Oxford Plant Systematics

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

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Widespread mistaken identity in tropical plant collections

Natural history specimens showing: top left – herbarium collections in Oxford University Herbaria (OXF); below - seed and fruit collections (FHO) © John Baker, Oxford Plant Sciences. Top right - diversity of plant herbarium specimens © Royal Botanic Garden Edinburgh.

Foreword

This year's issue of OPS provides plenty of food for thought as it highlights the central role of the specimen in botanical research.

Twenty-five years ago three Australian biologists asked the question about the contents of herbaria: 'what would be lost if label data were recorded, a careful selection of sheets kept and the rest pulped?' (*Nature* 346 (1990): 602). The question provoked a flurry of letters to *Nature* (e.g., 347: 222-224, 704) from the leaders of international biological collections and scientists involved with specimen-based research. Today, biological collections are being used in manners that were only being dreamed of in the early 1990s.

The research of Robert Scotland, his students and collaborators, highlighted in this issue of OPS, shows herbaria are not even in a position to be able to make the 'careful selection'. The level of mis-identification in herbaria estimated by Zoë Goodwin is sobering for curators but must also be a note of caution for users of specimen-based data; *caveat emptor*. David Harris makes the point that hard-pressed curators must find the resources to make the specimens in their collections available, reduce backlogs by getting specimens into cupboards and undertake housekeeping activities so specimen labelling is kept up to date. Annotations by taxonomic specialists enhance the quality of herbarium collections.

Rapid and effective access to specimen-based data and images is also important for Foundation Monographs. Wholesale collection digitisation makes specimens readily available to large numbers of different users, increasing the teaching and research value of the collection. Yet to achieve this there must be significant investment in digitisation. Furthermore, there will be significant costs associated with annual storage and security of data and images, not to mention periodic changes in technology. Collection digitisation must happen to make data available but it must be nuanced and it must be sustainable. At the same time, physical specimens must also be maintained, and systems put in place that prevent curation of the digital and physical collections diverging.

To John Wood's point of view one may also add the importance of editors ensuring types for new taxa have been deposited in the herbaria stated, and these types are made available for critical study by other researchers.

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Typesetting and layout of this issue of OPS by Serena Marner

News

Innovative Plant Diversity Research: a new website for the Oxford University Herbaria

A new website was launched for the Oxford Herbaria and our plant diversity research team. The site provides an overview of activities, people and publications as well as digital access to our botanical specimens, images and illustrations.

There are detailed pages on the integrated research areas of taxonomy, phylogenetics, species discovery, botanic survey, bio-quality, the BRAHMS project, plant ecology, biogeography and field guide preparation. The central role of specimens in research is stressed.

Access is provided to all our published newsletters, the Oxford Tropical Forest Paper series and the Plants 400 website. Our digital herbarium data, images, illustrations and paintings are searchable with cross referencing to the historical collection databases, the fossil collection and the xylarium. Our current team members are listed on the People page and the taxonomy research page lists some of our alumni. Website address: http://herbaria.plants.ox.ac.uk/bol/oxford

BRAHMS v8

The next generation of BRAHMS software is well on the way. BRAHMS v8 is being developed for collection managers in herbaria, botanical gardens and seed banks; plant taxonomists; and those working broadly on the study of plant diversity. For the latest developments, see http://herbaria.plants.ox.ac.uk/bol/brahms/Software/v8

Denis Filer

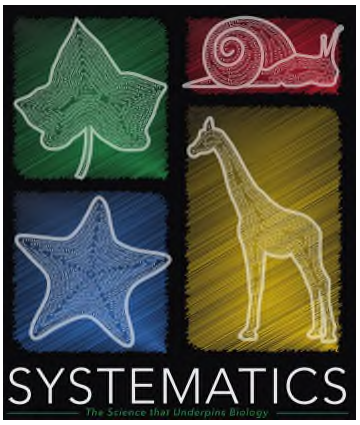
Media coverage

Stephen Harris was interviewed about seventeenth-century plant collections as part of a BBC television series *The Secret History of the British Garden*. He also appeared regularly on BBC Radio Oxford talking about plants as part of Plants 400 http://herbaria.plants.ox.ac.uk/bol/plants400, a joint project between the Herbaria and the Oxford Botanic Garden and Harcourt Arboretum. Stephen's popular book on the importance of plants for people, *What have plants ever done for us? Western civilization in fifty plants*, was published in 2015.

William Hawthorne has been discussing his latest research. 'Relationships' part 1 – People and plants: balancing conservation and commerce.

How can working with people to understand how they use their local plants be used to protect them when industry moves in? How do we find and conserve areas of high 'bioquality'?
http://oxfordsparks.ox.ac.uk/content/big-questions-relationships-1-people-and-plants-balancing-conservation-and-commerce

Systematics Association Conference



In his capacity as President of the Systematics Association **Robert Scotland** organized the 2015 Systematics Association Biennial Conference in Oxford. This took place during August 26-28th, hosting 225 delegates from more than 20 countries presenting 80 talks and 70 posters. The theme of the conference was 'Systematics: the science that underpins biology' and comprised four thematic sessions on ecology, evolutionary radiations, fossils and taxonomy. The conference was held at the University of Oxford Museum of Natural History with the conference dinner being held at Christ Church College. During the conference delegates were able to view Ferdinand Bauer's paintings for the *Flora Graeca* at the Sherardian Library in the Department of Plant Sciences. The conference also hosted a BioSyst EU council meeting, the umbrella body for Systematics Associations across Europe.

Visits and workshops

John Wood made two visits to the Americas in 2015 to look at specimens of *Ipomoea*. In March he visited Arizona to see specimens sent from across the Americas for study by the late Dan Austin, an expert in the genus. This visit was particularly useful in clarifying the identities of species from northern Mexico. In November John visited Cuba, an island outstandingly rich in endemic species of *Ipomoea*. Although field work was not possible, extensive material of the nearly unknown *Ipomoea montecristina* Hadač was found, a new species was discovered and several problems related to species collected by Eric Ekman and described by Ignatz Urban were resolved.

William Hawthorne and **Cicely Marshall** gave Rapid Botanic Survey (RBS) training and education in Africa in 2015. The first three-day RBS workshop took place for foresters and botanists on the Shire River Basin Project at the Zomba Herbarium Malawi in May. This was supported by the World Bank and entitled 'Strengthening the information base of natural habitats, biodiversity and environmental services in the Shire Basin, Malawi'.

In November, at the Yaounde Herbarium Cameroon, they gave an RBS presentation and bioquality training for botanists working in Cameroon on an RBS survey of Nguti. It was part of a European Forestry Institute (EFI)-funded project entitled 'Improving the transparency in spatial planning of commodity production in the context of palm oil development in Cameroon'.

Caroline Pannell continued her visit to Berlin Botanischer Garten and Botanisches Museum until July 2015, visited the herbarium of the University of Michigan, Ann Arbor (MICH), and New York Botanical Garden (NY) in September 2015. In November 2015 she was the guest of Colin Hughes at the Institut für Systematische Botanik, Universität Zürich, for three days. She determined the entire holdings of *Aglaia* in Z. The curator, Reto Nyffeler structures digitization efforts of the herbarium as 'manageable' projects and focuses on groups to which Z can add information in the form of expert annotations. As a result of Caroline's visit, he will digitize and publish their *Aglaia* collection during 2016.

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Student reports

Zoë Goodwin (D.Phil., 4th year) Completing the global inventory of plants: species discovery and diversity

Supervised by Dr Robert Scotland (Oxford) and Dr David Harris (Royal Botanic Garden Edinburgh)
NERC funded

This year part of my thesis was published in *Current Biology*. In the paper I examined the complete determination history of all specimens in the genus *Aframomum*. I did this by recording all of the species names applied to each specimen, the authors of the determinations and dates of the determinations from every single determination slip on each duplicate of each specimen on loan at the Royal Botanic Garden Edinburgh (RBGE) for a recent revision by David Harris and Alexandra Wortley. By comparing all of the historical determinations made on each specimen to that of the determination of each specimen in the current monograph I was able to score each historical determination as being either correct (including basionyms), a synonym (heterotypic or homotypic), as indeterminate (specimens identified as *Aframomum* or Zingiberaceae) or as 'other' (any other status, including incorrect). Combining this determination information with the dates that the determination was made allowed me to graph the relative status of each specimen duplicate throughout history.

This produced two important results. Firstly, that at any given point prior to the monograph less than 50% of the specimens had the correct name. Until the 1970s less than 15% of specimens had the correct name, from the 1970s onwards the work of Lock, Dhetchuvi and Harris the percentage rose to 42%. Not all of the remaining specimens were incorrectly named, some were determined under synonyms and up to a third were indeterminate. Synonyms and indeterminate names are not wrong, but they are not correct either. Consider the value of these specimens for conservation assessments or species modelling, both sets of names mean large numbers of specimens are missing from analyses. Blind acceptance of the synonyms, by a non-taxonomist for example, gives the impression that there are multiple species rather than just one.

In my study I was only investigating tropical plants, however there is plenty of evidence that the situation is similar, if not worse, in other diverse groups, such as fungi and insects.

Many people see this result as a criticism of the curators of natural history collections; surely they cannot be doing their job adequately if such large proportions of collections do not have the correct name? Well, the complicated answer is that a curator's job is not to name collections themselves, but to manage the collections so that experts can visit and access the collections in order to produce taxonomic revisions of groups, such as the one studied here, and make new determinations on the specimens.

