Oxford Plant Systematics

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

OPS 20 **May 2014**

Foreword

Once all the articles had been submitted for this year's issue of *Oxford Plant Systematics*, it became clear a theme had accidently emerged – plant collectors and their roles in plant science. Our knowledge of plant distribution, variation and biology requires access to living or dead plants, which ultimately depends on the activities of generations of dedicated plant collectors.

John Wood's article makes the case for the global importance of plant collectors and highlights his concern that collectors' activities may face a bleak future. Highly focused plant collecting aims to assemble specific material of particular taxa; biodiversity surveys aim to collect all plants of a specific area. The articles by Bethany Williams, Cicely Marshall and William Hawthorne show these two different faces of fieldwork and plant collecting in action, whilst Elizabeth Cooke's thesis abstract and the student reports illustrate the research applications of such collections. The historical importance of collectors in exploring patterns of plant diversity is illustrated by Caroline Pannell's article on *Aglaia* in Australia. At the local level, the field records of William Baxter provide a snapshot of plant diversity around Oxford in 1812.

The activities of plant collectors in the past have filled our gardens. Magnificent illustrations, such as those on the front and back covers of this issue of *OPS*, made by members of the Oxford Botanic Garden and Harcourt Arboretum Florilegium Group, vividly portray the results of collection activity. Another important product of collectors' activities is the specimen, and Denis Filer and Jan Wieringa show how images of specimens can be made available to the widest possible audience.

As the issue of *OPS* goes to press, Oxford University Herbaria has just made available images of the entire contents of the herbarium of William Sherard (c. 20,000 specimens) online (http://herbaria.plants.ox.ac.uk/bol/Sherard). This collection was described by James Edward Smith, founder of the Linnean Society of London, as 'perhaps, except that of Linnaeus, the most ample, authentic, and valuable botanical record in the world'.

The activities of plant collectors more than three centuries ago remain relevant today. Collectors may have little idea of how their collections will be used in the future, and users may have little appreciation of just how difficult material may have been to collect.

Stephen A. Harris
Curator of Oxford University Herbaria

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

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Oxford Plant Systematics Research Group website: http://herbaria.plants.ox.ac.uk
Oxford University Herbaria database at: http://herbaria.plants.ox.ac.uk/bol/oxford

The Florilegium Project – update

The object of the Oxford Botanic Garden and Harcourt Arboretum Florilegium group is to produce botanical illustrations, either line drawings or paintings, of a high standard, for archival purposes. These illustrations will further the documentation of the living collections at the Garden and Arboretum, providing us with an invaluable resource for the future. Each illustration will be fully comprehensive, showing flowers, fruits and enlargements and dissections where necessary. Our first themes are the medicinal plants, species from the 1648 border and plants with a special association with Oxford. Towards the end of 2013 we added "Trees" to the list. (See the illustrations on the front and back pages of this issue of OPS.)

The first full year has been very rewarding. Through the spring, summer and early autumn we met monthly in the garden and everyone enjoyed walking round, looking to see if there were flowers and later fruits available on their chosen species. Selected pieces were then cut for us by Alison Foster or Tom Price. A particularly valuable part of the project is the few hours that we then spend in the Garden library when Barbara McLean and I (Rosemary Wise) can help the team with any botanical or technical queries they may have. It is also good to make a start before the plants wilt!

In the winter Barbara and I ran workshops in the Department of Plant Sciences, covering techniques of pen and ink work, drawing from herbarium specimens, dissections and the composition of a plate. Twenty-five paintings were handed in for our panel of botanists to scrutinise; many were accepted outright while a few others were thought to need additions before they can be resubmitted.

Unfortunately, we have lost some of our original team and are always looking out for new members. If anyone is interested in joining the Florilegium, please contact me rosemary.wise@plants.ox.ac.uk. From May onwards we will be meeting monthly again. This year we plan on at least one outing to the arboretum and hope for another inspiring batch of artwork.

Alison Foster
Senior Curator, Oxford Botanic Garden
& Rosemary Wise
Botanical Artist

Front cover image: This page features *Pinus nigra*, black pine. The tree is one of the oldest in the Oxford Botanic Garden and was a particular favourite of J.R.R. Tolkein.
Painting © Rosemary Wise

Pressed for time – Plants 400 website

Dedicated individuals have created and used comparative collections to understand the natural world for centuries. At the core of such collections are specimens; preserved objects, such as rocks, fruits or bones, or living objects in botanic gardens, zoos, culture collections and gene banks. Today, such physical collections are augmented by the vast digital collections contained in on-line databases.

When Henry Danvers gave the University £5,000 to establish a Botanic Garden in 1621, he perhaps saw the function of the Garden as bringing together the 'vegetable products of Creation' and increasing our understanding of them. The first Keeper of the Botanic Garden, Jacob Bobart the Elder, recognised that botanical research needed living and dead plants, and that such collections should be amassed from across the planet. Consequently, a herbarium was essential. Herbaria provide information about species identity and occurrence in time and space. They are central to the initiatives to catalogue plant life on Earth, to understand plant evolution and in discussions about the future of plant diversity in the face of global planetary change. Oxford University Herbaria has been concerned with these issues, in various guises, for nearly four centuries.

The herbarium in Oxford had its roots in the Botanic Garden, opposite Magdalen College, but in the 1950s the whole collection moved to the Department of Plant Sciences; Oxford has Britain's oldest herbarium. Worldwide there are approximately 2,600 herbaria containing over 300 million specimens; Oxford University Herbaria contains approximately one million specimens.

Specimens are a permanent scientific record and are fundamental to taxonomic and ecological research. Furthermore, they are often the only means of identifying plants in poorly investigated parts of the world. Specimens are still being added to the Oxford herbarium, and although techniques for drying and preparing plants have changed little since the mid-sixteenth century, the quality of data associated with specimens has improved dramatically.

Diverse herbarium users put specimens to multifarious uses, most of which were inconceivable to the specimens' original collectors. For example researchers use herbarium specimens to collect data so that pollen grains from peat cores can be identified, species' range changes modelled and the consequences of climate change on areas of high biodiversity investigated. Specimens also become sources of DNA for difficult to obtain species for many investigations and mines of information for researchers in the humanities and social sciences.

Oxford University Herbaria is replete with botanical treasures including some of the first collections made in eighteenth-century North America and South Africa, some of the earliest collections of Australian plants (made in 1699), collections made by Carolus Linnaeus and Charles Darwin, tens of thousands of type specimens and many species which are now extinct. Illustrious botanists have contributed to, and studied, specimens in the Oxford herbarium over centuries, leaving their marks on its evolution. However, stewardship of such treasures has not always been at its best. For example, one of the world's oldest plant collections (dated 1606), made by the monk Gregorio da Reggio, laid abandoned and forgotten in the Botanic Garden until the late-nineteenth century when it was unearthed from 'a pile of material in the coke-house'.

On July 25th 2021, the Botanic Garden, Herbaria and Department of Plant Sciences celebrate their quadricentenary. As part of the lead-up to these celebrations 400 plants are being profiled in 400 weeks (in 400 words) at the Plants 400 website http://herbaria.plants.ox.ac.uk/bol/plants400. Profiles will be of plants growing at the Botanic Garden, include images of material from the Herbaria and reflect the botanical research and teaching interests of Oxford academics across four centuries. For an example, see page 15.

Stephen A. Harris
Druce Curator of Oxford University Herbaria

The Fungal Survey of Oxfordshire

The Fungal Survey of Oxfordshire (FSO) began in 1987. It was formed, by the then part-time departmental librarian, Marion Warland and her husband together with a small group of enthusiasts interested in field mycology. Our first president was the Sibthorpian Professor of Botany at St John's, Professor Harley FRS. Our second President was Professor Ingold who remained active for many years. He died about three years ago, aged 101. Our new President is Professor Richard Fortey FRS who has recently been involved in making a film on fungi in Scotland for Channel 4. The aim of the group, which is part of a national movement, is to record the distribution of fungal fruiting bodies occurring throughout the county. Each year we meet in the autumn to go on Fungal Forays to different places mostly to woodland areas but not always. Lists of the fungi that we find are entered into the National Database held by the British Mycological Society, FRDBI. We welcome new members, anyone interested please visit

our website where past and present Newsletters can be found and the Foray programme for 2014:
http://www.fungusoxfordshire.org.uk

Molly Dewey
Secretary FSO
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Herbarium Visits

John R.I. Wood:
As part of on-going monographic work on *Ipomoea*, John Wood has been visiting countries in North and South America. Field work in Bolivia is described separately in this issue (on page 9) but the main focus has been on herbaria. Following visits to Corrientes in Argentina and Asunción in Paraguay in 2012, visits were made to São Paulo and Brasília in 2013. This enabled contacts with both Rosangela Bianchini (SP) and Antonio Krapovickas (CTES) to be strengthened – the sharing of experience and knowledge with experts who have worked for many years with Convolvulaceae has proved especially useful. The herbaria in these two institutions are rich in well-named material. However, one of the most interesting herbaria in Brazil proved to be the EMBRAPA Herbarium in Brasília (CEN), which was rich in material from little-known parts of Brazil, some of which represents undescribed species.

