Oxford Plant Systematics

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

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New and endemic plants from the central valleys of the Bolivian Andes



Contents

Editorial
Robert Scotland……. 2

General news items .....…… 3

Trinidad & Tobago Darwin Project …….. 3

Student progress
Ruth Eastwood …….. 3
Marcelo Simon …….. 4

Publications 2005 ……. 4

Insights on Andean Iridaceae through the Darwin Initiative
John Wood and Hibert Huaylla …… 5

Evolutionary studies in Bromeliaceae
Andrew Smith ……... 7

400 years old! [A book herbarium from Italy]
Serena Marner ……. 9

Bobart the Younger's *Hortus Siccus*
Stephen A. Harris …….. 10

News from the herbaria
Fielding-Druce (OXF)
Serena Marner ……..…….. 11
Daubeny (FHO)
Alison Strugnell …… 12

***Aglaia* online**
Ca*roline Pannell* ……... 13

Robert Morison, the first Professor of Botany at Oxford
AnneHancock …… 14

Editorial

It is striking that most of the technological and scientific developments in systematic biology over the last 150 years do not challenge or alter the overall objectives in terms of what systematists need to be doing, but rather how we do it. The recent literature is awash with discussions about taxonomy and the web (access and presentation of results), databases (access and presentation), DNA bar-coding (identification of taxa), conservation measures (delimitation of taxa and their properties), the phylocode (naming), Bayesian statistics (tree building), electronic publication (access and presentation), molecular versus morphological data (data sources). However, the central goals of systematics – to build the evolutionary tree and complete the inventory of organisms - remain essentially the same. Just how effective new developments will be depends perhaps on keeping these objectives clearly in focus.

Once again this year OPS 13 reflects a broad range of research activity reflecting the botanical inventory as well as research on building the tree for selective groups. The Darwin-funded project in Bolivia is highlighted on our front cover and with an article by John Wood and Hibert Huaylla. As this successful capacity-building project comes to an end, another Darwin project in Trinidad and Tobago has begun (see News items). Congratulations to Alison Strugnell for the publication of the Mt. Mulanje checklist, a project that has developed over a 20 year period using the unrivalled collections in our Daubeny herbarium (FHO). Andrew Smith, a lecturer in ecophysiology in Oxford Plant Sciences, writes about his research interests in Bromeliaceae, highlighting the benefits of working in a university department that contains an active systematics research group and associated herbaria. From an historical perspective, Serena Marner writes about a 400 year old book herbarium from Italy and Stephen Harris on Jacob Bobart the Younger's *Hortus Siccus.* Caroline Pannell brings us up to date with database news on *Aglaia* online, whilst Anne Hancock contributes a short article on Robert Morison, the first Professor of Botany at Oxford.

Robert Scotland

Typsetting and layout of this issue by Serena Marner

Front cover pictures: New and endemic plants from the central valleys of the Bolivian Andes photographed on the Oxford-Bolivia Darwin Project. Top row, left to right – *Mimosa sp. nov.* (Leguminosae), *Puya weddelliana* (Bromeliaceae), *Salvia sp. nov.* (Labiatae). Middle row, left to right – *Hippeastrum sp. nov.* (Amaryllidaceae), *Varronia sp. nov.* Solanaceae), *Trimezia sp. nov.* (Iridaceae). Bottom row, left to right – *Trigidia sp. nov.* (Iridaceae), *Tecoma tenuiflora x sp. nov.* (Bignoniaceae), *Solanum stellativelutinum* (Solanaceae). See article on page 5.

General news items

Prize awarded

Congratulations to **Ruth Eastwood** who was awarded the prize for the best poster presentation by the Systematics Association at the 7th Young Systematists' Forum at the Natural History Museum in December. Her poster was entitled *Radiations reach new heights: exceptional rates of species diversification in Andean Lupinus*.

Gatsby Summer School

Robert Scotland was a practical organiser for the first Gatsby summer school at Bretton Hall Leeds, running two practical sessions on systematics that covered plant identification and phylogeny reconstruction. Robert was joined by a number of colleagues from Oxford (Stephen Harris, Ruth Eastwood, Jill Harrison), Edinburgh (Alex Wortley, Greg Kenicer, David Harris) and London (Mark Carine).
http://www.gatsbyplants.leeds.ac.uk/summer06/summer06.htm,

Educational posters completed

Rosemary Wise completed her paintings of the plants of the Andean Valleys, after two visits to Bolivia in 2004, which have now been printed as a series of six educational posters and distributed to various establishments in Bolivia through the Darwin Initiative Project.

Checklist published

The Checklist of the Spermatophytes of Mt. Mulanje by **Alison Strugnell** has just been published in the *Scripta Botanica Belgica* series, volume 34 (2006), 199pp. It is available from the National Garden of Belgium, Domein van Bouchout, B–1860, Meise, Belgium. http://www.br.fgov.be

African acacias

Chris Fagg (University of Brasilia) visited the herbaria for four months in order to complete work on a Conspectus of African acacias. This is the culmination of long-term research undertaken by the late Richard Barnes.

Trinidad and Tobago Darwin Project

Trinidad and Tobago (T&T) has one of the richest island biodiversities of the Caribbean archipelago but some of the most rapid rates of habitat loss. However, the capacity to manage and conserve plant biodiversity is compromised by a poor information base: basic habitat assessments and baseline population data are largely non-existent. This is aggravated by the low level of basic plant identification skills in T&T. It is within this framework that the Darwin Initiative awarded **Nick Brown** and **Stephen Harris** a three-year grant to work in collaboration with the National Herbarium of Trinidad and Tobago, the University of the West Indies, Forestry Division of the Ministry of Public Utilities and the Environment and the Asa Wright Centre. William Hawthorne is employed on this project in Oxford.

The project is designed to: 1) assess the conservation status of habitats and key species; 2) expand and enhance the National Herbarium of Trinidad and Tobago; 3) produce two user-friendly field guides; 4) train staff in collections and information management in the herbarium; and 5) provide training in plant survey and identification for students.

This project will provide direct support to the T&T Environmental Management Authority's process of identifying Environmentally Sensitive Areas and developing management plans, by highlighting key habitats and species which are under particular threat and identifying priority areas for conservation/restoration. The project will also enhance access to information about T&T plants.

Part of the project is to make available images and data from herbarium specimens collected in the Caribbean that are deposited in Oxford University Herbaria. A team of students have databased all of the Caribbean collections in FHO and about half of those in OXF, including the early 18th century collections in the Du Bois Herbarium. The remaining OXF collections will be added in summer 2006.

Data and images of all of these specimens are available via BRAHMS online at http://herbaria.plants.ox.ac.uk/bol/?caribbean.

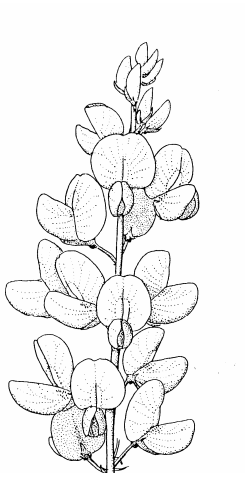
Field work for the project will be through the use of Rapid Biodiversity Surveys (RBS) to assess the vegetation at a wide range of sites scattered across T&T. During these surveys herbarium specimens will be collected to augment the collections of TRIN and digital images recorded to illustrate the field guides which will be an important output from the project.