This is where the second result from my paper is important; that half of the specimens collected up to 2000 had been collected since 1970. This pattern is replicated in all the data sets I examined and in all specimens collected in GBIF. This huge increase in the numbers of specimens in natural history collections means collections are increasing faster than many experts can cope. Overall this is positive: the more specimens we have for a species the more we understand that species, both in form, natural history, ecology and distribution. This is especially important given the evidence we have inadequate numbers of specimens for many tropical plant species.

These two results mean the roles of natural history curators and taxonomic experts are more important than ever in the current biodiversity crisis. Rather than being complacent about our existing knowledge of the natural world we have ever more species to discover and to understand. And that information is held within the specimens in our natural history collections.

Goodwin, Z.A., Harris, D.J., Filer, D., Wood, J.R.I., Scotland, R.W. (2015). Widespread mistaken identity in tropical plant collections. *Current Biology* 25: 1066-1067.

Cicely Marshall (D.Phil., 3rd year) Do hotspots of species endemism promote novel lineage diversity?

Supervised by Dr Stephen Harris (Oxford) and Dr William Hawthorne (Oxford).
Funding: Clarendon Scholarship and Merton College.

My interest is the Upper Guinean angiosperm flora, in particular its endemic elements. My aim is to draw on biogeographic, phylogenetic, ecological and taxonomic methods to illuminate the origins, diversification and botanic relationships of the Upper Guinean forest flora.

I have spent the last year assembling a large database of African plant distributions, with thanks to collaborators at the Conservatoire et Jardin Botaniques de la Ville de Geneve, University of Bonn and the National Hebarium of the Netherlands. Our database now holds more than 97,000 species and infraspecific taxon names, and more than 3 million distribution records.

Our current focus is to map bioquality hotspots across tropical Africa, using this

database. Identifying hotspots of biodiversity is an established way to prioritise areas for conservation, but is also a valuable tool in land use planning, especially in high biodiversity areas. Our approach relies on scoring each component species of a community for its global range ('Star rating'), and then calculating the proportion of globally rare species in each plant community. This metric, called the Genetic Heat Index, is a weighted range size rarity index, where rarity is measured globally.

Species name and location data were substantially checked and cleaned. For records without coordinates, the text locality information was parsed to assign bounding box coordinates. For records with coordinates, the text locality information was also parsed, and compared against the coordinates to identify internally contradictory records. All analysis and mapping was conducted by fitting the records' bounding boxes inside the sampling areas of interest, so that the geographic resolution at which the record was collected could be respected.

Our metric is based on a proportion, so the same metric can be calculated at any scale, giving it applicability in local land management scenarios as well as highlighting broad regional or global patterns. Each species is assessed for its global range before proportions are calculated, so the system can bridge the gap between species-specific valuations of biodiversity, and the biodiversity value of ecosystems at different scales. Our metric is continuous, so we can avoid the binary 'hotspot/not hotspot' distinction which can leave areas falling foul of a threshold.

We accept as a premise of the system that the data is never complete, and so the system is built to be flexible in the light of new information. The proportion of globally rare plant species in a flora is by no means the only important factor when designing a land management plan, but it is an important one.

Juan David Beltrán (D.Phil., 3rd year) **Ecology and evolution of CAM in the montane genus *Puya* (Bromeliaceae)**

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

Crassulacean acid metabolism (CAM) is a photosynthetic pathway used by nearly 6% of vascular plants. CAM plants fix CO_2 at night and maintain their stomata closed for most of the day, thereby minimising the amount of water lost in transpiration. Therefore, CAM is considered to be a water-saving mechanism representing an adaptation to dry and warm environments. However, there is no formal definition of the climatic niche of CAM plants and the environmental variables that distinguish it from the niche of C_3 plants.

Puya (Bromeliaceae) comprises about 230 species, and is found from central Chile to Venezuela and Costa Rica. The genus is predominantly Andean, but extends from sea level to 5000 m. Surveys of carbon-isotope values, show approximately 20% of *Puya* species are CAM plants; usually at least ten are found at very high elevations (>4000 m). The aim of my project is to investigate the occurrence of CAM in *Puya* to define the climatic niche in which this mode of photosynthesis is favoured and thereby to formulate a hypothesis about the ecological and evolutionary significance of CAM.

I have analysed the climatic niche of CAM and C_3 species in *Puya* using georeferenced herbarium records. After quality control, I compiled a set of 433 herbarium records representing 149 species. CAM species of *Puya* are largely restricted to the central Andes and the lowland regions of northern Chile. More importantly, temperature and elevation are not major contributors to predicting photosynthetic pathway, whilst aridity index, precipitation seasonality and actual and potential evapotranspiration ratio make major contributions.

To explain the apparent lack of CAM species of *Puya* in the northern Andes, I am exploring different hypotheses. The first proposes there is a lack of suitable CAM habitats in the northern Andes. However, ten different climatic niche models show, there are suitable regions in the northern Andes for CAM species. A second hypothesis is that the apparent lack of CAM species in the northern Andes is a result of sampling bias. During my last visit to the National Herbario in Colombia (COL) I sampled exhaustively the *Puya* species occurring in the northern Andes. The carbon-isotope values from these collections will contribute to understanding the apparent lack of CAM species in the northern Andes.

According to the carbon isotopes values, and based on the latest taxonomic review of Chilean *Puya*, the photosynthetic pathway of *P. alpestris* ssp. *alpestris* is C_3, whilst *P. alpestris* ssp. *zoellnerii* is CAM. I am currently analysing RNA-seq data from both subspecies to test the genetic differences between them. I will also measure day–night CO_2 exchange patterns, titratable acidity and enzymatic activity of both subspecies.

High-elevation CAM species of *Puya* are remarkable because they must fix CO_2 nocturnally at very low temperatures. My current hypothesis is that CAM species from higher elevations have molecular adaptations to fix CO_2 at very low temperatures compared to their counterparts at low elevations. Currently I am conducting experiments to investigate if cold tolerance in high-elevation CAM species is maintained after cultivation in common garden conditions. I am going to test the performance of the enzymes PEPC and PEPCK at low temperatures in CAM species of *Puya* from different elevations.

Claudia Havranek (D.Phil., 2nd year) **Agriculture and conservation in Oxfordshire**

Supervised by Dr Stephen Harris (Oxford). Funded by an Oxford-HDH Wills 1965 Charitable Trust Graduate Scholarship.

What could BREXIT mean for agri-environmental policy? The UK has as yet made limited progress towards its environmental commitments. With 70% of UK land devoted to farming, it is clear that agriculture must play a significant role in meeting these targets. But we do not currently have sufficient data to analyse how effective agri-environmental schemes in the UK are, nor how to go about improving them.

Current agri-environmental policy within the UK is determined by EU laws and directives. The upcoming UK referendum on membership to the EU provides the opportunity to consider if BREXIT would provide the freedom to make substantial changes to the UK policy, and help progress to these targets.

My work has focussed on evaluating current UK agri-environmental policies for their effectiveness in conserving plant diversity. I used data from fieldwork in Ditchley Park, Oxfordshire to evaluate how successful payments to farms for maintaining hedgerows and margins have been in encouraging floral diversity. By surveying the plant diversity found in margins, alongside key hedgerow characteristics, it was possible to identify the most important factors for plant diversity on farms.

This data can then be used to evaluate how effective agri-environmental schemes currently are, and goes some way in addressing whether EU-based agri-environmental policy is effective, both economically and environmentally. The data suggests that many factors which are thought to be environmentally friendly by the government, and which the government therefore financially incentivises, have negligible effects on plant diversity.

With UK government reports citing farmland as a target area on which to improve our progress to environmental commitments, further research is needed to evaluate how we can improve our agri-environmental schemes. The available data does suggest that current agri-environmental schemes are of limited effectivity. But we are not even close to having sufficient data to know how we might be able to change it.

Current agri-environmental policy within the UK is determined by EU laws and directives. The upcoming UK referendum

on membership to the EU provides the opportunity to consider if BREXIT would provide the freedom to make substantial changes to the UK policy, and help progress to these targets. Whilst leaving the EU would provide the opportunity for the change needed in agri-environmental policy, the question should not be "should we stay or should we go?" but "how, either in or out, could we have better policy?".

Pablo Muñoz Rodríguez (D.Phil., 1st year) **Systematics of the sweet potato and wild relative species**

Supervised by Dr. Robert Scotland (Oxford) and Dr. Steve Kelly (Oxford).
Interdisciplinary Bioscience Doctoral Training Partnership Programme, BBSRC.

Sweet potato (*Ipomoea batatas* (L.) Lam.) is one of the ten most important staple foods in the world, and produces more biomass and nutrients per hectare than any other crop. In recent times it has proved especially significant in addressing vitamin A deficiency in developing countries.

At a time when crop diversity is paramount for global food security, understanding the evolutionary relationship between crops and their closest relatives is of major importance because of the interest in wild species for breeding programmes. However in the specific case of sweet potato, most aspects of that relationship remain unclear, in part due to a lack of reliable taxonomic knowledge of its wild relatives. Therefore, the aim of this research is to resolve different aspects of sweet potato evolution, with a focus on the 15 putative species that are its closest wild relatives.

This research utilizes high-throughput DNA sequencing of a set of specimens representing the geographical and morphological variation of the species involved. These data form the basis of this project and will provide information on whole chloroplast genomes and a substantial number of nuclear genes. From this information we aim to identify suitable DNA regions to resolve the limits between individuals and species.

Tom Carruthers (D.Phil., 1st year) **Evolution of *Ipomoea* in the Neotropics**

Supervised by Dr. Robert Scotland (Oxford)
NERC funded.

I am interested in the evolution of plants over different spatial, ecological and temporal scales. For my D.Phil. I will be investigating the evolution of *Ipomoea* in the Neotropics.