Later in 2013, visits were made to six herbaria in the United States: New York, Harvard, Ann Arbor in Michigan, the Field Museum, Missouri and the Smithsonian Institute. As a result nearly all *Ipomoea* types from the Americas have now been seen – the principal gap is Cuba. Un-identified material was reviewed and much of this was identified but all six herbaria contained collections which could not be identified. These specimens have been loaned for further study and will be important in our monographic work. Further visits to herbaria in South America and Europe are planned for 2014.

Caroline Pannell:
2013 began with a Singapore Botanic Garden Fellowship to work on the SING collections of Salicaceae and Achariaceae from Peninsular Malaysia. During a two-month visit to Singapore and Malaysia, I identified all the herbarium collections of Salicaceae and Achariaceae from Peninsula Malaysia in SING and KEP. Descriptions of the Peninsular Malaysian species in these two families (more than 40 species in all) were written. In September 2013, I began a 10-month-long visit to New York Botanical Garden. The two family accounts for *Flora of Peninsular Malaysia* were completed and submitted to the editors at the end of the year. I continued biodiversity assessments for the plants of Peninsular Malaysia, focussing on the published species list for Krau Wildlife Reserve in Pahang State. After many years of contributing to identification and sampling of *Aglaia* for molecular projects, two manuscripts were prepared, one publishing a much expanded phylogeny of the genus and the other a new analysis of biogeography, based on the enlarged dataset.

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Abstract of systematic thesis submitted in 2013

The following D.Phil. thesis was submitted and successfully defended in 2013:

The Phylogeography and Systematics of *Cardamine hirsuta*

Elizabeth Laura Cooke
Wadham College

Supervisors: Dr Robert Scotland (University of Oxford), Dr Mark Carine (Natural History Museum, London) and Professor Miltos Tsiantis (University of Oxford and Max Planck Institute for Plant Breeding Research, Köln).

Cardamine hirsuta L. is an emerging model system in developmental genetics, where natural genetic variation within *C. hirsuta* provides the means to investigate the genetic basis of morphological traits. This thesis investigates the geographical structure and genealogical history of genetic variation within *C. hirsuta* and identifies its closest relatives. This will enable the accurate selection of species for comparison with *C. hirsuta* when making interpretations of evolutionary processes, and provide a better understanding of morphological character evolution in *C. hirsuta*.

The phylogeographic history of *C. hirsuta* was reconstructed using multiple chloroplast and nuclear markers and widespread accession sampling from across its native range. A distinct group was identified within *C. hirsuta*, restricted to the high mountains of East Africa. Climate suitability modelling showed that Pleistocene glacial dynamics have had a strong effect on the distribution of genetic variation within *C. hirsuta*.

The phylogeographical data generated here was used to investigate the origin of *C. hirsuta* in the Azores, an oceanic archipelago. The Azores are dominated by an endemic chloroplast haplotype which is associated with an endemic phenotype. Thus, *C. hirsuta* appears to have diversified *in situ* in the Azores.

Phylogenetic analyses of *Cardamine*, restricted to diploid species to remove the confounding effects of polyploids, found that *C. hirsuta* is most closely related to *C. oligosperma*, a western North American species. Multiple loci and extensive intraspecific sampling were brought to bear to demonstrate that *C. hirsuta* and *C. oligosperma* are reciprocally monophyletic. *Cardamine pattersonii*, a restricted endemic from north-west Oregon is likely to be an allopolyploid, with *C. oligosperma* as the maternal parent and possibly *C. nuttallii* as the paternal parent.

Student reports

Juan David Beltrán (D.Phil., 1st year) **Evolutionary origins and ecological significance of Crassulacean acid metabolism (CAM) in *Puya* (Bromeliaceae)**

Supervised by Professor Andrew Smith (Oxford) and Dr Stephen Harris (Oxford). Funded by awards from the Louis Dreyfus-Weidenfeld Scholarship and Leadership Programme and from Colciencias.

Crassulacean acid metabolism (CAM) is a photosynthetic pathway used by nearly 6% of vascular plant species. It is a carbon-dioxide-concentrating mechanism that also improves plant water-use efficiency. For that reason CAM plants are usually found in dry or seasonally arid environments in the tropics and subtropics, from semi-deserts to dry seasonal forest, as well as in the exposed canopies of tropical wet forests. The Neotropical family Bromeliaceae has been of particular interest in studying the evolutionary origins of CAM photosynthesis because this trait has been found in many terrestrial and epiphytic species. Furthermore, CAM appears to have evolved several times independently within the family, so making this a very good group in which to study the comparative ecology of C_3 and CAM species.

Puya, a genus in the Bromeliaceae with a predominantly Andean distribution, occurrs from sea level to almost 5000 m. above sea level. The genus comprises approximately 230 species, and is believed to be the result of a comparatively recent radiation, with the crown group dating to around 6 Ma. Carbon-isotope analyses conducted to date indicate that about 20% of *Puya* taxa surveyed show CAM photosynthesis, including a number that occur at unusually high altitudes for CAM plants (>4000 m). Preliminary molecular-phylogenetic work on *Puya* over the last five years has defined some broad relationships within the genus, but lack of sequence resolution and relatively sparse taxon coverage do not yet permit conclusions about the origins of CAM photosynthesis in this clade. The aim of my project is therefore to determine the number of times CAM photosynthesis has evolved in *Puya* and to relate this to the historical biogeography and ecology of this distinctive element of the Andean flora.

My current work is involved in improving the sampling of *Puya* with assistance from colleagues at various herbaria and botanic gardens, including much valuable advice on field material from John Wood. The aim is to achieve coverage of approximately 75% of the genus. I am trying to improve methods for isolation of DNA from herbarium specimens of *Puya*, as the chemical composition and succulence of some bromeliad material has made this problematic in the past. The ultimate goal is to use DNA sequence information obtained from reduced-representation libraries (RRL) and high-throughput sequencing to reconstruct a high-resolution phylogeny of *Puya*. This approach has not yet been applied to Bromeliaceae, but has been proposed as an effective way to reconstruct phylogenies of rapid radiations that cannot be solved using traditional methods using individual loci.

To complement the molecular phylogenetic work, I will be expanding the sampling of carbon-isotope determinations for *Puya* to identify C_3 and CAM taxa to achieve as complete coverage of the genus as possible. This information will be used to test historical and ecological questions concerning the occurrence of CAM in *Puya*, including the significance of its presence in high-elevation species. I have been developing an ecological niche-modelling approach using data from the Global Biodiversity Information Facility combined with bioclimatic variables, which so far has indicated that the CAM species of *Puya* are: (1) distributed from Chile to the western Andean portal in northern Peru/southern Ecuador, but do not extend into the northern part of the Andes; and (2) preferentially located in warmer locations with high seasonality, instead of wet habitats or dry environments with low seasonality. This work should ultimately contribute to a better understanding of the evolutionary origins and functional significance of CAM photosynthesis in one of the most ecologically diverse of angiosperm families.

Cicely Marshall (D.Phil., 1st year) **Do hotspots of species endemism promote novel lineage diversity?**

Supervised by Dr Stephen Harris (Oxford) and Dr William Hawthorne (Oxford). Clarendon Scholarship funding (University of Oxford).

The world's rarest plant species are not distributed evenly around the world, but are found aggregated in regions called hotspots. While hotspots are well known for their globally rare species, we know little about their evolutionary histories. I am working with the flora of the West African rain forest (Upper Guinea) to assess when most locally endemic species evolved, particularly with respect to major climate changes during the Pleistocene. The Upper Guinea forests extend along the West African coast from Sierra Leone in the west to Ghana in the east. About 2,800 angiosperm species occur there, c. 25% of which are endemic to the region.