Stephen A. Harris

Student progress

Ruth Eastwood (D.Phil., 4th year).
Systematics of Andean lupins and the origin of *Lupinus mutabilis*. Supervised by Colin Hughes (Oxford) and Julie Hawkins (University of Reading). BBSRC funded.

The starting point for my research on Andean lupins was to assess the relationships of the Andean species within the genus. *Lupinus* comprises ca. 275 species distributed between the Old and New Worlds. There are two main centres of



Lupinus mutabilis

species diversity, the Rocky Mountains (ca. 90 species) and the Andes (ca. 85 species). Previous molecular phylogeny reconstruction within the genus has suffered from low levels of resolution and poor sampling, particularly of South American taxa. During my D.Phil. I have addressed both these limitations by radically increasing South American taxon sampling and by developing a more variable DNA sequence locus, GPAT that provides additional characters. I have generated a large DNA sequence data set for intron 5 of GPAT1 and combined these data with two other nuclear sequence data sets (ITS and LEGCYCIA) to produce a much more densely sampled, well-resolved and robustly supported phylogeny for *Lupinus*. I am using this phylogeny to address questions about diversification and biogeography, character evolution, and domestication, and as the basis for a new infrageneric classification of *Lupinus*.

The new phylogeny of *Lupinus* shows clearly that the ca. 85 Andean lupins do not form a monophyletic group. Instead, Andean species are placed in two independent New World lineages which both comprise both North and South American elements. One well-supported Andean clade representing 81 species is nested in a large western North American / Mexican clade, while the remaining four Andean species are nested within a clade containing ca. 20 species distributed predominately in lowland South America. Evolutionary rates analysis using r8s has been used to estimate ages of the two independent lineages of *Lupinus* in South America. The results indicate both pre- and post-Panama landbridge origins for South American *Lupinus*. Futhermore, my results suggest that rates of species diversification within the large Andean *Lupinus* clade exceed known plant radiations.

There are only a few qualitative discrete non-molecular characters that can be unambiguously defined and coded within *Lupinus*. These include seed coat surface pattern, leaf type, eophyll type and

chromosome number. Optimising data for these characters onto the phylogeny has provided insights into character evolution. One striking feature is the convergent occurrence of unifoliolate leaves twice within *Lupinus*. Species from south-eastern USA and lowland South America have unifoliolate leaves and their disjunct distribution has previously been explained by long distance dispersal. However, the phylogeny shows unequivocally that the unifoliolate species from south-eastern USA are not closely related to lowland South American unifoliolate species. The presence of unifoliolate seedling leaves in some digitate species suggests a conserved developmental pathway between these unrelated species and the hypothesis that neotenous retention explains the unifoliolate condition.

The taxonomy of *Lupinus* has largely been fragmentary and lacking in monographic synthesis or any comprehensive infrageneric classification. For a group of this size a diagnostic classificatory system is needed. I have constructed a new infrageneric classification of *Lupinus* that recognizes eight sections that are both monophyletic and diagnosable. The new system retains previously recognised sections for Old World lupins and segregates the New World species into three sections. The two largest sections are further divided into series. Further subdivision, to recognise other strongly supported clades in the phylogeny, will not be implemented due to a lack of diagnosable morphological characters.

This year I have been finalising datasets and running phylogenetic and evolutionary rates analyses. I have also started to present some of the results from my research. This year I presented my work at the 7th Young Systematists' Forum at the Natural History Museum in December, the 7th UK legume workshop in November and at the 5th Biennial Systematics Association conference in Cardiff in August, for which I was awarded a bursary to attend. In addition, I contributed to a paper entitled "From famine to feast? Selecting nuclear DNA sequence loci for plant species-level phylogeny reconstruction" that is now in press in *Philosophical Transactions of the Royal Society B*., led a Mac-free phylogeny session on the Molecular Systematics course held at Reading University and enjoyed attending a two-week tropical plant family identification course run by RBG Kew. Finally, I have begun the task of writing my D.Phil thesis, which I aim to complete by Summer 2006.

Marcelo Simon (D.Phil., 1st year).
Ecological setting and the evolution of Neotropical plants: origins and diversification of the Cerrado flora.
Supervised by Colin Hughes (Oxford) and Stephen Harris (Oxford). Clarendon studentship.

Recent advances in molecular phylogenetics combined with taxonomic accounts for some speciose tropical plant genera offer new opportunities to investigate patterns of distribution of large species clades in an explicit phylogenetic context. Within the legumes recent data suggest that continental history has had limited influence on modern plant distributions and diversity. This shifts the emphasis toward ecological setting in terms of major habitat types or biomes – temperate, tropical wet, tropical savanna (Cerrado) and tropical dry – and dispersal, as factors determining modern patterns of diversity. Within the Neotropics, which harbour more than 30% of global species richness, there are very few empirical geographic and phylogenetic data sets for widespread and species-rich plant groups that can be used to test hypotheses surrounding the assembly of extant plant diversity. This is particularly true for the Cerrado biome, which covers 2 million km^2 in South America, harbours around 10,000 plant species, and is recognised as one of the top biodiversity hotspots. Despite this prominence, little is known about the origins and diversification of the Cerrado flora. The overall aims of my research project are to test the hypothesis that ecological setting is a prime determinant of phylogenetic structure, and gain insights into the origins and diversification of plants in the species-rich Cerrado biome using the plant genus *Mimosa* (Leguminosae).



Pod of *Mimosa revoluta*

Mimosa, with high species richness across diverse Neotropical habitats, provides an excellent study group to develop and test these ideas. Previous studies have revealed a high level of endemism in *Mimosa*, making it an appropriate group to also investigate whether patterns of rarity are phylogenetically structured or not. One of my working hypothesis is that narrowly restricted endemic species have evolved recently and are nested towards the tips of the phylogeny, while widespread species are in general older and thus nested more deeply. Furthermore, estimates of clade ages can be used to evaluate hypotheses about the evolutionary history and patterns of species diversification of *Mimosa* in the context of the Neotropical flora and the main biomes where *Mimosa* occurs.

At the heart of this project is construction of a species-level phylogenetic tree. Initial work is underway to screen a set of non-coding chloroplast DNA sequence *loci*, since initial amplifications suggest that the widely used ITS nrDNA locus may not be suitable for *Mimosa* due to paralogy problems. The ultimate objective of any species-level phylogeny is to sample all extant species and multiple accessions of widespread species. However, for *Mimosa*, with around 500 species, clearly this is unrealistic. Thus, initial taxon sampling will aim to cover all currently recognized infrageneric groups and the geographic and ecological range to provide a robust phylogenetic framework for more densely sampled studies of particular subgroups and regions, such as the Cerrado, where I aim to sample a substantial set of localized endemics.

A second important strand of this project is assembly of geographic data on species distributions and species abundance. As a starting point for this I am developing a botanical specimen database that can be used to quantify endemism or global rarity that can be used in conjunction with the phylogeny to test the hypothesis concerning the evolution of rarity. A phylogenetic tree time calibrated using recent legume age estimates and *Mimosa* fossils will allow the estimation of time of origin and diversification across several biomes.