The Neotropics contains particularly high plant species diversity, with different clades having an uneven distribution within and among the various Neotropical "biomes". With respect to *Ipomoea*, recent taxonomic work has highlighted that the genus is particularly species rich in the Neotropics, with two particularly interesting clades. One is located predominantly in Paraguay, in an ecologically heterogeneous region incorporating the understudied paraná, chaco and cerrado biomes. The other is centred in the Caribbean, but is considerably more widespread.

I have recently returned from a field trip to Paraguay, Bolivia and Argentina where I was able to increase the depth of sampling within these two radiations, record where different species were growing and observe the Neotropical biomes.

Based on the increased level of data now available for *Ipomoea*, I will construct a maximally resolved and robust phylogenetic tree for these two radiations to provide insights into the relationships within the two clades. The phylogenetic tree will be time-calibrated and constructed in conjunction with an analysis of the spatial distribution and ecological characteristics of different species.

This will enable me to answer questions such as: what are the distinctive evolutionary dynamics of the paraná, chaco and cerrado biomes of Paraguay and to what extent is dividing the region into different biomes relevant in this context? How do evolutionary transformations and their underlying processes differ between deeper (and more persistent) lineage divergences compared to more recent (and ephemeral) lineage divergences? What are the overall contributions of non-adaptive and adaptive lineage divergences and how do they differ at different spatial scales?

Gail Stott (D.Phil., 1st year) **Bioquality in Belize**

Supervised by Dr William Hawthorne (Oxford).
Funding: NERC Doctoral Training Programme
Gail has spent the last five months carrying out a Rapid Botanic Survey in Belize. Her aim is to increase the botanic distribution data available across the country, and to use this to inform better land management strategies. Her thesis will focus on using species distribution models to infer biodiversity hotspots in Belize.

Expedition and workshops in Ethiopia

In December 2015, Ben Jones, Curator of the University's Harcourt Arboretum and Kirsty Shaw, Conservation Officer, Botanic Gardens Conservation International, delivered a week-long workshop on establishing and maintaining conservation collections of endangered and important ecosystem trees.

With more than 46 critically endangered woody taxa in need of urgent conservation action in Ethiopia, tree species such as *Hagenia abyssinica* (Bruce ex Steud.) J.F. Gmel. and *Juniperus procera* Hochst. ex Endl., are of particular importance throughout the Horn of Africa (Ethiopia, Eritrea, Djibouti and Somalia). In this region of low forest cover, but high diversity of shrub and tree species, the remnant forest stands are adversely affected by anthropogenic disturbance and climate change. Land-use and frequently occurring droughts, reinforced by climate warming, result in a constant loss of forest habitats containing high diversities of trees and shrubs species. More than 90% of the total energy used in Ethiopia is produced from biomass, with fuelwood being the major component.

Hagenia abyssinica (Bruce ex Steud.) J.F.Gmel.

Botanic Gardens and Arboreta can contribute to plant conservation in many ways, including the production and dissemination of research leading to an increased understanding of plant diversity (Global Strategy for Plant Conservation (GSPC) Objective 1), the effective conservation of plant diversity (GSPC Objective 2), the promotion of education and awareness about plant diversity (GSPC Objective 4) and by ensuring the capacity for public engagement has been developed to implement the Strategy (Objective 5).

This week-long practical workshop took place at the Wondo Genet College of Forestry & Natural Resources, Ethiopia. There were 45 participants from Ethiopian Botanic Gardens, arboreta and similar institutions, and the training, as part of ongoing capacity-building activities, focused on key areas of collection management, including seed collection, propagation, nursery management and tree planting.

Workshop at Wondo Genet College of Forestry & Natural Resources, Ethiopia. Dec. 2015 (© Ben Jones)

The workshop served as a crucial networking opportunity enabling new partnerships to be made, friendships to be forged and collaboration between institutions. These links began the formation of a national network, which will encourage institutions to share plant material, providing increased security for target species by enabling more genetic diversity to be held within collections. Such partnerships also facilitate sharing of propagation and care tips, which can be critical for species where few individuals remain.

Participants worked to identify their core mission and develop a collection policy for their garden that reflected this mission. Each institution was encouraged to 'adopt' a threatened tree local to their botanic garden as a flagship for their institution, to drive the conservation mission of their gardens forward and generate wider interest and support for tree conservation locally. The skills developed during the training course will now be applied to these flagships to eventually prepare for population restoration programmes.

With the right support, a relatively easy step for botanic gardens and arboreta is to utilise their wealth of expertise and knowledge, for purposes of either in or ex situ conservation activities. From this knowledge base, expertise in horticulture, curation, species-based research, and educational displays can be used to broaden engagement, through outreach initiatives, joint projects and short courses.

Ben Jones
Harcourt Arboretum Curator

I joined the December 2015 trip to Ethiopia; this was my 43rd botanical expedition. For the first three days at Wondo Ganet I ran an introduction to botanical illustration course with seven enthusiastic participants: five university lecturers and two technicians. This was a forerunner to a longer course to be held later this year and my idea was to cover techniques of drawing, pen and ink work and watercolour; rather a lot for three days. With plenty of flowering plants on the campus, the participants were all puzzled that I gave them leaves to draw. There was a good reason for this, leathery leaves do not wilt and the correct representation of leaf characters is a good exercise in observation and accurate drawing skills.

On the second day I introduced the class to line drawings and covered the various techniques of working with pens. With the very limited range of art materials that we were able to purchase in Addis Ababa this was challenging. Next time, I will do all the shopping in Oxford!

For the final day I had made up little 'paint boxes' for each person and demonstrated yet more techniques, colour mixing and how to build up the colours with a series of light washes of paint. People were probably tired of green leaves by now so flowers appeared – and soon, predictably, wilted. All the participants had had very little experience of drawing but were keen to learn and persevered. At the end of the day they put on an exhibition of their work for Ben and Kirsty's students to see. I gave a short talk to the entire group explaining the importance of such a course, which should give botanists the necessary skills to illustrate their publications. One of 'my' students followed this up, stressing the need for a longer course.

After this I was free to paint. In the woodland above the campus we collected *Brucea antidysenterica* J.F.Mill.. The Scottish botanist James Bruce (1730-1794) was suffering from a common tropical complaint and was given tea made from the leaves of this tree which is reputed to have cured him. In many ways this first visit to Ethiopia could be regarded as a recce for me, to see a new flora and to start thinking about the range of educational posters that could follow. A botanic garden is in the process of being established in the nearby town of Shashemene. I painted three plants from there including *Vernonia galamensis* (Cass.) Less.. Although this species is common over northwest Africa, only in Ethiopia it is found to have certain oils present which are economically important in the production of household paint.

We had several stops during the journey from Wondo Ganet to Goba to collect typical Afro-montane species for me to paint, including *Hagenia abyssinica* (Bruce ex Steud.) J.F.Gmel.. Similar in size and shape to English oak, these trees were in full bloom with long, pendulous panicles of small, deep-pink flowers. I had by now purchased a piece of plywood for a drawing board and could easily work in the car at any time when Ben and Kirsty botanised. My 'studio', as in Bolivia with John Wood, was stored in my work bag and could be assembled in less than two minutes.

At over 4000 m, the air was cool in the Bala Mountains. The vegetation in this rather bleak landscape consisted mainly of small hummocks of helichrysums and occasional stands of giant lobelias, (*Lobelia rhynchopetalum* Hemsl.). We were extremely lucky to see and photograph one of the endangered Ethiopian wolves, which nonchalantly walked towards us and crossed the road just behind our parked car. The final two days were spent in a lodge on Lake Langano. This lake is too mineral-rich to support the snails which transmit bilhartzia and is the only one of the chain of Rift Valley lakes where one can safely swim – as long as you take care to avoid wallowing hippos.

Rosemary Wise
Botanical Artist

Below are three short commentaries covering the Goodwin et al paper and the foundation monographs of *Convolvulus* and *Ipomoea* published in *Current Biology* and *Kew Bulletin* in 2015 (see publications).

Half the world's natural history specimens may have the wrong name

As many as 50% of all natural history specimens held in the world's museums could be wrongly named, according to a new study by researchers from Oxford University and the Royal Botanic Garden Edinburgh.

Even the most accomplished naturalist can find it difficult to tell one species of plant from another or accurately decide which genus a small insect belongs to. So when a new specimen arrives at a museum, finding the right name from existing records can sometimes prove difficult. In turn, that can lead to specimens being given the wrong name – which can prove problematic for biologists.

'Many areas in the biological sciences, including academic studies of evolution and applied conservation, as well as achieving

the 2020 targets under the Convention on Biological Diversity, are underpinned by accurate naming,' explains Dr Robert Scotland of the Department of Plant Sciences at Oxford. 'Without accurate names on specimens, the records held in collections around the world would make no sense, as they don't correspond to the reality outside.' Dr Scotland also points out that the negative effects of this are increasingly multiplied as large databases are aggregated online, gathering together vast amounts of specimen data, many of which have incorrect species names.

So his team, which includes researchers from the University of Oxford and the Royal Botanic Garden Edinburgh, decided to carry out a formal study to establish just how bad the situation was. Gathering data into the Botanical Research and Herbarium Management System (BRAHMS), developed at Oxford by co-author Denis Filer, it was possible to compare and analyse the species names used on the sampled specimens. The team actually used three different approaches to work out how many mistakes there were likely to be.

