *Leucochloron* (Fabaceae) sent for the attention of Colin Hughes and John Wood.

Due to the successful field excursions in South America undertaken by various members of the systematics research group (see articles on pages 4-6), we were able to send many duplicates from FHO to other herbaria. Marcelo Simon's collections of Brazilian Fabaceae were sent to HUEFS Brazil and many of Tiina Sarkinen's duplicates collected in South America were distributed to BM, E, HUEFS, K, L, MO, MONT, NY, RNG and US.

Incoming loan material during 2007 comprised mostly specimens of *Amicia* (Fabaceae) sent for study by Tiina Sarkinen, with some material of *Tecoma* (Bignoniaceae) also being requested and received. Other loans received included material of *Mimosa* for study by Marcelo Simon, *Lupinus* for Colin Hughes and a small quantity of *Aglaia* (Meliaceae) for Caroline Pannell. A number of loans were returned after completion of studies and those consisted of material of *Tecoma* (Bignoniaceae), *Strobilanthes* (Acanthaceae), *Hippeastrum* (Amaryllidaceae), *Acacia* (Fabaceae) and *Faurea* (Proteaceae). Loan material sent from FHO to other herbaria included specimens of Podocarpaceae, Annonaceae and Thymeleaceae.

Work on the Darwin Trinidad and Tobago project continued and in connection with this a number of colleagues from Trinidad and Tobago spent three weeks in FHO in July working on databasing specimens.

Serena Marner
Herbarium Manager

Databasing collections and repatriating information – a digital shortcut

The world's herbaria are under pressure to database their collections. With ever improving access to the internet, access to the contents of a herbarium need no longer be available only to visitors or by loaning specimens. Label data can be recorded in databases and specimen images taken with digital cameras, and the whole can be made available via the web. The dynamics of consulting herbaria is changed rapidly.

However, the processes of preparing the data and images can be anything but rapid and can be costly. At the end of January 2008, I visited the Oxford University Herbaria (OXF & FHO) for six days to test a methodology that could accelerate the databasing process and, at the same time, repatriate important information to the countries where the plants were originally collected.

Amazonian Brazil has three medium-sized herbaria (180,000 – 220,000 specimens) and about seven smaller ones. All the herbaria have been databased using BRAHMS. This is an unusual situation - a region the size of Amazonian Brazil has all its local herbarium data in the same system. BRAHMS is also used widely in other regions of Brazil and in several other South American countries – a significant achievement for the Department of Plant Sciences in Oxford.

As botanists often collect plants in duplicates, there can be considerable overlap of content between herbaria. One would expect to find most of the Amazonian material in FHO to be duplicated in one or more of the Amazonian herbaria. Thus, when staff in Oxford type in data from their Amazonian collections, they are likely to repeat work already done in Amazonia. On the other hand, specimens present in Amazonian herbaria may not have the same quality of identification as their duplicates in Oxford; Amazonian herbaria are visited by specialists much less frequently than foreign herbaria. Tiny Amazonian herbaria, e.g., those in Macapá or Jari, receive very few visitors. As a result, many specimens remain with their original field determinations, often only best guesses at family or generic level, despite duplicates having been identified by renowned specialists elsewhere. I estimate that about 40% of the determinations at INPA (located in Manaus, the main herbarium for Western Amazonian Brazil) would change with efficient interchange of information between herbaria.

Step 1: Using medium-priced digital cameras (we use FujiFilm FinePix S5800), medium resolution pictures are taken of each specimen. The label and whole specimen are photographed. Separate photographs of det-slips and other annotations are taken as necessary. Using a hand held, autofocus camera, it's possible to take at least 1200 photographs per day which, at 2 images per specimen, covers 600 specimens.

Step 2: The camera images are collectively transferred to disk and appended into a BRAHMS image Rapid Data Entry (RDE) file. By viewing the images, the barcode (or accession numbers) are added to the file together with information on the photo category. An 'e' is added to a field FOTOSUFFIX for labels, 'e1', 'e2' for any further label images (e = 'etiqueta' in Portuguese). Within the image RDE file, using a BRAHMS processing function, the image files are then physically renamed using a combination of the herbarium name, barcode and the FOTOSUFFIX. Thus 'FHO_00012345' is an image of the whole exsiccata with barcode 00012345 and 'FHO_00012345_e' is its label.