One of the greatest challenges for projects on this scale is assembly of material across a broad range of species and a wide geographic area. Fieldwork to collect plant material and herbarium work to assemble geographic distribution data are planned in key areas of *Mimosa* diversity. Field visits to Brazil and Mexico, both major centres of diversification for *Mimosa* are planned during the first year.

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Insights on Andean Iridaceae through the Darwin Initiative

During the last three years the Darwin Initiative has funded a project to investigate plant endemism in the central valleys of the Bolivian Andes. In this project the Department of Plant Sciences at Oxford has collaborated with four herbaria based in different Bolivian universities. The main project aim is to identify hotspots for conservation where significant numbers of endemic species are concentrated. A report with our recommendations is being submitted to the Bolivian authorities.

The project has a strong taxonomy element and an important aspect of the project has been our training component which aims to pass on taxonomic skills to a group of younger Bolivian botanists. As part of this programme five Bolivian botanists have come to Oxford and have undertaken taxonomic projects under the guidance of Oxford staff and botanists from Kew, Edinburgh and Bonn University. Three botanists came in 2004 (Wood 2005) and three others in 2005. This latter group consisted of one person, Eliana Calzadilla, to work with Rosemary Wise on botanical illustration, and two others, Magaly Mercado to study *Scutellaria* (Labiatae) in Bolivia and Hibert Huaylla to work on Iridaceae.

The project has given a lot of emphasis to the use of tools which help to make taxonomic research more effective and its results more accessible. Training in botanical illustration was one aspect of this and the use of digital photography is another. All four counterpart herbaria were presented with Nikon Coolpix 4500 cameras and training was provided in their use for botanical photography. As a result a large bank of photographs has been built up in Bolivia. These are being linked to collections through the BRAHMS data base developed in Oxford and they have also formed the basis for the popular field guide 'La Guia "Darwin" de las Flores de los Valles Bolivianos' which was published by the project in December 2005. Additionally digital photography has proved a near essential tool in the studies of Andean Iridaceae being carried out by one of the authors of this paper, Hibert Huaylla.

The family Iridaceae is well-known for its large, attractive flowers and is frequently cultivated in gardens. In Bolivia it is a smallish family with some 30 species. The largest genus in the country, to which belong about half the recorded species, is *Sisyrinchium* L. The other species belong to smaller genera, which all share the same unfortunate characteristic of having extremely delicate flowers, which are open



Fig. 1 Herbarium specimen of *Cardenanthus tunariensis* (Photo Margoth Atahuachi)

mostly in the morning. These are usually seriously distorted on herbarium specimens and it is impossible to make out their form. Attempts to dissect them usually result in the destruction of the tepals when they are hydrated. Since flower structure is of great importance for identification both at species and genus levels, this makes taxonomic studies based on herbarium specimens extremely difficult. This is probably the reason that there has only been one serious student of the Iridaceae of Bolivia, Robert Foster, and we are unaware of any publication related to this family in Bolivia for over 60 years.

During the course of his research in the genus *Sphenostigma* Baker with Paul Wilkin from Kew, Hibert Huaylla's attention was drawn to the genus *Cardenanthus* R. C. Foster. This was described by Foster (1945) and named in honour of the Bolivian botanist, Martín Cárdenas. The genus is centred on Bolivia but it is also found in both Peru and Argentina (Foster 1945, 1950, 1962). It is a high Andean genus of short, seasonally moist grassy banks occurring between 3000 and 4000 m. Species of *Cardenanthus* are small bulbous herbs, in which the three outer tepals are much larger than the three inner tepals. The shape, size and colouring of the tepals are important characters for distinguishing species as are the size and form of the anthers and the style branches.

Most herbarium specimens consist of one or two plants whose floral details are impossible to make out. Fig. 1 shows a typical herbarium specimen of what is probably *Cardenanthus tunariensis* R. C. Foster. Fig. 2 shows a photograph of the same species taken from the area of the type locality, in which the form and size of both the inner and the outer tepals can be clearly



Fig. 2 *Cardenanthus tunariensis*
(Photo Margoth Atahuachi)



Fig. 3 *Cardenanthus sp*. from Torotoro
(Photo Magaly Mercado)



Fig. 4 *Cardenanthus sp*. from Tarabuco
(Photo Hibert Huaylla)



Fig. *5 Cardenanthus sp.* from Cerro Chataquila near Sucre (Photo Hibert Huaylla)

made out. This is a plant with very pale tepals, which dry blue. The inner tepals are lanceolate, acute, and relatively long while the outer tepals are weakly three-toothed. Figures 3-5 show photographs of three other species found by the Darwin project in Bolivia in the last 12 months. They may represent new species or may be conspecific with one of the other species described by Foster (1945, 1946, 1948, 1950). What, however, is abundantly clear is how the photographs show diagnostic details, which are completely lost in the herbarium specimens. Fig. 3 shows a plant collected near Torotoro which has pale flowers like *Cardenanthus tunariensis*, but in which the inner tepals are short, broad and rounded and the outer tepals untoothed. Fig. 4 shows a plant collected at Tarabuco in which the flowers are violet. The inner tepals are similar to those of the plant from Torotoro except that the tepals are acute and the outer tepals end in a distinct mucro. Fig. 5 shows a plant from Cerro Chataquila with variegated flowers and ovate, acute inner tepals. The outer tepals are rounded and slightly ragged at the apex rather than toothed.

It is abundantly clear that digital photography has enormously increased the value of our field collections and has given access to a difficult and little studied genus of very attractive bulbous herbs, almost all of which could be cultivated as ornamentals. It has made it possible for Hibert Huaylla to begin work on revising this genus and has provided a stimulus to field work in search of different species, which can only be found during a brief flowering period in the early summer.

Eight species of *Cardenanthus* have been described; three are endemic to Peru (*C. peruvianus, C. shepardiae* and *C. vargasii*), one to Argentina (*C. venturii*) and four to Bolivia (*C. boliviensis, C. longitubus, C. orurensis* and *C. tunariensis*). All were described by R.C.Foster. Many are only known from the type collection and all are very local in distribution. Taxonomic studies in this genus will help enormously to define the species and work out their distribution in detail. It is a good example of how the Darwin Initiative's support for taxonomy will provide accurate data to support conservation initiatives and is a model which other funding agents working in the same field could do well to follow.

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John Wood & Hibert Huaylla

Evolutionary studies in Bromeliaceae



Tillandsia guatemalensis L.B. Sm., an epiphytic bromeliad growing at 1600 m in the Merendón Mountains, Cusuco National Park, northwestern Honduras. (Photo Ching Lam)

The Neotropical family Bromeliaceae is often celebrated as an outstanding example of adaptive radiation in vascular plants. Amongst nearly 3000 species, the family contains almost equal numbers of terrestrial and epiphytic life-forms, which between them occupy an extraordinary diversity of habitats. These range from exposed, hyperarid sands in the almost rainless coastal deserts of Peru at one extreme, right through to the humid understory of montane cloud forest. Bromeliads also show an impressive range of growth habits, from the huge Andean *Puya raimondii* – inflorescences of which can be 10 m tall – to extreme, effectively rootless epiphytes such as *Tillandsia usneoides* (Spanish moss). The family is also characterized by a famous synapomorphy: the elaborate, peltate epidermal trichome, which in epiphytic species allows absorption of water and nutrients directly through the surface of the shoot.