First, they considered how the name of a single specimen might change over time. Over the years, specimens in museums gradually have their names reviewed, as scientists learn more about the family, or new specimens help to redefine an existing species. The team studied 4,500 specimens of the African ginger genus ***Aframomum***, a detailed monographic study which had been completed in 2014, providing an accurate account of all the species and their specimens. The team were surprised to find that prior to this monograph at least 58% of specimens were either misidentified, given an outdated or redundant name, or only identified to the genus or family. As few plant groups have been recently monographed, the team suggests that a similar percentage of wrong names might be expected in many other groups.

Next, the researchers considered how duplicated specimens from the same plant might be given different names in different museums. It is common practice for plant collectors to take several samples of a single plant and distribute these to museums and herbaria around the world. 'It's a bit like separating identical twins at birth,' explains Zoë Goodwin, the first author of the paper. Once distributed, they are often independently named by an in-house expert. Analysing the ***Dipterocarpaceae,*** a family of rainforest trees from Asia, the team found that 9,222 collections had been divided into two or more duplicates, making a total of 21,075 specimens. Of these, 29% had different names in different herbaria. 'And at least one of these names must be wrong,' points out John Wood, another of the authors on the paper.

Finally, the team considered mistakes contained within aggregated records stored online. They scoured the records of ***Ipomoea*** – a large and diverse genus which includes the sweet potato – on the Global Biodiversity Information Facility database. Examining the names found on 49,500 specimens from the Americas, they found that 40% of these were outdated synonyms rather than the current name, and 16% of the names were unrecognisable or invalid. In addition, 11% of the specimens weren't identified, being given only the name of the genus.

The team thinks there are three main reasons for these inaccurate names. First, they suggest that there simply isn't enough time or research devoted to writing monographs. Second, they point out that the number of specimens in the world is increasing too quickly for research to keep up – with 50% of the world's specimens in 2000 having been collected since 1969. And finally, there are now so many museums and herbaria around the world that experts cannot view all the specimens in a genus and revise the names accordingly.

But there is a more worrying problem underlying their snapshot of incorrect naming. Of 1.8 million different described species on Earth, 0.35 million are flowering plants and a further 0.95 million are insects. While Dr Scotland and his team have shown that the names of flowering plants are commonly incorrect, other researchers have shown that the insect kingdom is potentially in an even worse situation. 'We think a conservative estimate is that up to half the world's natural history specimens could be incorrectly named,' says Goodwin.

The team suggests that digitised specimens – that can be remotely accessed so that researchers anywhere can use them for species-level taxonomy – as well as DNA sequencing are two essential tools that can be used to improve the names associated with the world's natural history collections. But they also caution that these approaches will only improve the quality of naming if integrated alongside taxonomic projects. For their part, the team is already actively exploring new integrated approaches to taxonomy and has brought these techniques together into what they call 'foundation monographs'. They have recently published two such studies, for ***Convolvulus*** and ***Ipomoea*** in Bolivia.

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Oxford University News & Information Office

Are half the specimens in the herbarium at Edinburgh wrongly named?

Zoë Goodwin, who first arrived at RBGE as an M.Sc. student, became a member of staff, and is now a D.Phil. student (University of Oxford), has just published a paper on misidentifications.

In that paper two world-wide phenomena are quantified:

1. In large tropical plant groups most of the specimens in that group are unlikely to have the correct name unless the whole group has recently been revised by an expert.
2. The number of herbarium specimens worldwide is increasing exponentially.

If you had asked me, before Zoë's study, what percentage of collections had the wrong name in the herbarium I might have guessed it was about 20%, now I am sure it is well over half.

That will not be the case for some groups: the specimens from Britain and Ireland will mostly have the correct name. Similarly the folders from areas where there has been a recent Flora written by botanists based in Edinburgh will contain a high proportion of specimens with the correct name. The plants of Turkey, Bhutan, Nepal, Chile, the Arabian Peninsula and Socotra may need some updating but for the most part they are internationally important collections with a high proportion of names following the latest taxonomy. Certain groups such as conifers, *Rhododendron*, *Begonia*, Gesneriaceae, Zingiberaceae and Sapotaceae will also be well named, due to the years of in-house taxonomists and visiting experts checking them. But apart from the other groups for which an expert has seen all the specimens – and perhaps the specimens from the living collection at RBGE – the rest have less than a 50% chance of having the correct name.

So how does that make me feel? Isn't it my job as the curator to make sure the specimens have the right name?

That is a common misconception: "large natural history collections have to have the most up-to-date name to be useful". Not at all! The real function of these collections is to allow specialists to generate the most up-to-date names and understanding of plants for society. Lots of unnamed specimens in the herbarium mean lots of new information. The specimens are there to be identified, renamed, analysed and synthesised to give us new and better knowledge of our green planet.

In addition – given the dynamic nature of our understanding of plants and fungi in so many parts of the world, it would be a waste of time for a curator to try to name three million specimens. Our job as curators is instead to make sure the specimens are in the right family and the right genus so that when the expert wants to consult them she or he can find them.

There is one task we curators need to allocate more time to, taking recent monographs and revisions and to update specimen names from those publications, if the specimens in our herbarium were not annotated by the taxonomists who wrote the books.

Give me your misidentified, your undetermined, your piled masses of

specimens yearning to be named (with apologies to Emma Lazarus) – *we will put you in the cupboards and have you waiting and ready for the next specialist to work on you.*

David Harris
Royal Botanic Garden Edinburgh
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Diversity of herbarium specimens © Royal Botanic Garden Edinburgh

Creating a fast-track for accurately classifying plants: Foundation Monographs

It can take botanists decades to accurately classify plants after they've collected and stored away samples from the wild. But now Oxford University researchers have developed a technique to try and streamline the process.

In 2010, researchers from the Department of Plant Sciences, led by Dr Robert Scotland, published a paper that investigated how long it takes for plants to be described after they've been first collected. The results came as a surprise: it turned out that just 14 percent of specimens were described within five years, and on average it took 35 years for specimens to be recognised and described as 'new'. 'People might imagine that researchers venture into the wild, point at something and say "that's new",' explains Dr Scotland. 'But it doesn't work like that: mostly they get collected and added to collections, then they're discovered at a later date.' All the while, then, collected flowers sit dried and mounted and stored in herbaria. From their figures, the team estimated that of the 70,000 species of flowering plants thought to remain un-described, up to half may in fact sit in collections awaiting discovery. Given the rate of discovery currently averages around 2,000 flowering plant species per year, the team vowed to investigate whether there may be a way to expedite the process.

Generally, botanists perform one of two types of study to describe species in a given genus. The first, called floristics, is performed in a limited timeframe and describes all plant species in a particular country or region, using short descriptions and simple illustrations with generally no assessment of phylogeny or DNA sequencing. The second, referred to as the monographic approach, takes a global view of all the species in a given genus, accurately demarcating each species and providing comprehensive descriptions, genetic analyses and detailed illustrations.

The latter is considered the gold standard in botanical taxonomy, not least because it provides a reliable means of identifying redundancies (synonymy) in existing classifications. But comprehensive monographs take a long time to produce and involves intensive study. 'It would be lovely to monograph the whole world, but that's a pipe-dream,' explains Dr Scotland. 'Especially in the tropics, where there are too many plants, written about in too many places, often in too many different languages, with too much redundancy in existing names. The size of the task is just too big.'

Instead, the team thought there could be middle-ground between the two approaches. 'We wondered if we might be able to combine some of the speed of a floristic approach with some of the rigour of a Monograph,' explains Dr Scotland. 'And we've ended up with what we call "foundation monographs".' The new approach combines the time-limited approach and short descriptions of a flora with the DNA, phylogeny and fieldwork of monographs, enabling species to be uncovered quickly, but accurately.

With a year of funding from Research Councils UK's Syntax program, Dr Scotland's team that included the experienced taxonomic botanist John Wood, performed a one-year pilot study to create a foundation monograph for *Convolvulus* (bindweed). It worked well: in 12 months, they accounted for 190 species, including 4 new species.

That was enough to help them secure a larger grant from the Leverhulme Trust to perform a three-year study of the *Ipomoea* (morning glories), a genus that includes the sweet potato. Taking 1,500 samples from around the world, they sequenced DNA from the samples to refute or corroborate existing species concepts. In the first published part of the study they described 18 new species of *Ipomoea* from Bolivia, accounting for 102 separate species in that country which was a five-fold increase from what was known at the time of the last compilation.

As far as Dr Scotland is concerned, we're likely to see more species being identified like this in the future. 'We're probably seeing the end of the traditional approach to botanical taxonomy,' explains Dr Scotland, 'the world has enormous taxonomic problems and to tackle them we need to adopt new working practices and methods for speeding up the taxonomic process'.

An Oxford Science blog
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Where accuracy obscures truth: a point of view

In recent years my attention as a writer and reviewer of taxonomic papers has been drawn to three areas where the search for precision is obscuring the truth and leading to error. In all cases this is partly the result of fashion and partly a response to the demands of reviewers and journal editors.

1. The inclusion of precise coordinates using a GPS with specimen citations. There is, of course, nothing wrong with this so long as the coordinates were recorded at the precise point at which the plant was collected, but how often is this the case? I recall my frustration at trying to refind a species of *Salvia* based on the cited degrees, minutes and seconds only to find out subsequently that the same precise coordinates were used for all collections made over a trajectory of several kilometres. This may be an extreme example but I would wager that three quarters of all GPS coordinates made by a group travelling in a car were taken at the place where the car stopped, not the place where the plant was collected. The same thing would probably be true of a base camp from which collectors went out to bring back specimens to be included as part of the day's "catch". Very few collectors in a group would have their personal GPS or be systematic enough to record data for each collection made. If my observations are correct it is likely that over 90% of recorded GPS coordinates are inaccurate at least as regards the "seconds" recorded. My own suggestion is that coordinates should be 'corrected' to degrees and minutes only with seconds given to a single decimal place unless the collector specifies that that the collection was made from a single specimen at the precise recorded GPS reading.