Glaciations dried and cooled the climate in tropical Africa, leading to repeated contractions and expansions of the forest. Forest species are thought to have been confined to small areas, called refugia, during these glacial maxima. Putative refugia in Upper Guinea are characterised by high numbers of locally endemic species (and potentially unrecognised subspecies, or haplotypic diversity). However, whether these refugia acted as 'cradles', where allopatric speciation differentiated populations between refugia, or 'museums', where long-term climate stability promoted species longevity in spite of range reductions outside refugia, remains unknown. I am interested in where these locally endemic taxa lie on a community phylogeny of Upper Guinean forest taxa that includes their sister taxa. Do narrowly endemic species have close sisters, indicative of recent divergence and low extinction, or are they phylogenetically distinct, indicative of persistence amid widespread extinction? These questions are important for understanding the roles hotspots or refugia have played in lineage diversification, which in turn can give us clues about potential future adaptability of populations inside or outside hotspots. Are hotspots also hotbeds of genetic innovation, or is their high endemism because they harbour relictual lineages that are now extinct elsewhere?

I have spent the first six months of my D.Phil. assembling DNA barcodes for Upper Guinean forest species. Using the chloroplast marker regions *matK* and *rbcL*, I hope to assemble a community phylogeny to answer questions about speciation patterns in Upper Guinea. I have sequence data for 1,100 Upper Guinean forest species, mostly contributed by a DNA barcoding project funded by the International Development Research Centre and the Barcode of Life Database in Canada. This project funded William Hawthorne and me to travel to Ghana, along with Olivier Hardy from the Université Libre de Bruxelles. After a short stay in Accra to visit our long-term colleague Patrick Ekpe, curator of the Legon National Herbarium, and collect equipment, we headed north to Kumasi. Here we visited the Forest Research Institute of Ghana to meet their director, Ernest Foli, and pick up Jonathon Dabo, a very capable field botanist. Together we collected in Fure Headwaters Forest Reserve, Neung South Forest Reserve, Cape Three Points Forest Reserve, Axim and finally Ankasa. Back in Accra we identified our vouchers and began preparing samples for sequencing. After approximately one month of specimen preparation in Oxford and in Brussels, 967 forest species were sent for sequencing.

Estimating such a large and taxonomically diverse phylogeny has been challenging, not least because this is my first foray into phylogenetics! Although ambitious, initial results suggest that a reliable phylogeny can be produced. The next steps will be to include the full complement of locally endemic species, and fossil constraints for time calibration, in the phylogeny. I would also like to sample at the infraspecific level, as many locally endemic species are likely to have diverged before the Pleistocene.

Plant Hunters – A threatened species A point of view

Introduction

The origins of plant hunting are lost in the mists of time but the openings of the sea routes to Asia and America in the early sixteenth century provided an initial impulse, particularly to the hunt for plants of economic value. However, it was in the eighteenth century that various movements came together to bring about a veritable explosion of plant hunting activity. The birth of modern science and the thinking of the Enlightenment stimulated a desire to discover new things and to catalogue and explain the world around us. Linnaeus' work came out of this background and gave an added stimulus and focus to plant hunting. Then, at the end of the eighteenth century, the Romantic Movement gave birth to the worship of nature and stimulated a desire for the exotic and the beautiful, epitomised in the development of gardens with beautiful flowers. The century up to 1914 was the heyday of the plant hunter. Steam ships, colonial rule, relative peace, improved medical knowledge all made travel easier and plant hunters brought back specimens from all parts of the world to their home country.

Since the First World War, plant hunting has been in decline, at first almost imperceptibly but since the 1960s rapidly. Two world wars, low level conflict in many parts of the world, the end of the European empires and a more materialistic culture have all contributed to this but few have noticed this decline and fewer still have shown any concern, let alone awareness that our own institutions have contributed mightily to this.

Who are the plant hunters?

There are three basic types of plant hunter. There is the plant hunter sponsored by a government or government institution. Almost all of the expeditions and voyages of the late eighteenth and early nineteenth century were government sponsored, as was a lot of the plant hunting carried out by official institutions, such as national museums and big colonial botanical gardens in the nineteenth century. Today much of the plant hunting in the tropics is sponsored by official bodies such as the Chinese Academy of Science, the Botanical Survey of India, Embrapa in Brazil or much less commonly, research councils in the richer developed countries. However this kind of sponsorship has gone out of fashion in many countries and will probably decline in others. Another kind of plant hunting is that funded by a rich individual or syndicate. This has been the case particularly with expeditions to find plants of economic and especially horticultural value – the expeditions of Forrest and Kingdon Ward to China are good examples. The third kind of plant hunter, perhaps a particularly but not exclusively a British phenomenon is the private individual, a person who hunts for plants in the spare time of another occupation or of their retirement – examples include A.F.G. Kerr in Thailand or Mary Richards in Zambia. The end of colonial empires and the growth of short consultancies have reduced the numbers of this kind of expatriate plant hunter and there has been no significant compensating growth in the number of amateur national plant hunters.

Is plant hunting useful?

Plants have obvious economic and aesthetic value whether for gardens, horticulture, forestry, medicine or any other of many uses and someone has to find them and bring them into cultivation or acquire material for study. This is the work of the plant hunter. Without their work in previous centuries the world's gardens, agriculture, medicine and industry would be that much poorer. Is there any reason to think that there is nothing more to discover? At the very least, it is estimated that some 20-25% of the world flora still awaits discovery (Joppa *et al.* 2010, Bebber *et al.* 2010) and what may be contained in that undiscovered 25% we do not know and additionally a good proportion of the rest, another 25% perhaps, are extremely poorly known. For a host of studies, both living and dried plants are akin to a reference library in which a huge bank of information is stored. Sadly today most emphasis is put on imaging this data rather than adding to it, even though for scientifically important molecular research, new, carefully collected material is essential, something that suggests that our institutions would benefit from "new editions", (or should it be additions?) of their classical collections. And to continue the analogy, little effort and almost no budget is assigned to the acquisition of new publications, i.e. unknown species.

Finally, it is worth pointing out the truism that biodiversity is disappearing. This makes the task of finding it, studying it and conserving it a matter of urgency. We need to get there before it is too late. In a limited sense this is recognised, hence the Millenium Seed Bank project at Kew, but this is focussed almost exclusively on the conservation of the known, rather than the discovery of the new.

Then why is the plant hunter in danger of extinction?

While discoveries of new species commonly attract far more media attention than the more educational or conservation achievements of biodiversity projects, large institutions and funding bodies do not share this interest, perhaps because it is linked, at least in the minds of many, with the deeply unfashionable science of taxonomy. Studies, however, consistently show that there are still large numbers of flowering plants yet to be discovered and probably still more known from little more than one or two herbarium specimens so the work of the plant hunter and taxonomist is far from over. Despite this, very few botanical institutes are seriously interested in plant hunting, few sponsor expeditions to find new plants and even fewer pay for specimens. Plant hunting for gardens has largely become a small-scale private initiative, frowned on by the establishment institutions. I suspect that most institutions have a larger entertainments budget than an expeditions budget.

Another important factor is political sensitivity or "political correctness" as some would characterise it. From the eighteenth to the early twentieth century plant hunting was a heroic adventure in which the plant hunter braved illness, evaded the controls and demands of local rulers, endured imprisonment and the destruction of their specimens and often died on their journey, the experience of Forsskal in Egypt and Arabia or Schimper in Ethiopia illustrate these dangers well. Today health and safety regulations would preclude most of these expeditions and attempts to evade local, often unreasonable regulations, would be treated as biopiracy rather than heroic endeavour. The late twentieth century has seen controls on plant collecting grow exponentially in many countries of the world to the extent that even nationals of several tropical countries cannot legally explore their own flora without complying with complex restrictive regulations. These regulations do nothing to control the true bio-pirates who simply ignore them but they have a baleful effect on research institutions in all countries who strive to achieve whiter than white status by the simplest method – that is by abandoning the hunt for plants.