One other distinctive feature of Bromeliaceae is that many species show a form of photosynthesis known as crassulacean acid metabolism (CAM). This is an important adaptation to aridity found in many tropical and subtropical plants, especially succulents, which allows these plants to take up carbon dioxide from the air at night and to keep their stomata closed during the daytime. This greatly reduces the amount of water lost in transpiration – but carries with it the obvious disadvantage that light energy is not available for photo-synthesis at night. So CAM plants fix their carbon dioxide in the form of malic acid at night, accumulate this in their cell vacuoles, and then metabolise it again during the daytime, releasing their own internal store of carbon dioxide for photosynthesis behind closed stomata. CAM photosynthesis has been studied in detail in terrestrial families such as the Cactaceae, Agavaceae and Crassulaceae, but is also quite common (though much less investigated) in epiphytic members of the Bromeliaceae and Orchidaceae.

For a number of years, I have been interested in exploring the precise relationship between CAM photosynthesis and ecological diversification and habitat specialization in Bromeliaceae. Was CAM photosynthesis a 'key innovation' that permitted radiation of bromeliads into more arid habitats? What was the relationship (if any) between the origins of the epiphytic life-form in the family and CAM photosynthesis? Has CAM arisen just once in the family or on multiple occasions independently? Reflecting on these issues – and after several formative conversations with the systematics specialists in Oxford – I realized that nothing short of an all-out phylogenetic assault on the entire family would provide proper answers to these questions.

The opportunity to embark on such a study arose a few years ago when I was awarded a fellowship from the Andrew W. Mellon Foundation by the Smithsonian Institution. This allowed me to collaborate with senior staff scientist Klaus Winter at the Smithsonian Tropical Research Institute in Panama, and with an Australian molecular systematics specialist, Darren Crayn (now a staff scientist at the Royal Botanic Gardens, Sydney). One problem we faced was that – although long regarded as an isolated and natural group – the Bromeliaceae appeared to show a very low degree of sequence divergence within the family at the DNA level. This raised questions both about the choice of appropriate outgroup for rooting our phylogenetic tree, and about which genetic loci might show sufficient nucleotide sequence divergence to produce a well resolved tree.

Many lines of evidence now place Bromeliaceae within the large order Poales, but there have been different opinions about the family's immediate sister group. Most specialists regard Rapateaceae as being amongst the closest relatives of Bromeliaceae, and the two show some interesting ecological parallels. In both families, the basally diverging lineages are centred on the Guayana Shield of southern Venezuela. This is a dissected landscape of open habitats with rather infertile soils, dominated by a system of sheer-sided tabletop massifs (tepuis). Curiously, both Bromeliaceae and Rapateaceae, although almost exclusively Neotropical, are represented by a single species in West Africa, a result of chance long-distance dispersal (rather than Gondwanan vicariance). In a preliminary study of Rapateaceae – a little investigated family of about 100 species – we established that all species use the standard C_3 form of photosynthesis and found no evidence of CAM photosynthesis (Crayn *et al.*, 2001). (These assignments can be made by analysing by mass spectrometry the ratio of the two stable isotopes ^{13}C and ^{12}C in a few milligrams of dried plant material, since CAM plants discriminate less against the heavier ^{13}C isotope than do C_3 plants.) CAM photosynthesis is also unknown in other possible sister groups of Bromeliaceae, such as Typhaceae (+ Sparganiaceae) and Mayacaceae. These results suggested that C_3 photosynthesis was the ancestral condition in the common ancestor of these families, and that CAM photosynthesis must be the derived, apomorphic character-state.

So what further information does analysis of the ingroup, Bromeliaceae, provide about the evolutionary origins of CAM photosynthesis? We needed to confront the problem of low nucleotide sequence divergence within Bromeliaceae, which has also been found to characterize a number of other monocot families such as palms. This could either mean that rates of DNA sequence evolution in Bromeliaceae are intrinsically slow, or that the family is relatively young, or some combination of the two. At any rate, by combining sequence information from two relatively rapidly evolving chloroplast loci – the *matK* gene and *rps16* intron – we were able to obtain a well resolved phylogenetic tree of relationships within the family for all the principal genera (Crayn *et al.*, 2004). We also combined this analysis with a broad survey of carbon-isotope ratios in over 2000 bromeliad specimens sampled from various herbaria (principally HB, MO, NY, SEL, US and VEN).

Our study showed that both CAM photosynthesis and the epiphytic habit have arisen on multiple occasions within Bromeliaceae – but also that there is no obligatory association between the two. For example, in subfamily Tillandsioideae, all species are epiphytic, whereas CAM photosynthesis is restricted to more xeromorphic members of the derived (but very large) genus *Tillandsia*. In contrast, in subfamily Bromelioideae, the great majority of species (> 90 %) show CAM photosynthesis, but here the terrestrial life-form is plesiomorphic and epiphytism is found only in more derived lineages. Another finding was that the old subfamily 'Pitcairnioideae' is grossly polyphyletic, as had been suspected for some time, containing both the most basally diverging, C_3 lineages within the family (e.g. the Guayana Highland endemics *Brocchinia*, *Cottendorfia* and *Navia*), as well as separate, more derived lineages. Amongst these latter are three biogeographically distinctive clades of xeromorphic taxa containing CAM plants: (1) the genus *Hechtia*, mainly restricted to Mexico, (2) the largely Andean genus *Puya*, and (3) *Deuterocohnia*, *Dyckia* and *Encholirium*, centred on the arid regions of northern Argentina and south and eastern Brazil. *Puya* is of special interest because, in addition to *Tillandsia*, it is one of the few genera to contain both C_3 and CAM taxa, so these groups could be particularly informative about evolution of photosynthetic pathways at the species level. All the most extreme epiphytes in the genus *Tillandsia* – the so-called 'atmospherics', which have a dense covering of trichomes over the whole shoot – are CAM plants. So, in this respect, the evolution of CAM photosynthesis in the family may be regarded as a prerequisite for colonization of the most extreme epiphytic niches (including characteristic habitats such as telephone wires).

Our findings also have a bearing on a long-standing controversy concerning the evolutionary origins of epiphytism in Bromeliaceae. The 19th-century plant biogeographer A.F.W. Schimper originally proposed that tropical epiphytes arose from terrestrial ancestors in the forest understory; he suggested that, in 'striving for light', some of these forms migrated up the forest profile and eventually colonized the canopy. Although this model appears applicable to some families of rain-forest epiphytes (especially climbers and hemiepiphytes), a radically different hypothesis was proposed in the early 20th-century by M. Tietze, and was subsequently elaborated by C.S. Pittendrigh (later famous for pioneering work on circadian rhythms). These authors proposed that bromeliads may have originally entered the forest as epiphytes derived from terrestrial forms already adapted to relatively exposed, open habitats. Subsequent diversification and radiation of this lineage could have led both to more extreme epiphytic forms, as well as to species able to tolerate the lower strata of the forest profile. This latter scenario neatly explains the complete absence in the forest understory of soil-rooted transitional forms expected under Schimper's hypothesis: at least in subfamily Tillandsioideae, even the bromeliads growing close to the forest floor are strict epiphytes, independent of the soil for their nutrition, often growing on a fallen branch or twig.