2. Conservation assessments. Most reputable journals now require authors to provide conservation assessments for any species described in a paper. This is required for new species and is particularly deleterious in this case. The correct assessment in the case of almost every new tropical species is Data Deficient within IUCN guidelines as it is likely to take many years to establish the true distribution of a species after its first description. Yet editors and reviewers often insist on authors applying mathematical assessments based on Geocat to establish areas of occupancy and areas of occurrence, assessments often based on a few records

and which can take no account of the complex mosaic of habitats either in mountainous areas such as the Andes or in savannas such the cerrado or chaco biomes. In many cases the area is poorly explored botanically and even when well-known very few botanists are able to reliably identify poorly known species so plants are often under-recorded. Any attempt to assess potential presence is equally likely to be flawed, as most 'potential distributions' I have had a chance to review accord poorly with the reality of a plant's true distribution. Consequently most of the published assessments can only be regarded as provisional, if not downright wrong. Should all new tropical species be assessed as Data Deficient? Possibly, but that does not preclude an author with good field knowledge making a provisional assessment based on observations which would provide some understanding of the likely threat to a species, as well as the size of its population. Informed comments of this sort are nearly always a more reliable and more informative assessment of conservation status than a mechanical assessment of area of occupancy or occurrence.

3. Typification. Several journals and some Flora projects are now demanding that all cited names are typified, thus obliging authors to lectotypify or, if necessary, neotypify names which lack a unique holotype. It is argued that this will eliminate ambiguity in the application of names, thus advancing scientific precision. Unfortunately this presupposes that the author has a good knowledge of the original author's methods, handwriting, access to type material, as well as a comprehensive knowledge of the genus or family they are writing up. Unfortunately this is not always the case. A writer of an account for the *Flora of Argentina*, for example, may have expert knowledge of Argentinian plants and issues related to the typification of plants described by authors who worked on the Argentinian flora. However this does not hold good for their knowledge of the typification of plants introduced from other countries. Authors are thus being obliged to make typification decisions for which they are not equipped. While this will no doubt increase the need to publish corrections and secondary lectotypifications, it is hardly desirable or wise. It would be much better to allow authors to make well-founded decisions on lectotypification where they feel able but not to oblige them to make premature and often incorrect decisions.

These are just three areas where our obsession with precision is resulting in the multiplication of errors. I would urge writers, editors and reviewers to adopt a more flexible approach to all these issues. Truth should not be sacrificed to the god of precision.

John R.I. Wood
Research Associate

Illustrations in the Morisonian Herbarium

Planting the Oxford Physic Garden began in the early 1640s with the appointment of Jacob Bobart the Elder, and subsequently his son, also called Jacob. The Bobarts appear to have used herbarium specimens as permanent records of the plants growing in the seventeenth-century Garden, and to record the diversity of plants being returned to British shores. The Bobarts built three separate herbaria during their stewardship of the Garden: Bobart the Elder's Herbarium; Bobart the Younger *Hortus Siccus* (Harris, 2006); and the Morisonian Herbarium (Vines and Druce, 1914). Until Bobart the Younger's death in 1719 these herbaria were the Bobarts' private collections but were treated as the *de facto* herbarium of the Physic Garden; they are the founding collections of Oxford University Herbaria. The Bobart's herbaria were significantly increased in size and quality with the bequest of William Sherard's herbarium to the University in 1728. Sherard's interest in plants and herbaria had been sparked by Bobart the Younger in the 1680s, when he was an undergraduate studying law.

Until the end of the eighteenth century, the University's herbaria were housed in the private accommodation of the Sherardian professors. Eventually, short-lived herbarium space was found by converting the eastern conservatory in the Physic Garden. However, the space was needed for other things so in the early nineteenth century there was a 'Room for Seeds & Herbarium', which backed onto a garden shed, on the banks of the River Cherwell (Daubeny, 1850). In 1852, the then Sherardian Professor, Charles Daubeny, convinced the University to accept the herbarium and library of Henry Fielding (Daubeny, 1853). Fielding had spent much of his inherited fortune accumulating one of largest personal herbaria in the Victorian world. Overnight, Fielding's herbarium tripled the size of the Garden's herbarium, thrusting it once again into the top rank of the world's collections. The Fielding Herbarium got a new home in the converted western conservatory. Since 1951 the herbaria have had purpose-built accommodation in the Department of Plant Sciences, outside the Garden.

The first Fielding Curator, Maxwell Masters, was appointed in 1853, but resigned after about three years. Subsequent care of the herbarium was sporadic. No Fielding Curator was appointed again until 1886, when Selmar Schönland arrived but he remained in post for only three years. The post was vacant until George Claridge Druce became honorary curator in 1895 (Harris, 2007). With no one to look after it, the conditions under which specimens were kept had deteriorated; curation was only taken seriously under Druce's stewardship.

Druce was complaining about the difficulty of accessing material in the herbaria and the general conditions under which the material was stored. Druce's concerns over the conditions are borne out by the substantial amount of water damage suffered by sheets in the Morisonian Herbarium and the amount of remedial conservation work that has been necessary during recent digitisation work.

The Morisonian Herbarium was created by Bobart the Younger to illustrate Robert Morison's *Plantarum Historiae Universalis Oxoniensis* of which only Part 2 (1680) was published in Morison's lifetime (Mandelbrote, 2015). Part 3 (1699) was completed by Bobart the Younger, whilst Part 1 was never completed, although herbarium specimens were amassed. Despite its name there is no evidence Morison was involved in making the Morisonian herbarium; the name comes from the ordering of part of the collection. However, it is evident the herbarium was added to after Bobart the Younger's death.

The Morisonian Herbarium comprises more than 7,000 herbarium sheets collected from across the then known world. Bobart the Younger experimented with multiple methods to record the diversity of plants with which he was familiar. In addition to herbarium specimens, 290 sheets either have illustrations attached or are solely represented by an illustration. Five types of illustrations are represented: pen and ink drawings, pencil sketches, engravings, water colours and nature prints. The vast majority of these illustrations appear to have been made in the late-seventeenth century or early eighteenth century.

Engraving of 'Helichrysum sive Chrysocome frutescens latifolia flore corymbifero, toto aureo' (Helichrysum orientale (L.) Vaill.; Mor_III_086_01) associated with Morison (1699, Section 7, tab.10)

Pen and ink drawing of ‘Scorzonera humilis Syriaca, sinuata, flore subcaeruleo’, probably by Bobart the Younger, together with fragments collected by Huntingdon in Aleppo, Syria (*Reichardia tingitana* (L.) Roth. Mor_III_083_20b)

There are 23 engravings from more than four separate sources. At least two of the illustrations (Acc. No: Mor_III_086_01; Mor_III_356_24) appear to be versions of engravings eventually published in Morison’s *Plantarum Historiae Universalis Oxoniensis* (1699). At least three artists contributed to the 119 pen and ink drawings. One of the artists, thought to be Bobart the Younger (e.g., Mor_III_018_30 and Mor_III_344_01b), copied images from published sources or unpublished manuscripts (e.g., *Codex Comptoniana*) or used images to show the form of plants for which only fragments of material were available (e.g., *Thelypteris tetragona* (Sw.) Small; Mor_III_575_08). In other cases, pen and ink drawings represent plants that are difficult to preserve or which lose their form when dried, e.g., Cactaceae (*Mammilaria* sp.; Mor_III_171_08) and succulent Euphorbiaceae (Mor_III_345_07). The 62 pencil sketches and five water colours are used in similar ways to the pen and ink drawings; most of the sketches appear to have been done by Bobart the Younger.

Of greatest interest among the illustrations in the Morisonian Herbarium are the 81 nature prints. Dresser (1857: 285) explains the simple procedure as it was applied as early as the 1650s: 'the plant, after being dried, was held over the smoke of a candle or oil lamp, when it became blackened by a deposit of soot, after which it was placed between two sheets of paper and rubbed with a smoothing-bone, which caused the soot to leave the prominence of the leaf and adhere to the paper. In this way an impression of the plant was produced'. By the end of the nineteenth century, nature printing had come to mean the process of creating a printing plate directly from a natural object (Cave, 2010). These nature prints were presumably done by Bobart the Younger.

Bobart appears to have experimented with nature printing for a brief period to record botanical diversity. We do not know the precise time in which this experimentation occurred but it is likely to have happened early in the eighteenth century. Unfortunately, specimens represented only by nature prints are generally impossible to identify with certainty.

In 26 cases, the whole plant specimen is represented only by a nature print, e.g., 'Tussilago Alpina folio oblongo' (Mor_III_130_03). In a further 26 cases, the nature print of the whole plant includes fragments of dried specimens, such as flowers and leaves, e.g., 'Anemone tenuifolia multiplici' (Mor_Misc_0591). Bobart's experimentation with nature printing included 26 specimens represented by leaves only, e.g., 'Althaea arborescens amplissimo folio incano et hirsuto' (Mor_Misc_0539). One particularly delicate specimen used by Bobart the Younger was the flower of *Gloriosa superba* (Mor_Misc_1599), though it is unclear whether the specimen was raised in the Physic Garden or received as dried material from India or elsewhere. The two most frequently represented families are the Asteraceae (10 specimens) and Apiaceae (8 specimens). Many of the Asteraceae are represented by flowering or fruiting specimens, whilst the Apiaceae are primarily represented by basal and cauline leaves.