Step 3: A further BRAHMS routine is used to process the image RDE file directly into a collection RDE file, gathering all the images associated with each specimen and linking them to a single record for each barcode. This produces an RDE without any data, but with images. Thus, if a specimen has three images, the collection RDE file will have one record with three images added to the RDEIMAGES memo field.

Step 4: In the collection RDE file, one can view the label image(s) and type in the data directly. This has advantages. The typing can be done anywhere, not just in the herbarium, and you are no longer obliged to enter the data in taxonomic order. If collector name and number information is entered first, you can order the records in the manner they were originally collected, which can save hours of repetitive typing of geographical data and reduce typing errors. The process becomes even more efficient when you have access to data from databases with duplicates of the newly photographed specimens. For example, working on an RDE file with the INPA database open, means that by just typing in the collector name and number the INPA database is automatically searched for duplicates. If duplicates are found then the all the fields are automatically filled-in.

Most of the Brazilian specimens photographed in FHO do indeed have duplicates in the Amazonia herbaria. The material in OXF is another story, since much of this older material is not present in Amazonia, or indeed Brazil. In the long-run, high resolution images of these specimens should be made but there is little point in photographing material already duplicated in Amazonia and available as high resolution images.

In Amazonia, we have found images are essential for data verification. Typing errors are ubiquitous in all databases. One error in a collection number causes incorrect specimen matching. If you can consult an image of the label data, such errors can be corrected immediately. The Embrapa Amazonia Oriental (IAN) herbarium has been 100% imaged and databased this way (ca. 332,000 images) and about half the INPA herbarium has been photographed (ca. 260,000 images; ca. 40,000 per month).

Especially interesting for botanists in Amazonia are the identifications of material duplicated in other herbaria. On the trip to Oxford I concentrated on those families which had recently been determined by specialists: Chrysobalanaceae, Ebenaceae, Meliaceae and Sapotaceae. Theoretically, these families should have 'better' determinations than those available in Amazonia. When there is an apparent conflict between identifications between duplicates, one needs to make an educated decision about which is more authoritative, and especially check if the duplicates really are from the same collection; images help enormously with this task.

In the brief visit made to Oxford, some 9,000 images were taken which will result in *c.*4,000 specimens being databased in Oxford, and the data for some 7,000 specimens improved in the Amazonian herbaria. It is unlikely that there will be large numbers of changes in identifications, since Iain Prance and Terry Pennington have been active visitors to Amazonia herbaria. If this methodology was applied at New York or Kew it would make a huge contribution to the quality of the Amazonian herbaria.

Many thanks to Colin, Denis, Serena and Stephen and for making my visit enjoyable. This work was undertaken as part of the Brazilian Government's Biodiversity Research Program (PPBio) which has, as one of its objectives, the dissemination of collection data on the web.

Mike Hopkins, *INPA, Manaus, Brazil*

Publishing online from BRAHMS

Herbaria are under increasing pressure to publish their specimen data and images online and research projects often have this as a funding prerequisite. One of the priorities with BRAHMS 6, published January 2008, has been to simplify online publishing, enabling those with and without internet skills and/or server resources to present their data online with minimum fuss via a project-tailored interface.

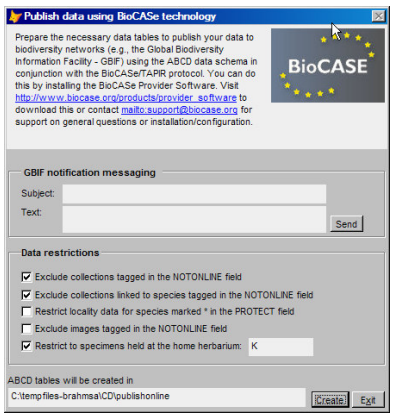
BRAHMS facilitates publishing online in three ways:

- Projects can contribute data to global on-line networks including the Global Biodiversity Information Facility (GBIF) via a locally installed provider service. Explicit links are provided using BioCASE Provider Software (BPS).
- Institutions using BRAHMS for research projects, but with their own in-house online service, can upload relevant data to this service using one of the BRAHMS transfer mechanisms.
- Projects can publish directly to the SQL Server BRAHMS online (BOL) service.

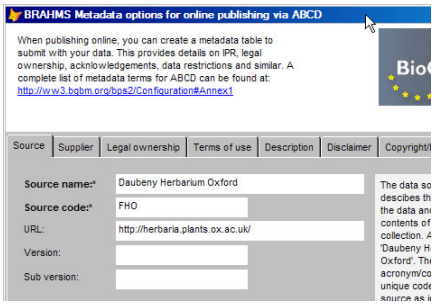
Some institutions or projects may have good reason to opt for all three of these options taking the view that the wider the access to their data, the better.