Inevitably, perhaps, our results suggest that the evolutionary history of epiphytism was a little more complicated. For a start, the epiphytic habit clearly arose independently in Tillandsioideae and Bromelioideae. The last common ancestor of Tillandsioideae was a C_3 plant, but was already epiphytic; subsequent diversification has led both to the more extreme epiphytic forms found in *Tillandsia* (and eventually to the evolution of CAM photosynthesis), as well as to highly shade-tolerant species in genera such as *Guzmania*, *Vriesea* and *Werauhia*. In contrast, all the epiphytic lineages in Bromelioideae appear to be derived from terrestrial ancestors that had already acquired CAM photosynthesis, and so were presumably more drought-adapted. This view of bromeliad evolution is certainly closer to that of the Tietze–Pittendrigh hypothesis than to Schimper's. But the lesson may be that we should be cautious about sweeping generalizations and should examine each lineage carefully on a case-by-case basis. A unifying theme, however, first suggested by E. Medina (IVIC, Caracas, Venezuela), is that the immediate terrestrial ancestors of these epiphytic lineages were most likely adapted to exposed, nutrient-poor habitats, and possibly had even evolved absorptive trichomes. These forms may have been poised ready to take the leap necessary to exploit the epiphytic niche – and indeed certain species of present-day *Aechmea* are equally common in both terrestrial and epiphytic growth-habits.

What about future directions? Having answered some of the phylogenetic questions in Bromeliaceae, we are currently completing a more detailed analysis of the relationship between photosynthetic pathway, plant life-form, ecology and biogeography in the family. This will incorporate some new information that I obtained during fieldwork in the Merendón Mountains in northwestern Honduras last August with Operation Wallacea. We are also collaborating with Tom Givnish (Madison, Wisconsin, USA) and others on a large multi-locus study of Bromeliaceae, which we hope will lead to a fully resolved phylogenetic tree containing almost all of the 56 genera in the family. Further, I have been conducting some biochemical work on Bromeliaceae together with Joe Holtum, a colleague from James Cook University, Townsville, Australia, including perhaps the most famous bromeliad of them all, *Ananas comosus* (pineapple). We are interested in using this exceptionally stress-tolerant crop plant as a model for understanding aspects of plant adaptation to high light, high temperatures and drought, bearing in mind the severe challenges that will be posed by the direction of future climate change.

In the course of this work, Darren Crayn was able to visit Oxford on two occasions for a total of several weeks. During this time, we benefited greatly from the advice and constructive comments of many members of the Oxford Plant Systematics group, in particular Jill Harrison, Colin Hughes, Robert Scotland, Tim Waters and John Wood, and we received very valuable assistance from the staff of OXF and FHO. We have also discovered that FHO holds a fine collection of epiphytic myrmecophytes from the family Rubiaceae, which we believe might warrant a prize for the most unexpected group of plants currently known to exhibit CAM photosynthesis!

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Andrew Smith



Puya raimondii Harms, a high altitude terrestrial bromeliad growing in puna vegetation at 4000 m in Ancash, Peru. (Photo Colin Hughes)

400 years old! [A book herbarium from Italy]



Herbarium Diversarum Naturalium, pages showing specimens numbered 304 and 305, *Gentiana* species collected in 1606

In Italy, at the beginning of the 17th Century, a very industrious Capuchin monk named Gregorio da Reggio (Emilia) studied and collected plants. The fruits of his labours still exist today (in Oxford) in the form of a book containing about 300 dried plant specimens, all of which are labelled with a good deal of information. The book herbarium itself is labelled "*Herbarium Diversarum Naturalium Gregorio a Reggio*" and the collection is dated 1606.

During the Renaissance, the Capuchin monks made known their love of nature and belief that every living thing be seen as a gift to mankind. Research into the natural world followed and Gregorio da Reggio was dedicated to studying the plant kingdom and the uses plants could be put to medicinally. He worked in an 'infermariae' at curing his 'brothers' of their illnesses. He lived in Emilia-Romagna. The year he was born remains a mystery but it is thought he died about 1618 in Fontevivo. Gregorio da Reggio was well respected in the botanical and medicinal world of the day. This is borne out by letters. He wrote to the Dutch botanist Carolus Clusius (Charles de l'Ecluse) (1526-1609) mentioning his work in the infirmary. During 1606 Fr. Gregorio made his collection of dried plants from places he visited around Bologna, especially from the mountains of Parma and Piacenza. Most unusually for the time, the specimens are extremely well labelled giving names for the plants, followed by notes, sometimes on the habitat, the locality, often the medicinal uses of the plant and sometimes other information such as the time of flowering. Synonyms of the names are also given. There are many references to the names given by previous writers of herbals /botanists – for example those described by Dioscorides, Brunfels, Fuchs, Caesalpino, Lobel and Bauhin. The Monastry must have housed a significant library to enable Fr. Gregorio to add the references to his plant labels. All the labels are written in Latin and the plant names given are in the form of polynomials, as this collection was prepared almost 150 years before the introduction of the binomial system devised by Carl von Linnaeus.

Fr. Gregorio was regularly accompanied on field trips by his friends, Alessandro Amico and Christophorus Pogginus. Pogginus was instructed to produce a handwritten volume consisting of the collection labels from the book herbarium. This volume is now to be found among the manuscripts in the Sherardian Collection in Plant Sciences Library (MSSherard 252). It is entitled "*Reductorium plantarum aridarum*". The script is now bound into a book and is some 365 pages long. It is signed by Christophorus Pogginus at the end, which is preceded by a short prayer. This manuscript was obtained by John Sibthorp (1758-1796), Sherardian Professor of Botany at Oxford, probably when he passed through Bologna on his way to Greece and the Aegean in 1786 on his expedition to try and re-discover the medicinal plants described by Dioscorides centuries before.



Reverse of page 54, specimens numbered 228, '*Lysimachia*' species

The plants themselves are mounted on thick grey paper, the paper produced before any refined techniques for its manufacture came into being, and is fortunately acid-free and therefore of archival quality. The plants have been fixed to the paper by a glue perhaps prepared by boiling up fish bones and skins, which is still working effectively. The Capuchin monks possibly wanted to economize on the binding of the volume itself and have re-used pieces of music taken from a discarded liturgical book of the later middle ages for the covers. A Senior Assistant Librarian from the Bodleian Library understood the music on the covers to be in plainchant which could date from between the 13th and 15th centuries.