Nature print and specimens of ‘Anemone villosissima alba’ and ‘Anemones tenuifolia multiplici’ (*Anemone* sp.; Mor_Misc_0591)

All of the nature prints are made from separate specimens, except two. The same specimen, collected from the Leiden Botanic Garden, was used to produce two separate images: 'Bryonia aspera Zeylanica' (Mor_Misc_0732, Mor_Arb_0434_v). Unsurprisingly, the specimens used to create the nature prints were not preserved in the collection.

As a technique for the scientific recording of plant diversity and enabling identification of critical taxa the nature print method proved to have limited value. Bobart the Younger clearly found the procedure unsatisfactory as the herbarium comprises only a tiny proportion (c. 1%) of nature prints. Despite their limited scientific value, some of Bobart’s nature prints have great aesthetic appeal.

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Stephen A. Harris
Druce Curator of Oxford University Herbaria

German contributors to Oxford University Herbaria

When asked to give a talk to the Anglo-German Society on the theme of German-born collectors in Oxford University Herbaria, it was surprising to discover just how much influence Germany has had on the collection. The connections go back to the beginning of plant-based studies in Oxford in the seventeenth century. The first Keeper of the Oxford Physic Garden, Jacob Bobart the Elder, was German. He took up his post at the Garden in 'about' 1641 and appears to have begun making plant specimens soon after; many have survived to the present day. In the eighteenth century, the first Sherardian Professor of Botany was appointed; this was Johann Jacob Dillenius a German from Darmstadt. When looking through a list of collectors whose specimens form part of the herbaria over the last four centuries, it became apparent that there were many German explorers, plant hunters and naturalists whose specimens and books are found here; in fact over one hundred. For much of the period covered Germany included a series of regions, and therefore contributors may have been born in Prussia, Saxony or Bavaria. The specimens arrived in Oxford by different routes and come from all continents apart from Antarctica. Some of the most significant characters are mentioned below.

Jacob Bobart the Elder (1599-1680). Born in Brunswick, he was a successful, self-taught gardener who had learnt English and some Latin. He was also a very well-known auricula breeder. By 1648 he had stocked the Physic Garden with about 1600 plants, and a catalogue of the plants growing therein entitled *Catalogus Plantarum Horti Medici Oxoniensis* is attributed to him. He preserved dried plants in his *Hortus Siccus*, which includes many unusual flower forms, some cultivated varieties popular at the time, plus many wild plants. Instead of the garden being stocked just with medicinal plants, it soon evolved into a garden of plants with scientific interest. Bobart the Elder was a flamboyant character who was noticed by others, e.g., Robert Plot, the first Keeper of the Ashmolean Museum, and the English gardener and diarist, John Evelyn. Bobart's eldest son, also Jacob, was born in Oxford and became the second Keeper of the Physic Garden in 1679 (see also OPS 13: 10-11; 14-15 and the article in this volume on pages 10-11).

Georg Marcgrave [Markgraf] (1610-1644). A naturalist and astronomer born in Liebstadt. He was a pioneer who accomplished the first scientific investigation of Brazilian plants between 1638 and 1644, with a party from the Dutch West India Company. He was accompanied by the Dutch physician Willem Piso and both were appointed by Count Moritz of Nassau-Siegen. The Count was trying to establish a Dutch outpost in north east Brazil (near present day Recife). Marcgrave drew up maps of the area, collected plants and painted watercolours. Most of Marcgrave's collections are now held in Copenhagen (C) but OXF holds twelve of his plant specimens, plus the Sherardian Library holds a copy of his edited notes which were published posthumously by Piso as *Historia Naturalis Brasiliae* (1648). When the Dutch West India Company was ordered to leave Brazil in 1644, Marcgrave travelled to Angola but unfortunately caught a fever and died soon after his arrival.

Engelbert Kaempfer (1651-1716) was a scientist, physician and explorer from Lemgo. After becoming secretary to the Swedish Embassy in Russia in 1683 and then Persia, Kaempfer travelled quite extensively around Russia, Persia and India. He joined the Dutch East India Company and travelled in Japan during 1690-1692 as their surgeon, starting from the trading post in Nagasaki. He wrote extensively of his travels and collected many plants; his *Amoenitatum exoticarum* was published in 1712. This was an illustrated work including Japanese and Latin names, plus Japanese characters, describing the plants, plus their medicinal uses. In the Sherardian Herbarium there are about thirty specimens with reference to the descriptions in Kaempfer's book, that also give their Japanese names (see OPS 5: 10-11). A specimen of *Sium ninsi* L. has recently been rediscovered and this is labelled by Sherard as 'd. Kaempfero' and named as 'Ninzin'. Collecting in Japan at that time was a hazardous pursuit but Kaempfer was sympathetic and diplomatic towards the Japanese people. A preserved specimen of *Kaempferia galanga* L., 'Wanhom', corresponds to an entry in his book; Linneaus named the genus in honour of Kaempfer. He is probably best known for being the first westerner to describe the Ginkgo tree, and for the posthumously published *The History of Japan* (1727) translated by J.G. Scheuchzer.

Johann Jacob Dillenius (1684-1747). Originally named Dill, Dillenius was born in Darmstadt but soon moved to Giessen where his father was Professor of Medicine at the University. Johann became a member of the 'Imperial Academia Naturae Curiosorum' and developed an interest in mosses, lichens, fungi and algae. He was one of the first people to classify cryptogams and to try and work out how they reproduced. He described 200 mosses, 160 fungi and many new genera of plants in a Catalogue of plants in the Giessen area. The Englishman William Sherard was impressed with this work and asked Dillenius to work with him in London on

Johann Jacob Dillenius, first Sherardian Professor of Botany at Oxford University

the collections that he was amassing (see OPS 21: 13-15).

While working in England, Dillenius produced three major publications; each has contemporary herbarium specimens associated with them. He edited and produced a third edition of John Ray's *Synopsis* (1724) although not credited as either editor or author. He described many new plants, facilitated by Sherard's herbarium and collected more British plants during a tour around England and Wales. The book was much-admired and acted as the text-book on British botany for about 40 years until superseded by Hudson's *Flora Anglica* (1762).

Sherard's endowment of a Professorship upon his death (in 1728) was on condition that Dillenius was appointed for life. Before Dillenius could take up this post, William's brother James requisitioned Dillenius to describe and illustrate all the exotic plants growing in his garden at Eltham in Kent. This caused a delay of six years before Dillenius could take up residence in Oxford but the result was the splendid '*Hortus Elthamensis*' (1732). Dillenius was a good artist and even engraved the plates himself and described several new genera. It was said to be 'the most important book to be published in England in the eighteenth century on the plants growing in a private garden'. In 1735 Dillenius was conferred with a Doctorate by the University, and in 1736 received a visit from the young Swedish naturalist Carolus Linnaeus. After an initial misunderstanding, and despite not speaking the same language, Dillenius and Linnaeus became friends, exchanged books and specimens and corresponded for the rest of Dillenius' life.

The third and perhaps most scientifically important work published by Dillenius was his illustrated *Historia Muscorum* (1741), which described cryptogams. He sent a copy to Linnaeus who cited it repeatedly in *Species Plantarum* (1753), as a consequence many of Dillenius's specimens and drawings are type material.

Ferdinand Deppe (1794-1861). Born in Berlin, Deppe began his working life as a gardener but gave that up to travel to Mexico in 1824 to collect and study birds, insects and plants. Following Mexican independence in 1821, it was made easier for Europeans to travel and collect natural history specimens there. Deppe sent the material back to the Berlin Museum. A few years later Deppe was joined by his friend Wilhelm Schiede and they tried to establish a business selling natural history specimens. Unfortunately, although they collected many specimens, their business was a financial failure and Deppe returned to Berlin but he was not given an academic position there. An archive of letters from Deppe's expeditions is held by the Zoological Museum, Berlin. His legacy is the large amount of material he collected that was new to science. There are many plant specimens that he collected in OXF. For example one of his new species, *Tillandsia multicaulis* Steud. is a bromeliad related to Spanish Moss. One plant named after him, the so-called 'lucky four-leaf clover' *Oxalis deppei* Lodd. (syn. of *Oxalis tetraphylla* Cav.), was not so lucky for Ferdinand Deppe himself!

Johann Franz Drège (1794-1881). Born in Altona, Hamburg, Drège studied horticulture in Göttingen before working in major botanic gardens, including Munich and Berlin. In 1826 he joined his brother Carl in the Cape Region of South Africa, where they set up a business as professional natural history collectors. Carl collected zoological specimens, Franz specialized in plants. For the next eight years, Franz amassed about 200,000 specimens reportedly comprising some 8,000 species.

Type of *Trichilia dregeana* Sond. collected by Drège (OXF)

After Drège returned to Hamburg, and while running a successful commercial nursery, he offered sets of his Cape specimens for sale. Henry Borron Fielding acquired a full set of these specimens for his herbarium (Fielding, 1844), which was later bequeathed to the University in 1851. It was fortunate the specimens were distributed, as part of Drège's collection was destroyed in the 'Great Fire' in Hamburg in 1842, and the set which had been acquired by Ernst Meyer and moved to the Berlin Herbarium in 1915, was also largely destroyed during World War II. Drège's specimens were of excellent quality as he had kept very good locality and environmental notes. Meyer working with Drège's material, and a map drawn by Drège, was able to classify the vegetation of the Cape into broad phyto-geographical regions. He named a new genus *Dregea* (Apocynaceae) after him. Drège had discovered many new species; at least 100 have been named after him.