Publishing to GBIF

The Global Biodiversity Information Facility (www.gbif.org) is a mega-science project *to make the world's primary data on biodiversity freely and universally available via the Internet*. Selected data can be uploaded from BRAHMS to GBIF (and other portals such the Biological Collection Access Service for Europe - BioCASe) by installing a provider service on your local server. BRAHMS 6 has an export function to generate tables conforming to ABCD (Access to Biological Collections Data) v.2.06. ABCD is a common data specification for biological collection units based on the GBIF infrastructure. (http://www.bgbm.org/tdwg/codata/schema/).



The data are then connected to GBIF via the BioCASe provider package which must be installed locally. http://www.gbif.org/dataproviders/howto.



Details describing your institution, IPR, legal and data restrictions, and acknowledgements are registered within BRAHMS and submitted as part of the ABCD output.

BRAHMS online (BOL)

Herbaria and projects often need to publish data online with a more personal institutional or project specific interface. For example, many herbaria wish to disseminate and promote their holdings and provide web-based curation services; a cluster of herbaria may wish to have their data accessed via a common portal thus providing a regional online service; or a research project may wish to publish data for a taxon group or geographic area.

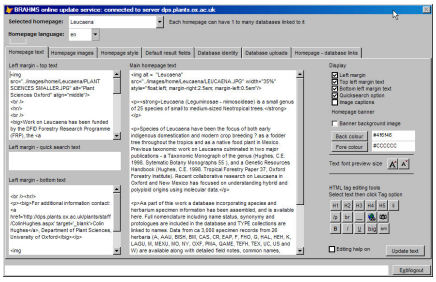
To facilitate this, an online publishing service has been fully integrated with BRAHMS 6 with options to develop the online interface (*i.e.* homepage), upload data as required and configure this to provide the required service. Some BRAHMS online facts:

BOL is an SQL Server system by default running on the BRAHMS server. BOL can be installed on your own Windows server. It includes an 'update service', operated from within BRAHMS 6 that links to the designated server.

The BRAHMS 6 update service is used to configure a website and the attached data. Homepage text and design images can be uploaded and configured with HTML tags. Style sheets can be applied. Search parameters and result presentation can be selected for the data categories taxa; specimens/observations; seed records; living collections; DNA samples; and literature. Sites can be published in English, French, Spanish, German and Chinese.

Data uploading restrictions may be applied, for example, excluding or reducing data for protected taxa. When uploading, data are compressed locally, streamed to the server then installed and stamped with the provider database identity. Data already on the server with the same database identity are replaced. Online data can be updated on any selected time basis. Databases can also be removed from the server or temporarily hidden.

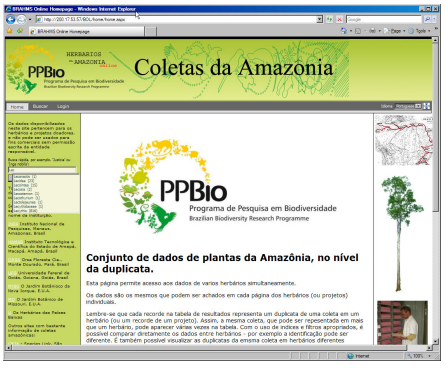
A given BOL homepage can be associated with multiple databases, each maintaining a separate identity on the server but searched as a whole. In this way, regional curation networks and other logical groups of databases can be established.



The BOL update service opened in BRAHMS 6 showing the homepage text editing section. HTML tag help is provided for text editing. From this dialog, homepages are designed, data uploaded and homepage-database links edited.



An example BOL service for Gabon developed at Wageningen. The website links to 90% of all plants known to have been collected from Gabon. http://dps.plants.ox.ac.uk/bol/?gabon.



A multiple database example. The Brazilian Government's Biodiversity Research Program (PPBio) has established a BOL service providing access to specimen data and specimen/label images from nearly all herbaria of the Amazonian region of Brazil, initially some 270,000 specimens with 300,000 associated images. When made public shortly, the service will provide un-precedented access to botanical data from the region, a boost to research and regional curation and should attract other herbaria with Amazonian holdings to contribute further data and images.

***Denis Filer,** Research Associate*