Why do countries impose restrictive regulations? They are usually justified in the name of conservation. Clearly many species and the habitats in which they live are under threat and it is right to devote legislation, funds and effort to their conservation, but it is largely through the efforts of plant hunters and taxonomists that we know which areas and which species are priorities for conservation. In all countries, it is not the plant hunter but development in the broadest sense, whether urbanisation, construction of new transport systems, the demand for timber, land demands by peasant farmers or the growth of agroindustry that is causing the destruction. Only in the case of a small number of specialist groups, mostly succulents, which are now correctly listed under CITES, are plant hunters rightly seen as a threat. However, it is probably not a love of conservation but rather a misplaced nationalistic desire to exercise control combined with a feeling that national resources should be protected for national advantage that underlies much of the legal restrictions on plant hunting. The removal of rubber plants from Brazil in the nineteenth century is often cited as an example of biopiracy by plant hunters, but rubber trees, like most plants of economic value were never limited to one country and, in any case, attempts to maintain a monopoly of any plant of economic importance have never been successful. Science like national economies flourishes in eras of internationalism, openness and transparency and it is for international collaboration, benefit sharing and open access that our institutions should be striving, rather than acquiescing silently in restrictions borne of unreasonable fears.

A spectacular species of *Aristolochia* (Aristolochiaceae) discovered in Bolivia on a recent field trip. Photo © Bethany Williams

Is there a way forward?

Of course. Our institutions need to be proactive in supporting plant hunting. There has to be an emphasis on collaboration and transparency, and collaboration has to be lubricated with money so that all parties in collaborative plant hunting benefit and are seen to benefit. This, of course is dependent on the will and self-belief of our institutions so they prioritise plant hunting within their plans, budgets and mission statements. This is where leadership with a clear vision is necessary in our botanical institutions and the absence of this kind of leadership over the past fifty years has resulted in numerous missed opportunities, which could easily be enumerated. With a positive vision opportunities can be seized on when they come up and the resources, that is the collections, of institutions in all countries involved can be strengthened for research now and for the future.

Conclusion

I have been asked whether it matters if a species becomes extinct and it is not always easy to answer in many particular cases except by quoting John Donne "Every death diminishes me …" but in the case of the plant hunter it is easier. If we want to complete the inventory of plants, then someone has to go out and find them - that is the role of the plant hunter. If we want to have the resources to study biodiversity and its conservation, not to speak of systematics and taxonomy, we need the resources – that is the specimens in our botanical institutions – to facilitate these studies, not forgetting that new, green material is needed for genetic sequencing. Again the plant hunter is needed. And then there is the need for new genetic resources for crops, medical research and horticulture. All of these depend on the work of diligent plant hunters. The bell will toll for all these sciences if the plant hunter becomes extinct.

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John R.I. Wood
Research Associate

Rapid Botanic Survey arrives in Ethiopia

Dry type of afromontane forest at Wondo Genet

RBS trainees at Wondo Genet. All photos on this page © William Hawthorne

William Hawthorne and Cicely Marshall from the Department of Plant Sciences, along with Ben Jones, Curator of the Harcourt Arboretum, part of the Oxford Botanic Gardens, demonstrated Rapid Botanic Survey (RBS) to staff and students at Wondo Genet College of Forestry and Natural Resources, Ethiopia. The demonstration was part of a workshop and training supported by ARBOPRO (Arboretum Project), a project to rejuvenate the Wondo Genet College Arboretum.

The nascent RBS team surveyed four samples and collected 279 specimens. A visit to the Addis Ababa National Herbarium was made to identify the specimens, which will shortly be returned to the College for use as a reference collection.

The Wondo Genet College of Forestry sits in a small bowl of montane forest in the Ethiopian highlands at an elevation of almost 2000 m. Thanks to its geography, the forest surrounding the college has largely escaped transformation to *Eucalyptus* or coffee plantations, but is now under significant pressure from firewood collection and fire. Botanic highlights included the sweetly scented arrow-poison treelet *Acokanthera schimperi* (Apocynaceae), with a limited global distribution in north east Africa; *Coffea arabica* (Rubiaceae) in its native habitat, *Vepris dainelli* (Rutaceae), a globally rare small tree and *Afrocarpus falcatus* (Podocarpaceae), one of Africa's few conifers.

Alongside its forest, the college boasts a four hectare arboretum which was established in 1978. The arboretum holds about 95 mostly non-native species, originally chosen for their ornamental or silvicultural properties. Activity at the arboretum all but stopped in 2000, but since 2012 ARBOPRO has contributed an entrance gate and a fence to the arboretum, as well as salaried positions for a Site Manager and an Arboretum Curator. Ben Jones has been helping and advising the project. To establish a network of botanic gardens, ARBOPRO is in discussion with Botanic Gardens Conservation International (BGCI) and the Ethiopian Institute of Biodiversity (IBC) to develop a capacity building programme for Ethiopia's new and restored botanic gardens (http://www.bgci.org/africa/news/1104/).

At the Wondo Genet Arboretum, botanic survey is to be used to inform and guide *ex situ* conservation. One new aspiration of the arboretum restoration is to establish a national collection of endemic and endangered plants. Funds are being sought for a full RBS of the area, and of other parts of Ethiopia, which will identify these and other target species. The arboretum will also support education of students and visitors about the flora of Wondo Genet, a goal to which a systematic botanic survey would contribute by supplying baseline data and botanical training.

Vepris dainellii (Rutaceae), a globally rare tree

Stephania abyssinica (Menispermaceae), globally widespread, medicinal plant

ARBOPRO involves a collaboration between the University of Hamburg (Peter Borchardt, borchardt@geowiss.uni-hamburg.de); the Harcourt Arboretum (Ben Jones, ben.jones@obg.ox.ac.uk); Botanic Gardens Conservation International (Kirsty Shaw, kirsty.shaw@bgci.org); Wondo Genet College of Forestry (Habtamu Asaye, habtamuasaye@yahoo.com); Addis Ababa University (Zerihun Woldu, zerihun_woldu@yahoo.com); and, for RBS, Department of Plant Sciences William Hawthorne, (william.hawthorne@plants.ox.ac.uk) and Cicely Marshall (cicely.marshall@plants.ox.ac.uk).

Cicely Marshall
D.Phil. student
& William Hawthorne
Research Associate

Collecting *Ipomoea* in Bolivia

As part of the first year of my research associate post working on the *Ipomoea* project I went on a five-week collecting expedition to Bolivia. In contrast to most early career scientists' experiences of field work abroad I was fortunate to be accompanied by John Wood, someone who not only speaks fluent Spanish and has many friendly contacts, but also has an intimate knowledge of Bolivia and its flora.

This collection trip was part of a 33-month Leverhulme-funded project to monograph *Ipomoea* (sweet potato and morning glory) worldwide providing basic descriptions and diagnostic keys for all 600-800 species (including satellite genera). In the process we aim to develop a methodology that will speed up monographic work for other large genera. Integral to the project is a revision of authentic material of all species and the use of modern methods such as molecular sequencing to produce a well sampled phylogeny. Although we are using herbarium material as the main source of DNA, silica-dried fresh material has a much higher sequencing success rate and enables us to include species without suitable herbarium material. It was with this in mind that we travelled to Bolivia to collect leaf samples and corresponding herbarium vouchers for as many different *Ipomoea* species as possible.

We arrived in Santa Cruz, the largest city in the Bolivian lowlands in late March, when the worst of the rainy season was over. After a short stay and meeting everyone at the Museo de Historia Natural Noel Kempff Mercado we travelled on our first excursion to the south of the country with Daniel Villarroel, a Ph.D. student at the Universidad de Brasília interested in Myrtaceae and cerrado vegetation.

Our first day of field work in Tarija was extremely successfully. A short trip down a steep sided gorge resulted in 12 *Ipomoea* collections including three undescribed species of *Ipomoea*. Fortunately *Ipomoea* have showy flowers and often grow on exposed areas alongside roads so we were able to spot the plants from the car whilst also covering large distances. However many species of *Ipomoea* do look quite similar from a distance and it was often difficult to see if we had a different species from one we had already collected.

Over the next 10 days we continued collecting *Ipomoea* as well as other interesting species as we drove north towards Sucre, cutting through the mountains to the west. The mountainous landscape produced some breath-taking scenery and some very steep rocky roads which luckily John was able to navigate with expertise. The ecology often changed dramatically over only short distances and we continued to find a huge variety of *Ipomoea* species as well as undescribed species of *Philibertia* (Asclepiadaceae), *Escallonia* (Saxifragaceae) and two of *Euphorbia* (Euphorbiaceae). In less than a half hour's drive, moist Tucamano-Boliviano Andean forest would change into dry inter Andean valley forest. In addition to finding interesting species these valleys also provided warm places to dry specimens while we had our lunch.