Nearly all the plants preserved in the collection have recognisable 'generic' names today e.g. *Ranunculus*, *Solanum*, *Digitalis*, *Hypericum*, *Pyrola*, *Thlaspi*, *Nicotiana*, etc., although none have been re-determined since they were collected four centuries ago. Often there are two specimens mounted on the same page, but with their own separate labels. Much care must have gone into the arrangement of the plants in the book, as they are not simply randomly arranged, an attempt has been made to place plants with similar characteristics together. A number of different plants in the Asteraceae have been placed one after the other, similarly grasses have been placed together, and an *Echium* species has been coupled with a species of *Cynoglossum*, both we know now as in the family Boraginaceae. In one particular case a species of *Polygala* and a species of *Linaria* have been mounted on the same page as they have similar linear shaped leaves and habit.

This is the oldest herbarium collection held in the Fielding-Druce Herbarium at Oxford and it has survived remarkably well for 400 years. It was presented to William Sherard by his friend Giuseppe Monti (1682-1760), the Italian Professor of Botany and Director of the Botanic Garden in Bologna. William Sherard (1659-1728) left his collections to Oxford University on his death and founded the Sherardian Professorship of Botany. Giuseppe Monti was expecting to receive from Sherard a copy of Hans Sloane's *Natural History of Jamaica* Volume 2, in exchange for the book herbarium, but unfortunately Sherard died before he had a chance to send it to Bologna. Monti, so

keen to receive the book, then asked William's brother James Sherard to send it to him. James, unhappy at not being left a legacy from his brother's Will, made some excuse for not sending the book. However, we know from letters in the Sherard Correspondence, that William's friend and colleague, Johann Jacob Dillenius, came to the rescue and sent a copy of the *Natural History of Jamaica* to Monti so that there would be no slight against the memory of William Sherard.

Besides being the oldest collection in Oxford University Herbaria, the Gregorio da Reggio book herbarium is one of the oldest collections of dried plants in the world (after those of Ulisse Aldrovandi dated 1551 in Bologna and Andrea Caesalpino dated 1563 in Firenze). It could be the oldest collection of its kind in the UK today having made its way from Bologna, the birthplace of the drying and pressing method of preserving plants. It seems quite remarkable that the process used for preserving plants in the 17th century has proved to be so effective that we still use a similar technique for preserving plants for scientific study in the 21st century. It is also surprising that the Gregorio da Reggio collection has never been studied in detail given that it is so well labelled for its time. The collection deserves further attention.

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Acknowledgements

I would like to thank Paolo Piazza, of the Plant Sciences Department, for translating the Italian script of the second reference.

Serena Marner

Bobart the Younger's *Hortus Siccus*

One of the problems with growing unusual plants is keeping them alive. In the mid-17th century, unusual plants were arriving in the European gardens from Africa, Asia and the New World and the Bobarts, father and son, tried to germinate and propagate these new curiosities. They had their successes and their failures. Some of their successes were recorded in the two Catalogues of the Botanic Garden published in 1648 and 1658. Unusually, we also know something of their failures, as these were not converted to compost but became part of the Bobarts' *Horti Sicci* or herbaria.



Portrait of Jacob Bobart the Younger
Department of Plant Sciences

Jacob Bobart the Younger (1640-1719) was a son of Jacob Bobart the Elder (?1599-1680), succeeded his father as *Hortus Praefectus* of the Oxford Botanic Garden, and remained in charge almost until his death. Bobart the Younger was evidently a precocious botanist, as he received special mention for his contribution to 1658 Catalogue. Like his father, Bobart the Younger was a skillful plantsman, developed the Garden, exchanged plants with a wide range of the botanical elite of the late-17th and early-18th centuries, for example, William Sherard (1659-1728), Hans Sloane (1660-1753) and John Ray (1627-1705), whilst his plants populated the great gardens of the day, for example, he attracted the envious attention of Duchess of Beaufort (1630?-1714). Furthermore, in 1699, he completed the third part of Robert Morison's (1620-1683) *Plantarum Historiae Universalis Oxoniensis*.

Bobart the Younger evidently saw the values of both living and dead gardens; values that were forcefully made by Professor Charles Daubeny in 1853 when he emphasised the partnership of the living and dead in botanical research and teaching. This partnership continues to the present day. Yet the recognition that such collections were valuable was not new. Evans, in his prose poem *Vertumnus* (1713), written to praise Bobart the Younger, makes similar points rather more verbosely:

'Their Barks, or Roots, their Flow'rs, or Leaves,
Thy HORTUS SICCUS still receives:
In Tomes twice Ten, that Work immense!
By Thee compil'd at vast Expence;
With utmost Diligence amass'd,
And shall as many Ages last'.

Indeed, this is the first mention of Bobart the Younger's herbarium. The most complete reference is found in the catalogue to Bobart's library, where two items are mentioned; a *Hortus Siccus* of 38 volumes and mixed *Horti Sicci* of eight volumes. All histories of the Botanic Garden in Oxford make reference to the herbarium of Bobart the Younger as comprising two collections; the collections associated with the publication of Morison's *Plantarum Historiae* (the Morisonian Herbarium), and the more poorly known 'Bobart's *Hortus Siccus*'. It is the latter collection that is of interest here.

Bobart's *Hortus Siccus* comprises specimens mounted on paper, each specimen labelled with a Latin phrase name and a common name. Originally, the sheets were bound together as books arranged according to Morison's *Sciagraphia*, and stored in the Botanic Garden. Today, the *Hortus Siccus* is part of Oxford University Herbaria, Department of Plant Sciences, and is stored as separate sheets in 16 boxes, although when the bound volumes were cut-



Helianthus annuus "Chrysanthemum Indicum annuum maximum sive flos solis major. Great annuall Sunflower." Bobart *Hortus Siccus*, Box 6, f. 46

up is unclear. There are indices at the start of some of the volumes, which George Druce (1850-1932) used as evidence that the sheets were originally bound as 14 volumes. However, the indices are written on paper from George III's reign, long after Bobart the Younger had died. The majority of labels are in Bobart the Younger's hand, and all the specimens are undated and collection sites are not given. The dating of the *Hortus Siccus* is difficult, although it is likely to have been created early in Bobart the Younger's career. Previous commentators on the *Hortus Siccus* have placed considerable weight on a manuscript note, dated 24th November 1666, pinned into one of Bobart's notebooks preserved in the Plant Sciences Library, although there is no indication in Bobart's notes to what this date refers. Additional complications arise over



Tulipa sp. "Tulipa montrosa, The Royal Parrot." Bobart *Hortus Siccus* Box 3, f.110

where the material was collected. It is likely that the majority was from material growing in the Botanic Garden and around Oxfordshire, although some specimens evidently were not, for example, the marine alga that Bobart refers to as 'Fucus sive Alga latifolia major dentata' (*Fucus serratus*).

It should not be imagined that the *Hortus Siccus* is the mere 'refuse of nature', a record of horticultural failure. Many of the plants that it contains were evidently successfully grown by the Bobarts. As with the two Catalogues, the contents of the *Hortus Siccus* reveal that the Botanic Garden was not just a collection of medicinal plants. The *Hortus Siccus* is rich in the fashionable ornamentals of the day,



Digitalis purpurea "Digitalis vulgaris. Common Foxglove." Bobart *Hortus Siccus,* Box 4, f. 21

e.g. anemones, narcissi, hyacinths and myrtles, and foods and spices, e.g., cabbages, coriander and caraway. In addition, numerous developmental, colour mutations and variegated forms are represented, e.g., double anemones and wallflowers, which were starting to attract scientific interest. No doubt curiosities such as 'Ficus Indica minor', the *Opuntia* cactus, or 'Limonio congener Virginensis longiore folio', a North American *Sarrecenia*, were popular with visitors. Among the apparent horticultural failures one can find specimens represented by single, poorly prepared leaves, such as 'Staphis agria' or 'Hedera trifolia erecta Virginiana'.