Robert Hermann Schomburgk (1804-1865) was born in Freiburg. He was best known for his work for the Royal Geographical Society of London exploring and collecting plants in British Guyana. For the fixing of a boundary for the British Government between British Guiana and Venezuela, he was knighted in 1844. Schombugk was the first person to discover the magnificent giant water lily *Victoria regia* Lindl. (syn. of *V. amazonica* (Poepp.) J.C.Sowerby) in 1837, thriving in the shallow waters of the Amazon in British Guiana. The plant was greatly admired by Victorian gardeners who tried to grow it in England. The very large leaves of the plant are ribbed on the undersurface and the pattern of veining inspired Joseph Paxton's design for The Crystal Palace built for the Great Exhibition of 1851. Schomburgk also discovered many new species of orchids, one of which *Schomburgkia*, was named after him. OXF holds about 450 specimens collected by him from Guiana which were acquired by Fielding.

August Fendler (1813-1883) is another plant collector whose specimens are well represented in OXF. He was born in East Prussia and collected in New Mexico, Tennessee, Panama and Venezuela, overcoming many difficulties to be able to travel. He was fortunate to meet Ernst Meyer, like Drège, who offered to buy specimens he collected from the Americas. Between 1854 and 1855, Fendler collected about 2,600 flowering plants from Tovar in Venezuela plus many ferns, a large proportion of which are new species and types. He tended to collect the most uncommon plants, hoping to obtain a higher price for these specimens, although after many years he had to find other methods of earning a living. On one occasion he lost all his equipment in a flood, and on another lost many possessions to a fire.

Ferdinand Jakob Heinrich von Mueller (1825-1896) from Rostock went to Australia in 1847 and became Government Botanist in Adelaide in 1853. Four years later he became the Director of the Melbourne Botanic Garden and founded the National Herbarium of Victoria. Many of his Australian specimens from South Australia, Western Australia, Victoria, New South Wales and Queensland are to be found in OXF. For his extensive work on the Australian flora, and with George Bentham on *Flora Australiensis*, he was elected a Fellow of the Royal Society and knighted in 1879.

William Schlich (1840-1925) was an eminent forester, born in Flonheim, who gained a doctorate from Giessen University before moving to Burma, then India, where he worked for the Indian Forest Service. He was responsible for part of reorganization at the Forest Research Institute at Dehra Dun, he founded the journal *Indian Forester* (1875) and a few years later became Inspector-General of Forests in India. In 1885 he took up the post of Professor of Forestry at the Royal Indian Engineering College at Cooper's Hill in England and trained foresters there. The college at Cooper's Hill closed in 1905 and moved to Oxford. Schlich moved with it and his previous experience put him in a position to establish a School of Forestry at Oxford University. He was able to set up Forestry as a subject for a BA degree and persuaded the University to establish the post of Professor of Forestry with its own Department (once known as the Imperial, then Commonwealth, then Oxford, Forestry Institute). Later an M.Sc. degree was also introduced. Like von Mueller, for his unceasing work, Schlich was elected a Fellow of the Royal Society and knighted in 1909. The Department of Forestry merged with the Department's of Botany and Agriculture in 1985 to become the present day Department of Plant Sciences, where there is a lecture room named in his honour. Many thousands of Indian specimens from Schlich and ex Cooper's Hill collections can be found in the herbaria.

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Serena Marner
Herbarium Manager

News from the Herbaria

Fielding-Druce (OXF) and Daubeny (FHO)

During 2015 we received a record number of visitors. Many more group visits were made than in previous years, covering a wide range of themes. The materials displayed catered for each group's interests and showed the modern relevance of collections. Furthermore, significant progress was made in returning specimens which had been loaned to the plant diversity research team. The numbers of sheets returned were more than three times those received as loans for research!

Visitors

19 group visits were made which included 204 people. In addition 48 individual visits were made making a total of 252 visitors for the year. Many of the groups consisted of staff and students working or studying at the University. The Department of Continuing Education ran a course in Ecological Survey Techniques and 15 students from this course came for a session focusing on macrophytes. 32 students from the Oxford University Doctoral Training Centre (DTC), undergoing a four-year D.Phil. in Systems Biology, were introduced to the botanical collections as part of a two-week course on 'Data Management, Analysis and Statistics for Bioscience'. The aim was to introduce botanical/ natural history collections as sources of data for research and to show examples of outputs from work on the material. Another 18 doctoral students on another course from the Centre, plus a further 18 students from the Doctoral Training Programme (DTP), were also introduced to herbaria and collections.

Ten researchers from the Oxford Long-Term Ecology Lab and eight staff from the Oxford University Natural History Museum were given tours of the herbaria. Three separate visits by Botanic Garden staff were made who were also introduced to the botanical archive held by the Sherardian Library. The three sessions focused on different centuries highlighting the work of Jacob Bobart on the early planting of the garden, the work of John Sibthorp on the *Flora Graeca* and Charles Daubeny's and William Baxter's modifications to the Garden in the 1830s/1840s. On another occasion members of the Oxford Conservation Consortium visited. They were shown how specimens are collected/preserved and used for research. The group was especially interested in a seventeenth-century 'book herbarium' and Robert Morison material, including his illustrated work *Historia Plantarum Universalis Oxoniensis Pars Secunda* (1680) and the copper plates associated with the illustrations in this work.

The Systematics Association three-day Biennial Conference was held in Oxford in August with 225 delegates attending. Several groups of visitors from the conference came to see the *Flora Graeca* materials during this period; they were interested in looking at the material from a botanical/biological perspective. During the Oxford Alumni reunion weekend in September, fifteen alumni visited the herbaria. Two local natural history groups were given tours of the collections – these were the Abingdon Natural History Group and the Ashmolean Natural History Society of Oxfordshire. On other occasions a small group of secondary school teachers were introduced to the herbaria, and a group attending a workshop organized by Dr David Boshier (Department of Plant Sciences) was shown the collections.

Ferdinand Bauer's drawings, watercolours and the herbarium materials of John Sibthorp, associated with the publication of the *Flora Graeca*, were again the reason for a visit by a group of art students introduced by Dr Sarah Simblet. The students were taking part in a week-long international summer school focused on botanical drawing, being taught by Sarah, from the Ruskin School of Fine Art. Dr Richard Mulholland was also present and he discussed the Bodleian Bauer Research project and some of the techniques currently being used to rediscover the pigments used in Bauer's lost colour chart for the *Flora Graeca* (see OPS 21:11-12). A group of five physicists/artists also came for a tour of the herbaria/library when *Flora* Graeca materials were displayed. Rosemary Wise, botanical artist, showed some of her work and publications, plus botanical art by the Oxford Botanic Garden Florilegium Group.

One of the individual visitors who made several visits to draw from specimens was Emily Freeman studying at the Ruskin School of Fine Art. A four-day visit was made by Dr Virginia van der Lande, from Nottingham University, to research herbarium material collected by George Anderson FLS. All the above visits were enjoyable and memorable.

Loans for exhibitions

Three loans from OXF were lent for exhibitions. Nine miscellaneous specimens from the Sibthorpian Herbarium were sent to the Pera Museum, Istanbul, Turkey. The museum put on an exhibition entitled "Life is Short, Art is Long. The Art of Healing in Byzantium" which ran from 10 February to 26 April 2015. We were very pleased to work with the Bodleian Library Conservation Department in affecting this loan. One specimen of *Indigofera tinctoria* L. from the Sherardian Herbarium was lent to the Bodleian Library for display in the exhibition "Armenia – masterpieces of an enduring culture' running from October 2015 to February 2016 at the Weston Library. One sheet of *Medusagyne oppositifolia* Baker collected by Rosemary Wise in the Seychelles accompanied an exhibition of prints of Rosemary's paintings at the Linnaean Society in London. This was for a special display celebrating Rosemary's 50 years as a professional botanical artist.

Loan material

Much activity took place in this area of curatorial work. A total of 2,575 specimens were returned from loan to other herbaria comprising 43 different transactions. This included 1,145 specimens of Acanthaceae, mostly *Strobilanthes*, from 28 loans or part loans, which had been studied by John Wood and Robert Scotland's research students. 1,423 sheets of *Cardamine* were returned after completion of studies by Elizabeth Cooke. 695 specimens of OXF and FHO material were received back from loan in the same period. 705 specimens were also received as incoming loan material for John Wood and Pablo Muñoz Rodríguez to study, and some for Rosemary Wise to draw. Most of the incoming loans consisted of specimens of *Ipomoea* for the Foundation Monograph project, but one loan of Acanthaceae was received for John Wood to identify.

New accessions and mounting

Material collected from Japan in 2014 by a team from the Oxford Botanic Garden and Harcourt Arboretum, in conjunction with the University of Tokyo, is in process of being mounted and accessed. Specimens of a very rare endemic species of Japanese birch, *Betula chichibuensis* H.Hara, was collected, as well as seeds. This received some publicity as its seeds were successfully germinated, thus hopefully ensuring the ultimate survival of the species. 76 miscellaneous specimens sent from TNS (National Museum of Nature and Science, Amakubo, Tsukuba, Japan) labelled "The 21st Century Flora of Japan exsiccata" were also received. Specimens of *Psychotria*, *Keetia* & *Chazaliella* collected in Ghana and Liberia by William Hawthorne and colleagues were accessed before being sent out on loan for critical examination. 32 miscellaneous British species of Cyperaceae and Juncaceae collected by H.J. Killick were incorporated. British material consisting of several hundred lichen, moss and liverwort specimens collected by H.J.M. Bowen were transferred from Oxfordshire County Council's Museum's Resource Centre to OXF.

Mounting for FHO included miscellaneous specimens collected by Professor J.K. Morton from Sierra Leone and duplicates collected by M.Y. Chew, C.M. Pannell and colleagues in Malaysia. Mounting for OXF included plants collected by Dr D. Damrel from Clemson University Herbarium in South Carolina and *Ipomoea* specimens collected in Brazil by Dr de Queiroz and John R.I. Wood.