Ipomoea abutiloides from the chiquitania in Bolivia

Photo © Bethany Williams

Daniel Villarroel and John Wood pressing specimens of *Ipomoea* in the Bolivian Chaco

Photo © Bethany Williams

At Villagrande, Daniel left us and we were joined by Ivan Linneo, a botanist interested in bryophytes. Then, following a couple days in Sucre, a beautiful white city full of colonial buildings and elegant churches, we drove back to Santa Cruz. Although we collected few new *Ipomoea* species in the later part of this trip we did drive through cloud forest and tropical forest and saw some of Bolivia's many different biomes.

For the second half of the expedition we headed towards the east of the country with Gloria Gutierrez from the Natural History Museum in Santa Cruz. This area is vastly different from the mountains in the west and consists mainly of dry forests alternating with savannah with much cleared for farming. We again had some remarkably successful days with one trip up a muddy road towards Florida resulting in nine different species of *Ipomoea* in a single day. Granite domes in the forest were particularly good sites for finding interesting species, including another undescribed species of *Ipomoea* collected at Lomerio. After Gloria left us we were joined by Daniel Soto, a botanist with a special interest in *Bauhinia*. For the last part of the trip we explored Santiago de Chiquitos, an area of special interest with many endemic species. As well as its interesting flora the region had many flat topped mountains called mesetas. These were particularly stunning and climbing to the top of one was a great way to end the trip.

During the expedition we collected a total of 320 specimens including 45 different species of *Ipomoea*, four of which were undescribed. I have since extracted the DNA from my leaf samples and incorporated them into a phylogeny of *Ipomoea* and I am currently working on improving the species coverage in this large and diverse genus.

Bethany Williams
Research Associate

The history of discovery of *Aglaia* (Meliaceae) in Australia

The last two in a series of Flora accounts for the genus *Aglaia* (Meliaceae) were published at the end of 2013 (Pannell 2013a,b). There are 51 species of *Aglaia* in Peninsular Malaysia, where all but the highest mountains afford climate and habitats suitable for *Aglaia*. Three species are endemic. A distribution map and local conservation status is included for each species. One species is classified as rare, five are vulnerable, 10 are near threatened, one is endangered. Four are 'data deficient', because they are known in Peninsular Malaysia from only one collection. In Australia, there are only 12 species of *Aglaia*. Suitable tropical conditions are restricted to a narrow band in the north and east of the continent. Seven of these species were described from Australia and four are endemic. There are likely to be additional cryptic or poorly known species not yet recognized from the continent.

The discovery of *Aglaia* in Australia began with two expeditions sent to explore 'New Holland' at the beginning of the nineteenth century. The French set sail in November 1800, with 22 scientists, four of them botanists, led by Nicolas-Thomas Baudin. A British ship, the 'Investigator', under the command of Matthew Flinders, set sail on 18 July 1801. Its scientific team included the Scottish botanist, Robert Brown and the Austrian artist, Ferdinand Bauer. Ferdinand Bauer had already travelled in the eastern Mediterranean with John Sibthorp, Sherardian Professor of Botany in Oxford, and had completed the magnificent watercolour illustrations for *Flora Graeca* (1806-1840), Oxford's finest botanical treasure.

On the French expedition, Jean-Baptiste Leschenault de la Tour made collections of one species of *Aglaia*, date and locality unknown. In 1830, it was described as the type species, *Nemedra elaeagnoidea*, of a new genus, *Nemedra*, by Adrien Henri Laurent de Jussieu. George Bentham transferred it to *Aglaia* in the first volume of his *Flora Australiensis* (1863). Although a second species of *Aglaia* was collected by Robert Brown on Groote Eylandt in the Gulf of Carpentaria on 15 January 1803, Bentham included it in *A. elaeagnoidea*. It was not recognised and described as a distinct species, *A. brownii*, until publication of the monograph of *Aglaia* 189 years after its discovery (Pannell, 1992). Robert Brown's collection from Groote Eylandt is the type specimen. In 1862, six decades after Leschenault and Brown made their collections of *Aglaia*, John Dallachy, Superintendent of the Melbourne Botanic Garden, Victoria, began collecting in the Rockingham Bay area of Queensland for Sir

Above: *Aglaia australiensis* fruits
© W.T.Cooper from *Fruits of the Australian Tropical Rainforest*

Aglaia argentea fruits
© W.T.Cooper from *Fruits of the Australian Tropical Rainforest*

Ferdinand Jacob Heinrich von Müller. Two years after publication of Bentham's *Flora Australiensis*, von Müller described a new genus, *Hearnia*, in *Fragmenta Phytographiae Australiae* (1865). The type species, *H. sapindina*, was based on one of Dallachy's collections and was transferred to *Aglaia* by Harms in 1896. It was not until 1923 that a third species from Australia, *Aglaia ferruginea*, was described, by C.T. White & W.D. Francis. Nineteen years after that, in 1942, the first species of *Amoora* for the continent was also given the epithet *ferruginea*. The genus *Amoora* is now included as a section of the genus *Aglaia*; the epithet already being occupied in *Aglaia*, a new name, *Aglaia meridionalis*, was assigned to this species, along with publication of a second species in section *Amoora*, *Aglaia australiensis*, (Pannell, 1992). Finally, *A. cooperae*, named after Wendy Cooper was published in 2008 (Pannell, 2008). This species had been recognized and referred to as '*Aglaia* sp. (Silver Plains L.J. Webb+ 9734)' since 1997 (Jessup, 1997, Cooper & Cooper, 2004, Jessup 2007).

It is an indication of the distinctness of the assemblage of species found in Australia that over half the species known from the continent were new to science when they were discovered and that of those seven species, four are endemic. The first species to be described from Australia, *A. elaeagnoidea*, is one of the most widespread species in the genus, occurring from Sri Lanka to New Caledonia and from southern China to northern Australia. Its morphological variation is complex, and Muellner *et al.* (2009) demonstrated that it is polyphyletic. Further field work and DNA sequencing is likely to lead to its resolution into a series of morphologically recognizable monophyletic taxa, each with a more restricted distribution than the species as it is currently circumscribed. Three of the remaining non-endemic species of *Aglaia* in Australia, *A. spectabilis*, *A. argentea* and *A. silvestris* are widespread, variable and, according to Grudinski *et al.* (2014), polyphyletic species, all with distributions from mainland Asia, through Malesia and into Australia. *A. brownii*, *A. brassii*, *A. sapindina* and *A. euryanthera* are confined to Australasia, but one or more of these could also turn out to be polyphyletic. It seems likely, therefore, that *Aglaia* in Australia will ultimately prove to be even more distinct and have a higher level of endemism than is described in the newly published treatment for *Flora of Australia*.

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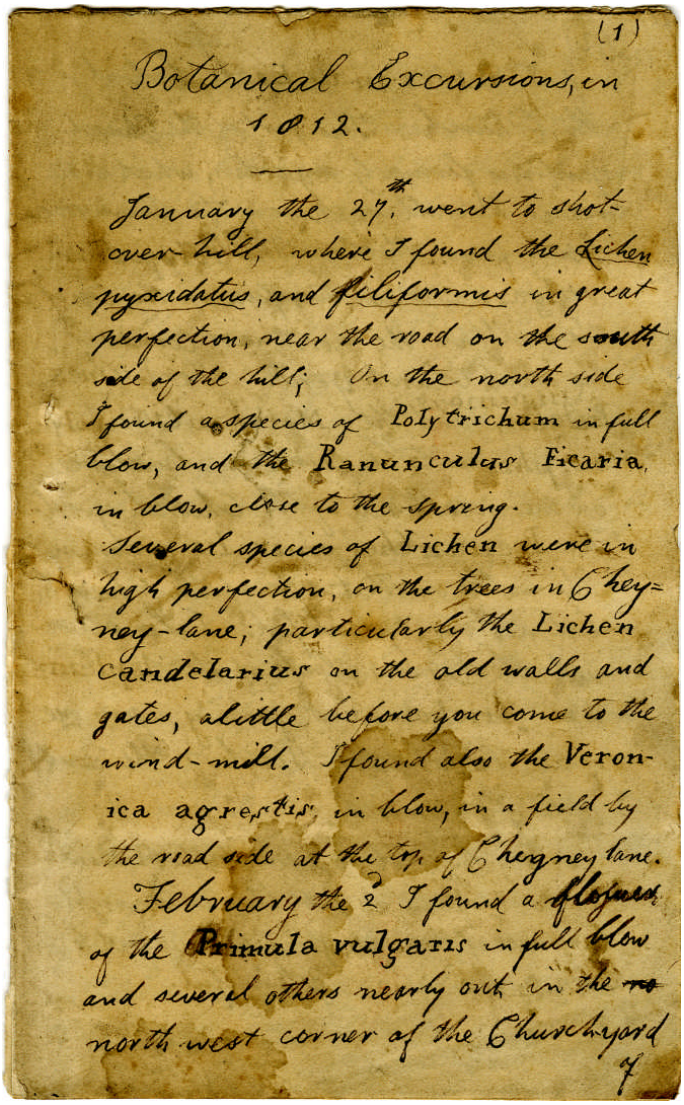
Caroline Pannell
Research Associate