The importance of Bobart's *Hortus Siccus* is three-fold; it provides a snapshot of a botanical collection made during an exciting period of Early Modern botanical investigation; is a means of verifying the identities of the names used in the 1648 and 1658 Catalogues; and illustrates the range of plants that the Bobarts were cultivating or attempting to cultivate in the mid- to late-17th century. Furthermore, the *Hortus Siccus* reveals some splendid common names (e.g., 'Bastard Bramble of Virginia', 'Frogs Lettice', 'Lancashire Asphodel' and 'Unpleasant Bawme') and is a collection that Druce credits with containing some of the first Oxfordshire records of native British plants.

Having been 'hidden' in the Oxford University Herbaria for over three centuries, a complete catalogue of Bobart's *Hortus Siccus*, together with images of all of the sheets, is now available using the links on either the Oxford University Herbaria website (http://herbaria.plants.ox.ac.uk/bol/?bobart).

Stephen A. Harris

News from the Herbaria

Fielding-Druce (OXF)

Although the refurbished Fielding-Druce Herbarium has been open to visitors for a year and a half or more, we are still receiving complimentary remarks over the up-dated facilities and environment. We have made full use of the new laying-out bench space during a number of group visits, the space being used for a number of different purposes at different times. The databasing and barcoding of the collections using BRAHMS by staff and students, and the digitization of type specimens, has been continuing throughout the year. Work on checking, relabelling and reorganizing the associated taxonomic literature housed in the herbarium was also carried out and is continuing by the Plant Sciences Reader Services Librarian.

All the OXF holdings of specimens in the families Chrysobalanaceae, Bromeliaceae and Eriocaulaceae (Fielding Herbarium) have now been added to BRAHMS online. The process of databasing has revealed that 35% of the OXF specimens of Chrysobalanaceae are types and 20% of the Bromeliaceae are types. At the same time the specimens were all re-organized and placed in new acid-free folders. The OXF Meliaceae specimens have also been databased and will be added to BRAHMS online shortly after some further checking of names.

Several hundred specimens from OXF were sent out on loan during the year, and on a number of occasions, images of historical specimens were posted on our website for identification purposes after requests. We are very grateful to Dr Bruno Ryves for having identified a substantial number of previously unnamed grasses from the Fielding Herbarium. We are also grateful to Dr Tom Cope at the Royal Botanic Gardens Kew for facilitating the loan and returning the material. A number of new specimens were added to the Druce Herbarium, donated and collected by Mr John Killick, these have been added to the BRAHMS database and are searchable on line.

Two historic specimens, one of *Sarracenia psittacina* collected by Mark Catesby from the Sherardian collection, plus a specimen of *Helleborus orientalis* collected by John Sibthorp, were lent to the Ashmolean Museum, together with a number of books from the Special Collections in Plant Sciences Library for an exhibition. The exhibition entitled *A New Flowering: 1000 years of Botanical Art* was open from 2 May until 11 September. The herbarium specimens were chosen to show the raw material used by the artists and naturalists Mark Catesby and Ferdinand Bauer for the paintings of the plants they prepared, which were displayed at the Museum. The exhibition was based on Dr. Shirley Sherwood's collection of botanical art, also included items of botanical art from various Oxford University Libraries including Plant Sciences. The exhibition was very popular. It precipitated a number of visits to the herbarium to view more herbarium collections and associated botanical art, especially the Sibthorp and Bauer collections. The visits included a number of members from the Bobart Group of the Friends of the Oxford Botanic Garden in February and in June, twelve members of the Eden Project Florilegium Society were given a tour of the herbaria before they visited the exhibition.

Again in February, members of the Rare Plants Group of the Ashmolean Natural History Society of Oxfordshire asked for a return visit to OXF especially to view specimens of Oxfordshire rare species from the historic collections that they had been monitoring in the wild. This visit proved

very popular and the herbarium was full to over-flowing on the occasion!

On 23 June we organized and hosted a day's meeting of talks for the Oxford University's Museums and Collections Histories Group. At the end of the day we gave a tour of the herbaria to the group. It was a nice opportunity to meet with, and show the herbaria and the work that takes place within it, to our colleagues from other museums in the University. We hope this may lead to some collaboration on various projects in the future.

During the summer, Eliana Calzadilla from Bolivia was based in OXF. Eliana came to receive instruction in botanical illustration from Rosemary Wise (see article on Darwin Initiative Project page 5). Also in the summer, four students spent about a month in OXF searching for and databasing Caribbean specimens from the Fielding and Du Bois collections (see page 3 for information on the Trinidad and Tobago Darwin Project).

We were very saddened to hear of the death of Mr Richard Palmer earlier in the year. Richard Palmer was a regular visitor to OXF for more than 40 years. He had been introduced to Oxford University Herbaria by his friend, the late Dr Brian Styles (Forest Botanist). Over many years Richard Palmer presented the herbarium with over 1100 specimens collected in the UK and several hundred plants from Majorca, Minorca and Turkey. Many of his British specimens were collected in Oxfordshire and have since been cited in the 1998 *Flora of Oxfordshire* by John Killick, Roy Perry and Stan Woodell. Other specimens he donated had been collected in Shetland, and after many visits there he wrote a flora of the islands with Walter Scott entitled *The flowering plants and ferns of the Shetland Islands* which was published in 1987. He cited many other specimens held in OXF in his flora. Richard Palmer was a meticulous botanist and collector of plants. His specimens are indeed a valuable, more recent part of the collections in OXF. His specimens were always named, well labelled and presented – he always mounted the specimens himself for the herbarium. Richard was a lexicographer and Latin scholar and was an invaluable help to many post-graduate students in taxonomy over the years in translating the descriptions of new taxa into Latin for them. We are also indebted to him for the bequest he left the herbarium in his Will. He will be sadly missed but his legacy will help future generations of botanists.

Serena Marner

Daubeny (FH0)

The Daubeny Herbarium has had a year of substantial activity. Fortunately, the new layout following the refurbishment in 2001 has allowed us to accommodate our resident staff and researchers involved in projects based in this department as well as visitors from other university departments and other institutions. However, we were often in a 'Cox and Box' situation over the multiple use of desk space due to the loan material being moved into the current space of the Daubeny Herbarium at the beginning of the year. This involved much moving of heavy boxes – again – all of which had to go through one domestic-sized freezer before it came into FHO. The process took 4 months to complete! Loan material is stored in sturdy filing boxes on specially constructed shelving which now stands on some of the work tops. As well as reduced desk space, 'laying-out' space is now also at a premium.