Serena Marner *Herbarium Manager*

Herbarium apprenticeship

As I approach the end of my second year as an Apprentice, I have taken time to reflect on my apprenticeship.

I am still learning new things every day and am constantly developing my skills and responsibilities in addition to my knowledge of the collections.

In the collections, I have been working on conservation tasks such as data-basing specimens from Morocco, making repairs to herbarium specimens and returning over a thousand loan specimens to various organisations across the world. I also have been helping with the new Herbaria website; I am very much enjoying my apprenticeship.

At the end of last year, I was elected as an Apprentice Ambassador, which allowed me to become more involved with the wider University, attending career fairs to promote apprenticeships across schools and hosts such as the Mini Plant in Cowley, Oxford. The University now has 64 apprentices, with hopes to reach 150 by April 2017. Not only do I feel a part of the Herbaria, but I also feel a part of the wider University.

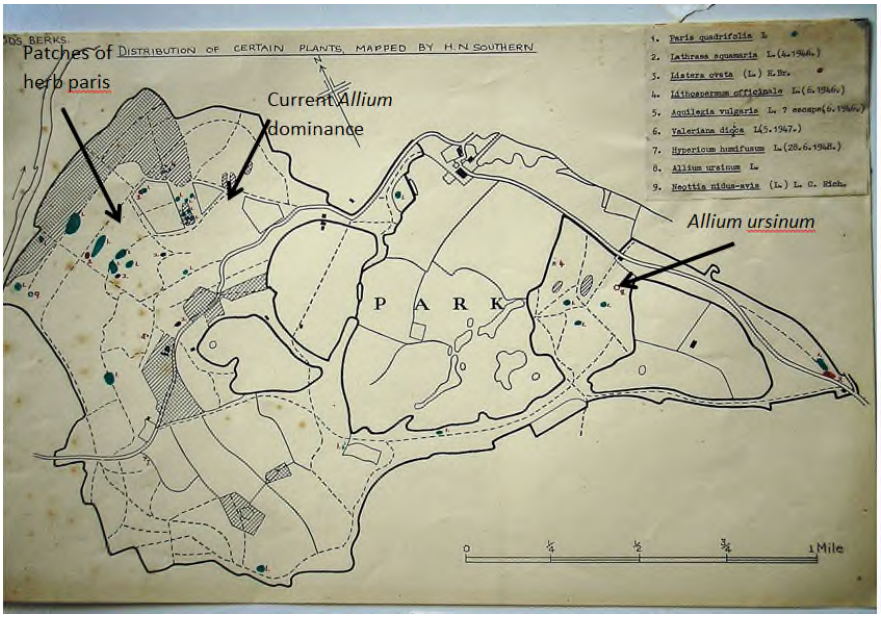
I have achieved my level 2 NVQ in Cultural Heritage and am now working towards a level 3 Diploma in Cultural Heritage, which I hope to achieve by the end of this year.

James Ritchie
Herbarium Apprentice

A smell in the air

Allium ursinum L. on the north side of the hill in Wytham Woods (May 2015)

There are not many plants in Britain that you can smell long before you see them, but wild garlic or ramsons, *Allium ursinum* L., is one. It is found in abundance in damp, nutrient-rich soils, almost always in woodland. Indeed like some other vernal plants it has been suggested as an ancient woodland indicator in some parts of the country, which might imply that it does not spread very well. The seeds generally fall close to the parent plant so one plant becomes a small clump, then a bigger clump and eventually a whole swathe of green and white. Once established it holds its own possibly through some effect of the rapid decay of the leaves in mid-summer inhibiting the growth of other herbs.



Mick Southern's map of the 'distribution of certain plants' in Wytham
(© University of Oxford, held by Conservator of Wytham Woods)

In Wytham Woods, near Oxford, its stronghold is in the ancient woodland on the north side of the hill where in places it forms dense carpets dominating site and smell for a couple of months and then disappearing almost completely, but this may be a relatively new state of affairs, at odds with the idea that it is a poor colonist.

In the 1950s Mick Southern, who worked in the Bureau of Animal Population under Charles Elton, drew up a map showing '*The distribution of certain plants*'. There is no text to go with this map, but eight of the nine species are rare or uncommon in a Wytham context so it would be logical for them to be mapped in this way : *Lathraea squamaria* L., *Listera ovata* (L.) R.Br. (now *Neottia ovata* (L.) Bluff & Fingerh.), *Neottia nidus-avis* (L.) Rich., *Lithospermum officinale* L., *Aguilegia vulgaris* L., *Valeriana dioica* L., *Hypericum humifusum* L. and *Paris quadrifolia* L.. This last is the most widespread of the group and in spring 2015 I spent a morning confirming that many of the patches marked on the north slope are still there. The odd one out in the species list is *Allium ursinum* L. This is shown as present only in one place in Marley Wood and not at all on the north slope where *Paris* was recorded. It seems inconceivable that Southern would have missed it there if it had been present.

In the 164 permanent plots set up by Colyear Dawkins in Wytham Woods it was not recorded at all in 1974 or 1991, but in two plots in 1999 and in five in 2012. These are too few records to be certain this is an increasing trend but it is consistent with the idea that the species has spread in recent decades. This is also suggested by the pattern of its occurrence: as you move away from the places where it forms solid sheets the patches get smaller and more dispersed. They appear to be where one or two plants have established and then start to spread.

In a survey of woods across Great Britain comparing plots first surveyed in 1971 with resurveys in 2001 ramsons had increased its cover and occurrence. European studies also suggest it may be increasing. As well as its ability to tolerate shade, it has an Ellenberg light score of 4 (= plants of shade, rarely in full light), it is also likely to be favoured by increased nitrogen deposition (Ellenberg nutrient score 7 = more often found in places rich in nitrogen). Its main vulnerability is disturbance: for example by heavy trampling.

This could certainly explain the sort of pattern seen at Wytham. Generally there is strong conservation concern about the spread of non-native species. At Wytham small balsam *Impatiens parvifolia* Bedd. has become established on some of the rides (probably brought in on researchers' boots) while *Nectaroscordum siculum* (Ucria) Lindl., the Sicilian Honey Garlic, has turned up in a few places (escaped from a garden in the middle of the wood) and attempts have been made to remove these.

However what if the invasive species is a native woodland plant like *Allium ursinum*, perhaps being spread as seed with soil on the feet of deer? Might we at some point think this also should be controlled? We have not reached that point yet and meanwhile it is worth noting that the great woodland ecologist Oliver Rackham commented that the leaves went well with peanut butter sandwiches.

Keith Kirby
Woodland Ecologist

The rediscovery of long-lost Acanthaceae from the Himalayan region

During the course of studies on Himalayan Acanthaceae at Edinburgh in 1993 and in Oxford since 2001 I have regularly come across new species, which have been published in many different papers, particularly Wood (1994), Wood et al. (2003), Wood & Scotland (2003, 2009). Most of these new species were based on herbarium collections made about a century ago by Charles Baron Clarke and Frank Kingdon Ward.

In the last five years this has all changed. I have been regularly sent photographs of plants by botanists working in Bhutan, India and Nepal which provide evidence that nearly all these species still survive, although in what quantity I have no idea. At a personal level it is very satisfying to see images of the living plants in full colour when all I had seen before were old dried specimens of a uniform brown colour. Examples of four species I have been shown recently are illustrated here, with thanks to the photographers who sent them to me and who have given permission to use their images.

Perhaps the most spectacular is *Eranthemum erythrochilum* J.R.I.Wood, last collected in 1912, described in 1994 and refound by Gopal Krishna in the original locality of Buxa in West Bengal. This is a spectacular subshrub with red flowers distinguished from related species by its very long corolla tube and strongly exserted stamens. It appears to be endemic to Buxa Duar. Images of two species of *Strobilanthes* were sent to me from Nagaland by Santanu Dey in 2015. One of these, *S. simplex* J.R.I.Wood, described in 1994 was last collected by Kingdon Ward in 1949. The photograph clearly shows the subterminal flower heads, persistent bracts, pilose calyx and glabrous corolla with included stamens, which characterise this species. I am pleased to say that very recently I have also seen specimens of this species from nearby in Myanmar. The other species sent from Nagaland is *S. decipiens* J.R.I.Wood, described in 2003 and last collected by the American naturalist Walter Koelz in 1950. This is a white-flowered species with imbricate flowers and exserted stamens. The fourth species illustrated here, *Strobilanthes saccata* J.R.I.Wood, was described in 1994 but last collected in 1974, fifty years before it was rediscovered in central Nepal by Bhaskar Adhikari. The image shows the anisophyllous leaves characteristic of many species of *Strobilanthes* as well as the saccate corolla and spicate inflorescence, very different from other species occurring in Nepal. What is does not show is the unusual spiny pollen; another characteristic of this species.

Eranthemum erythrochilum J.R.I.Wood
(© Gopal Krishna)

These four species are only some examples of the striking recent trend in the rediscovery of long-overlooked species from north east India. This is a very welcome development indicating a revival of botanical exploration in the region, the possibilities of photography for documenting rare species and, in particular, the survival of rare species in their native habitat. Much remains to be studied. We still have no idea about the frequency, flowering patterns or conservation status of any of these plants but it is hoped that the next decade will show significant advances in our knowledge in these areas too.

Above: *Strobilanthes simplex* J.R.I.Wood

Left: *Strobilanthes decipiens* J.R.I.Wood
(Both © Santanu Dey)

Right: *Strobilanthes saccata* J.R.I.Wood
(© Bhaskar Adhikari)

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