William Baxter's 1812 botanical excursions around Oxford

In 1813, the 26-year-old, Rugby-born botanist William Baxter (1787-1871) was appointed Curator of the Oxford Physic Garden, at a time when botanical research and teaching in the University was at one of its periodic low ebbs. A Bohemian academic, who visited the Garden in 1824, gave a sense of the problems Baxter had faced for over a decade: 'Baxter, devotes his attention chiefly to the Cryptogamia; partly from mortification at finding it impossible to make the garden such as he could wish … this industrious man … cultivates between 4,000 and 5,000 species of plants in the wretched houses of this garden, though, in fact, there is only one stove, properly so called, and this is much too small' (Günther, 1912: 23). Over nearly four decades, Baxter transformed the Garden through major improvements to the Garden's fabric and modernisation of its planting scheme, and overhauled the teaching of undergraduate botany. Baxter could not have made such transformations without the collaboration of the dynamic and charismatic Professor Charles Giles Bridle Daubeny (1795-1867), who was appointed to the Sherardian Chair in 1834; he went on to become one of the University's most outstanding professors of botany.

Baxter, together with Daubeny, was part of a team of natural scientists who founded the Oxford Botanical and Natural History Society in 1831; this eventually became the Ashmolean Natural History Society of Oxfordshire. In 1851, Baxter was succeeded to the post of Curator by his son, William Hart Baxter (c.1816-1890); his grandson was employed as a gardener (Druce, 1928). The Baxter succession recapitulated the Bobart succession, the first Curators of the Garden, over 150 years earlier. In addition to its dynastic aspects, the Bobart and Baxter successions were similar because of the inadequacy of the pensions accorded to the Curators by the University. Despite the horticultural prominence of Druce's (1928: 465) 'remarkable man' in the early nineteenth century, when Baxter died, twenty years after his retirement, he was virtually unknown.


(1)
Botanical Excursions, in 1812.

January the 27th, went to shot-over-hill, where I found the Lichen pyxidatus, and fibliformis in great perfection, near the road on the south side of the hill; On the north side I found a species of Polytrichum in full blow, and the Ranunculus Ficaria in blow, close to the Spring.
Several species of Lichen were in high perfection, on the trees in Cheyney-lane; particularly the Lichen Candelarius on the old walls and gates, a little before you come to the wind-mill. I found also the Veronica agrestis in blow, in a field by the road side at the top of Cheyney lane.
February the 2 I found a flowers of the Primula vulgaris in full blow and several others nearly out in the north west corner of the Churchyard
7

Photo © Oxford University Herbaria

Baxter had particular interests in cryptograms and willows, which was perhaps unsurprising since when he took over the riverside Garden it was poorly drained and frequently flooded. His other interests extended to local floras and he made important contributions to Thomas Purton's *Midland Flora* (1821) and Richard Walker's idiosyncratic *The Flora of Oxfordshire* (1833). However, Baxter is perhaps most widely known for his six-volume *Phaenogamous Botany, or, Figures and Descriptions of the Genera of British Flowering Plants* (1834-1843), with its over 500 distinctive hand-coloured, copper engravings. Baxter provided particularly detailed locality information on the Oxfordshire plants, so *Phaenogamous Botany* has been an important source for all subsequent writers of Oxfordshire local Floras (Druce, 1886, 1927; Killick *et al.* 1998).

Some years ago, among the papers of the prominent Oxford-based botanist George Claridge Druce (1850-1932), a 38-page, handwritten manuscript entitled 'Botanical Excursions, in 1812' was discovered. The manuscript is a snapshot of the plants the 25-year-old Baxter observed growing around Oxford between Monday 27th January and Monday 19th October. The first 17 pages of the manuscript are neatly written prose on paper with an 1810 watermark. Subsequent papers, written on the verso of State Lottery Bills dated 4th June 1812, comprise series of often hastily written notes; perhaps made in the field. Druce evidently went through the manuscript during the preparation of the second edition of his *The Flora of Oxfordshire*, ticking some entries and inscribing pages as copied, presumably after

he acquired much of Baxter's library and notes (Druce, 1927: cix).

During 1812, Baxter recorded plants on 73 dates from 74 locations. Baxter's locations were concentrated within what is today the city of Oxford; all localities fell within a 9 km radius of the current city centre. Baxter made the majority (c. 44%) of his observations at the weekend, presumably because he was employed in other activities during the week. Baxter recorded plants by a mixture of common and scientific names. In total, he recorded 521 names, of which 512 can be assigned confidently to genera or species. The vast majority of records were of vascular plants, although Baxter recorded a few lichens, mosses, liverworts and stoneworts. Nine of Baxter's 1812 vascular plant records pre-date their earliest reported Oxfordshire occurrences (Killick *et al*. 1998): *Rumex pulcher* (Polygonaceae; previous first record: 1821); *Linaria purpurea* (Scrophulariaceae; 1831); *Blysmus compressus* (Cyperaceae; 1831); *Arctium minus* (Asteraceae; 1840); *Viola canina* (Violaceae; 1859); X*Festulolium loliaceum* (Poaceae; 1865); *Meconopsis cambrica* (Papaveraceae; 1880); *Epilobium tetragonum* (Onagraceae; 1880); *Agrostis gigantea* (Poaceae; 1883). Despite having studied the manuscript, Druce appears not to have incorporated the information into his *Flora of Oxfordshire*.

The localities Baxter visited have changed dramatically since his time, through the effects of land drainage, urbanisation and agricultural practice; transforming species' distributions. Seven of the species Baxter recorded are now considered to be extinct in Oxfordshire: *Botrychium lunaria* (Ophioglossaceae); *Drosera rotundifolia* (Droseraceae); *Tordylium maximum* (Apiaceae); *Gentiana campestris* (Gentianaceae); *Trifolium subterraneum* (Fabaceae); *Bupleurum rotundifolium* (Apiaceae); *Jasione montana* (Campanulaceae).

Baxter's manuscript is significant for the study of Oxfordshire flora since it contains detailed, dated, locality information by a young, accomplished botanist; an expert witness. For those interested in habitat change, the manuscript contributes to the evidence of decline in the agricultural, aquatic and semi-aquatic species in the Oxford area.

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Stephen A. Harris
Druce Curator of Oxford University Herbaria

Sherardian Library Reprints Collection

The Sherardian Library of Plant Taxonomy holds a reprint collection that numbers over ten thousand items and is accompanied by card catalogues for author and subject. A project is under way to concentrate the collection to the library's intended focus of Plant Taxonomy while also preserving papers of historical value, especially those relating to plant sciences at Oxford. The long term plan is to catalogue the material on Solo (Search Oxford Libraries Online). As a result, the collection should become more relevant and easier to access, as well as releasing much needed space.

Eoin Davies
Graduate Library Trainee

News from the Herbaria

Fielding-Druce (OXF) and Daubeny (FHO)

2013, which is being reported on in this issue, again proved to be busy in the herbaria, with visitors not only from local organizations, but from other parts of the UK and many parts of the world. Individuals travelled from as far as USA, Canada, Brazil, Colombia, India, Turkey and Tasmania. It is gratifying to know that the collections can provide items of interest and usefulness to a wide range of researchers and artists from a broad range of disciplines, not only taxonomists! Another busy area of activity for 2013 was the processing of loans of specimens being returned to various herbaria after study in Oxford by members of the systematics research group, plus the processing of returned loans of OXF and FHO material.

Visitors

142 visitors came during the year and this included six group visits. In February a group of individuals from the general public came for a 'behind the scenes' tour which had been organized through the Oxford University Natural History Museum. In March, a group of students and their course supervisor from the Department of Continuing Education at the University, studying for a Diploma in Environmental Conservation, were given a tour. The focus of the tour was to elucidate the role of herbaria in environmental conservation, and how it could be used in conservation projects and research. Also in March, 28 people from the Friends of the Oxford Botanic Garden visited. The focus of this visit was to explain the early history of Oxford Botanic Garden, the role of the herbaria in plant collecting and the use of herbarium collections in modern plant sciences research. In July, Sarah Simblet, from the Ruskin School of Fine Art, brought a group of nine professional and amateur artists to see Ferdinand Bauer's drawings, watercolours and herbarium materials associated with the publication of the *Flora Graeca*. The group were part of a week-long international summer school focused on botanical drawing and came from a variety of countries including Canada, China, India and Australia, as well as the UK. One of the big attractions was the opportunity to see the material associated with the *Flora Graeca* and hear about the construction of this enigmatic volume. At the beginning of Michaelmas Term, eight students on the University's Graduate Training Programme were shown the herbaria and the significance of the collections explained as a potential resource for research. During December, three teachers plus nine A-level students (from Oxfordshire/Dorset) visited the Fielding-Druce Herbarium for a talk and demonstration about "The Victorian Collectors" as part of a "Wallace 100" day. The topics for the whole day were chosen to celebrate the life and work of Alfred Russel Wallace 100 years after his death. The event was organized by the Secondary Education Officer at Oxford University Museum of Natural History.

Jane Pottas, Juliet Brodie and Jo Wilbraham (Natural History Museum, London) made visits to collect data from the OXF seaweed collections. They gathered together similar data from national and regional museums in the UK and launched a website entitled "Seaweed Collections Online", where the amalgamated data can be viewed and analyzed. This can be found at http://seaweeds.myspecies.info/

Paul Harmes and Jessica Turner have been continuing occasional visits to locate records of plants from Sussex in the collections, and have now recorded more than 2,200 specimens mostly from the Druce Herbarium, plus a few from the Sherardian Herbarium. Artists Emma Reynard and Rachel Barbaresi made visits to look at specific plant specimens of a medicinal nature under the microscope. These they wanted to draw for a public art commission which was then to be installed in a new hospital in Aylesbury. One visitor came after seeing the exhibition in Banbury (see below for details) and this led on to the discovery that the herbaria also held material collected by Clarence Bicknell in the nineteenth century from France, Italy and Corfu. This was of much interest as the (newly formed) Clarence Bicknell Association is planning to commemorate the centenary of Bicknell's death in 2018.

After several visits, Professor John Edgington, the President of the British Pteridological Society, published *Who found our Ferns? A history of the discovery of Britain's ferns, clubmosses, quillworts and horsetails* (2013, British Pteridological Society Special Publication, No. 12), in which several of the fern specimens in the OXF pre-Linnean collections were highlighted.

Loans for exhibitions

We were pleased to work in collaboration with colleagues from the Oxford University Museum of Natural History and the University Museum of the History of Science in providing specimens for a special exhibition entitled '*Natural Histories*'. This exhibition, in the Museum of the History of Science Oxford, ran from 14 May to 29 September 2013. The items lent included botanical specimens collected by Carl Linnaeus, Johann Dillenius, Edward Lhuyd and Charles Darwin, an extinct legume species from the Azores, a rare British orchid, algae, fungi, carpological specimens and a wood block. These illustrated different aspects of natural history collections and how they have been interpreted and understood. The exhibition proved popular and later in the year it was set up again in the Banbury Museum. A bark specimen and herbarium specimen of *Cinchona* (quinine) were lent to the Bodleian Library, Oxford, for display in an exhibition entitled *'Great Medical Discoveries: 800 years of Oxford innovation'* to run from 21 November 2013 to 18 May 2014.

Loan material

During 2013, much material which had been loaned to other herbaria was returned to OXF and FHO. This consisted of 722 specimens in 22 different transactions. The returned FHO material included specimens of *Euphorbia* and *Uapaca* (Euphorbiaceae), *Podococcus* (Arecaceae), *Neostenanthera* (Annonaceae), *Lonchocarpus* (Fabaceae)

OXF specimen of *Vicia dennesiana* (Fabaceae) from the Azores – the species is now extinct
Photos © Oxford University Herbaria

The rare British orchid *Liparis loeselii* – sheet of specimens collected by Alfred Fryer in 1885 from the Druce Herbarium

and a new species of *Strophanthus* (Apocynaceae), plus 61 specimens collected by William Hawthorne in West Africa which had been named. These transactions included nine type specimens. A similar number of specimens were returned to OXF and included the following - *Scrophularia* (Scrophulariaceae), *Myosotis* (Boraginaceae), *Macleania*, *Psammisia*, and other miscellaneous Ericaceae, *Lundia* (Bignoniaceae), miscellaneous Loranthaceae, *Urtica* (Urticaceae), *Uapaca* (Euphorbiaceae), *Elytrigia* (Poaceae) plus miscellaneous Poaceae and Cyperaceae. On return, the OXF material included almost 16 % types. Nine specimens from the Sherardian Herbarium which had been collected by William Dampier in 1699 from the coastal area of Western Australia, then New Holland, were also returned from the Übersee-Museum in Bremen Germany, where they had been in an exhibition on '*Adventurers, Explorers and Researchers*'.

858 specimens, which formed part of 32 individual loans, were returned to loaning institutions throughout the year after completion of studies and publication of papers by members of the systematics research group. The material returned included specimens of *Amicia* (Fabaceae), *Mimosa* (Fabaceae) *Tecoma* (Bignoniaceae) and *Oxalis* (Oxalidaceae) which had been sent for study by Colin Hughes and Tiina Sarkinen. Also specimens of *Strobilanthes* (Acanthaceae), *Talinum* (Portulacaceae) and some *Convolvulus* (Convolvulcaeae) were returned after study by John Wood. A further 344 specimens of unnamed *Strobilanthes* (Acanthaceae) were received on loan for John Wood to determine. Selected specimens of *Convolvulus* and *Ipomoea* (Convolvulaceae) were received on loan for study by John Wood for the Foundation Monograph project and also a few sheets of *Salvia* (Labiateae).

New accessions

Many boxes of unmounted duplicates of African material were sent to FHO from WAG and three boxes were accessed during the current year comprising 323 specimens. This material consisted of miscellaneous species collected mainly from Gabon and Ethiopia and the majority were very proficiently mounted by a temporary student employee, Libby McGowan, in the summer vacation. Further duplicate material which had been collected from many different African countries was sent by WAG and this material is awaiting processing. New accessions to FHO also included an isotype specimen of *Faurea recondita* (Proteaceae), a recently discovered plant from the Kamdeboo Mountains of the Eastern Cape of South Africa, which was sent from NBG. Other accessions included specimens of *Lupinus* (Fabaceae) and a flowering specimen of *Hydrocarpus filipes* (Flacourtiaceae) collected in Malaysia by Caroline Pannell *et al*. The latter specimen had a flower attached being unusual, and this required extremely careful mounting!

New accessions to OXF included 58 miscellaneous species collected from the UK and Ireland by John Killick for the Druce Herbarium. Many of the specimens were new county records and at least four of these new records were collected from Oxfordshire between the years 2002 and 2007.

Serena Marner
Herbarium Manager

Oxford University Herbaria database and back issues of OPS at:
http://herbaria.plants.ox.ac.uk/bol/oxford

Imaging specimens with BRAHMS – two very different approaches

Typing in data from specimens is not the most exciting part of any botanical project. Nevertheless, for those wishing to take advantage of what a database can offer for curation and research, a minimum set of data fields must be entered and given that projects spend enormous amounts of time on this task alone, choosing the right approach is vital.

Many BRAHMS databases include images of living plants, linked to observations or vouchers. These images, taken on field trips, surveys or perhaps in a botanic garden, have multiple uses, for example helping with identification and publishing in field guides and websites. And of course, images of the plants with vouchers are a valuable addition to any herbarium database, providing instant viewing not just of the dried, dead plant but as it was before its demise.

Back in the herbarium, imaging specimens with cameras or scanners is, for many, an integral part of routine digitization, be this for types, image-loans, valuable historical material or the bulk imaging of an entire collection. Data are often entered directly from images of specimens and/or their labels and this approach is gradually transforming the business of data capture. With good specimen/label images, projects can then decide how, where and when the data are typed and which fields they really need to enter, leaving some, such as lengthier field notes, to read from the images, saving much time on the typing. And as long as the image is kept and linked to the specimen record, it will continue to serve as source for checking and providing (remote) quick access to the specimen. In the ideal world, all images would be taken with something like 600 dpi to allow the study of the minutiae of hairs and the features. But costs of taking and storing such images escalate. There's a trade-off between cost and image purpose.

A low cost and fast approach which has turned out to be very effective and used widely with BRAHMS, initially with the Brazil Amazonian regional herbaria has been to use a hand-held camera to image specimens and their labels at between 2 and 4MBs per picture. As a result, the main herbaria in this region are almost 100% imaged and databased. These images have proved invaluable for curation purposes, helping to clean up typing errors, misidentifications and the correct matching of duplicates. A trained technician can take as many as 1500 images per day. That's 750 specimens with separate label images. The same approach was used for the e-monograph of the Caricaceae where Fernanda Antunes gathered images from specimens on her various herbarium visits. The result with about 8000 images can be queried on http://herbaria.plants.ox.ac.uk/bol/caricaceae

Imaging is a trade-off between time, cost and an end-product that is 'fit for purpose'. The equipment used and resolution for imaging is very much up to individual projects. The hand held camera approach offers max versatility and speed especially when separately imaging labels. The tripod offers more precision and allows, for example, comparative measurement of morphological characters.

BRAHMS itself includes image management tools to assist with assembling camera images taking advantage of the label-specimen imaging sequence. Images are transferred from camera to a PC folder in groups, perhaps for a few hundred specimens and then appended to a new botanical record Rapid Data Entry (RDE) data entry file. Within the RDE file, images of the labels and specimens are easily viewed, often on a separate monitor, and various tried and tested functions are then used to assimilate and rename the image files normally using the label barcode or accession number. Over the years, RDE has evolved various standard features that help alleviate the pain of data capture. One of the key challenges has been to eliminate unnecessary typing by dynamically consulting existing database lists (taxa, places, collector names, habit categories and the like). But also to avoid the entry of data from specimens that have already been added, by checking the main collection file or even an external file with data from other herbaria. Such checks are automated as the user types.

The process of imaging and capturing data from images using BRAHMS is described in http://herbaria.plants.ox.ac.uk/bol/Content/Groups/brahms/Resources/EnteringDataFromImages.pdf.

A process recently developed by Picturae in the Netherlands has taken image-based data capture to an entirely new level, although only suitable for larger projects. Confronted with the task of imaging and databasing some 4 million specimens in nine months, the Netherlands adopted a commercial imaging process known in the Netherlands as 'Digistreet' (digital conveyor) upping the tempo from *Allegro to Prestissimo*.

Specimens are physically brought to the digitization room in their boxes and laid out on a conveyer belt. The species cover folders lead the way and these are given their own barcode. All specimens are barcoded – even if they have an existing barcode. The actual imaging is done using a

https://picturae.com/uk/projects/250-cultural-heritage-institutions/2350-herbarium-digistreet

high spec Nikon camera and importantly, the camera-related software reads the barcodes of the folder covers and specimens. The cameras image the specimen at about 300dpi. Multiple sheets are recognized by the camera using a colour coded disk added on the conveyor belt by the technical staff. The image file names are generated by the camera software using the new barcode. The conveyor/camera setup snaps away about 8,000 specimens per day and as they have three running at the same time, data and image totals build up fast. All yielded data are saved by the process in a CSV file.

Within BRAHMS, a new set of image management functions has been added to RDE to process the Digistreet files and images as fed from the cameras, preparing the way for fast data entry.

The CSV files are added to an RDE file using the import function provided and multi-sheet images are merged to a single record. Data entry is now performed in two stages: first the cover sheet data are used to enter the taxon name and geographic detail as available. After checking by control staff these data are then copied down the RDE file for all herbarium sheets within that cover. The cover records, no longer useful, are then deleted.

Records that show an old barcode next to the new one, are copied out to a separate file, since these records should already be in the Naturalis database and need no further entry. A separate RDE function is used to check these records, especially the identification. Mismatches between cover folder detail and the database ID are reported.

For all the new records, data are entered for selected fields from the sheet images. In the case of Naturalis, this task has been seconded out to a company based in Surinam where some 50 typists with two monitors each open the images in RDE and then enter the data. Quite a few data checking functions are performed along the way. Finally, these new records are imported to BRAHMS. If already stored, the details are updated.

All specimens now have a new barcode and a link to a barcoded BRAHMS folder record. As it happens, the boxes themselves are given a barcode and these too end up in the database. As a final step, BRAHMS generates a URL based on each image file name as Naturalis's images are all accessed via a URL rather than a physical file name.

The high speed Picturae Digistreet is only a temporal facility at Naturalis. All new accessions, or material coming back from loans, will be processed by Naturalis staff using a scanner. This scanner can process 2 - 3000 sheets a day with well-trained staff. An advantage of the scanner is that it can also produce scans of higher resolution, for instance 600 dpi scans of types for JSTOR.

***Denis Filer**, Plant Sciences, Oxford*
***& Jan Wieringa**, Naturalis, Netherlands*

Oxford Plants 400 *Heliamphora nutans* Benth. (Sarraceniaceae)

Lithograph of *Heliamphora nutans* (Curtis's Botanical Magazine, 1890, t. 7093)

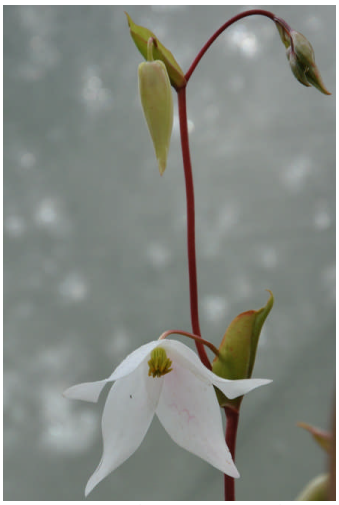
Specimen of *Heliamphora nutans* collected by the Schomburgk's from Mount Roraima in 1842-43 (Photos © Oxford University Herbaria)

Growing in the marshy highlands of the Guiana Shield, the pitcher plant *Heliamphora nutans* is intricately adapted to its environment. Produced by a 1.7 billion year old Precambrian sandstone formation in northeast South America, the Guiana Shield underlies Guyana, Suriname, French Guiana and parts of Brazil, Colombia and Venezuela. In 1978, Ken Burras (Superintendent of the Botanic Garden between 1963 and 1988) joined a Kew Expedition to Mount Roraima, Guyana; where *Heliamphora* was originally collected by the Schomburgk brothers in 1839. The Expedition returned with 400 plant collections, including *Heliamphora*. The Oxford Botanic Garden soon developed expertise in growing these challenging plants, but they were highly collectable, being rare in cultivation. Consequently, it was difficult to stop visitors from stealing them. In 1987, Ken passed some of the plants to the Micropropagation Laboratory of the Oxford Forestry Institute, formerly part of the Department of Plant Sciences. Led by Stephen Woodward, the team developed an efficient propagation process and was soon able to introduce the plant widely into cultivation. More importantly, sufficient specimens were grown to enable the plant's continuous public display at the Garden. Some of the plants growing at the Botanic Garden today are direct descendants of the original Mount Roraima collection.

In 1989, Oxford-based botanist Barrie Juniper and colleagues proposed four traits to define the true carnivorous syndrome. Plants (i) attract prey using special signals; (ii) trap and kill prey using specially evolved structures; (iii) digest prey by secreting enzymes; and (iv) have specialised structures to absorb nutrients from the digested prey, whilst the presence of commensals indicates a long evolutionary history of the carnivorous trait. Under this definition, *Heliamphora nutans* becomes a 'doubtful carnivore' since the presence of digestive enzymes in its pitchers has never been confirmed.

The pitchers are supremely adapted to catching insects. They have a red, sticky nectary zone right at the top containing two types of nectar glands. On the internal surface of the top-half of the pitcher is a zone of downward pointing hairs, surrounding a smooth attractive area. The pitcher constricts and then widens with the lower half covered in hairs, which become denser towards the bottom. It has recently been shown that when wetted these hairs become extremely slippery and that insects "aquaplane" into the pitcher, thereby increasing the trapping efficiency. Each pitcher also has an overflow mechanism; a drainage hole at the constriction between the top and bottom halves.

***Alison Foster,** Oxford Botanic Garden*
http://herbaria.plants.ox.ac.uk/bol/plants400



Heliamphora nutans flower in the Oxford Botanic Garden (March 2014)

This page shows the work of four of the team from the Oxford Botanic Garden and Harcourt Arboretum Florilegium group (see page 3), clockwise from top left - *Asphodeline lutea* (king's speare) by Tracy Howell, *Atropa belladonna* (deadly nightshade) by Gaye Norman, *Euphorbia pasteurii* by Penny Gould and *Nymphaea x daubenyana* by Maggie Fitzpatrick. Copyright with individual artists.