The processing of our own specimens, whether they be new to the collection or already in it, has now reached the stage when all aspects can be done in a logical sequence which prevents extracting specimens from the collection more than once. Following mounting and accession for new specimens, and extraction from the collection for old specimens, the databasing using BRAHMS is now routine and includes barcoding the specimen. If the specimen is to be photographed, a digital image is taken with the Nikon D100 camera which is then transferred to the computer and linked to the database by means of the barcode (see article: *The Oxford University Herbarium database* in *OPS* **12**: 11). Only when all this has been done is the specimen incorporated or replaced into the collection. All specimens being sent out for loan are barcoded and entered on the herbarium database; a separate database is used for specimens arriving in FHO on loan from elsewhere.

The above process has been of great use in conjunction with two current projects in FHO. Firstly, the processing and documenting of the specimens collected during the field work for the book by William Hawthorne entitled *Caribbean Spice Island Plants: trees, shrubs and climbers of Grenada* (see *OPS* **12**: 11-12) before they were incorporated into FHO. This also added information to the Virtual Field Herbarium web site. Secondly, all the FHO holdings of *Aglaia* (Meliaceae) have now been fully databased, including recent name changes, barcoded and the Type specimens photographed. This has also contributed to an FRP-funded project held by Caroline Pannell to produce a database of *Aglaia* for BRAHMS online (BOL – see page 13).

The Oxford-Bolivia Darwin Project has had some of its activity centred on the Daubeny Herbarium with the training of Bolivian research staff. To this end we welcomed three Bolivians to Oxford in the summer of 2005, following on from a successful visit the previous year by three others (see *OPS* **12**: 8-9). This year Hibert Huaylla (working on Iridaceae here and at Kew), Magaly Mercado (working on *Scutullaria* here and at Kew) and Eliana Calzadilla (working with Rosemary Wise on botanical illustration) joined us for several weeks.

The availability of the imaging facilities also allowed the Darwin Trinidad and Tobago Project to employ three undergraduate students over the summer of 2005 to database and photograph all the FHO and some of the OXF Caribbean specimens. This contributes to part of the herbarium training and specimen availability requirement of the project.

The Daubeny Herbarium is providing a resource for researchers in the Oxford University School of Geography and the Environment to sample specimens for pollen. This is only allowed from specimens with plenty of floral material and is on the understanding that a duplicate slide of the pollen is presented to FHO. These are added to the associated collection of microscope slides which is available alongside the herbarium specimens. They have been using this facility for about three years now as one method of monitoring the long-term relationship between vegetation dynamics and environmental change.

Loan specimens have continued to go in and out as various projects require. Additional material of *Aglaia* for Caroline Pannell, West African specimens for William Hawthorne, Bolivian/South American specimens for John Wood and Robert Scotland and *Lupinus* specimens for Colin Hughes have arrived this year. *Strobilanthes* (Acanthaceae) material is beginning to be returned as the major revision of this genus reaches its final stages.

FHO continues to be the depository for current research material of members of the systematics group in Oxford as well as being a collection valuable to other herbaria, especially for African and Central/South American specimen requests. A considerable number of specimens have been added to BRAHMS online this year, which we hope will gradually become a useful tool for remote searching of our collections. During the coming year we hope this facility will develop further towards the goal of exchanging images and determinations on a regular basis, linking with other databases and further input into the Virtual Field Herbarium.

Alison Strugnell

For the Oxford Herbaria online see:
http://herbaria.plants.ox.ac.uk/bol/?oxford

Back issues of OPS will soon be available for viewing on the Oxford University Herbaria web page:
http://herbaria.plants.ox.ac.uk

Aglaia online

Introduction

The genus *Aglaia*, with 120 species, is the largest in the Mahogany family (Meliaceae). It is a common component of the rain forests of SE Asia, is grown as a fruit tree and yields perfumes and bioactive chemicals of insecticidal and therapeutic value. It is a taxonomically complex genus. Although the first ever comprehensive treatment of the classification of the genus was published in 1992, the results of this work remained largely inaccessible to foresters and researchers. They still needed access to accurate identifications of existing collections and accurately identified reference collections against which new collections could be matched. The availability of reference collections would aid them in their search for new, potentially useful active chemicals, lead structures for drug-development, and for *Aglaia* trees suitable for use in forestry and village economies.

In order to disseminate information on *Aglaia* more widely, databases for specimens, nomenclature and literature references have been created for BRAHMS online (BOL). This will enable users to identify and further investigate individual species of *Aglaia*.



Leaves of *Aglaia densisquama* Pannell, from the Semengoh Arboretum near Kuching, Sarawak held by Caroline Pannell

Output

A new project, *Aglaia,* has been added to BOL (http://herbaria.plants.ox.ac.uk/bol/?Aglaia). It includes the following data:

a) *Nomenclature.* There are over 600 published names for *Aglaia* and synonymous genera such as *Amoora*. The database of accepted names and their synonyms enables researchers to apply up-to-date names when reporting their research. It includes new developments in the taxonomy of the genus since the taxonomic monograph of the genus was published in 1992 and the *Flora Malesiana* account in 1995. It enhances communication of research results, which are often difficult to interpret or repeat because of use of non-accepted names.

b) *Bibliography*. Much of the published research on the genus is brought together in one place. References on phytochemical compounds and their bioactivity are presented, along with field surveys and ecological investigations of species in the genus. The bibliography has been compiled using search facilities such as ISI Web of Knowledge, PubMed, NCBI, Google, Google Scholar, EMPAS and Synergy.

c) *Specimens.* These have been made available to us by the directors and curators of herbaria with large holdings of *Aglaia* and by individual research groups who have made collections of smaller numbers of specimens associated with their phytochemical or molecular research. So far, only those databases for which determinations have been verified during the course of this project are posted on the website in order to maintain a high level of accuracy in the information presented.

As part of her contribution to the *Tree Flora of Sabah and Sarawak*, Caroline Pannell visited the herbaria of the Forestry Departments of Peninsular Malaysia (KEP), Sarawak (SAR) and Sabah (SAN) in May 2005 and determined the entire holdings of *Aglaia* in each. A total of over 6000 sheets, were determined, so that there is a named reference collection for the genus in each of the Malaysian herbaria to accompany the account for the flora. The existence of such reference collections is important for local identification of new specimens collected for phytochemical, molecular, taxonomic, ecological or forestry-related research on the genus. By publishing these data online, we can thus provide up-to-date information to local researchers, scientists and curators.

d) *Images of living plants* of those *Aglaia* species for which we have photographs have been linked either to individual specimen or to species names. Most of these images have been scanned from transparencies taken in 1978, 1979, 1981, 1983 and 2004. A few were taken with a digital camera in May 2005. If a herbarium specimen was collected from the plant photographed, the scanned image has been labelled with the collector and number and is linked to its herbarium specimen.



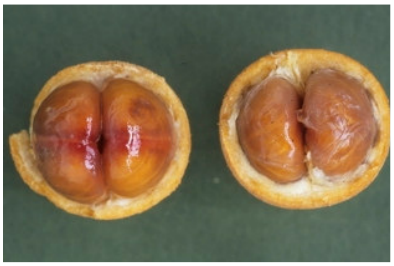
Aglaia tenuicaulis, undersurface of leaf



Aglaia macrocarpa, fruits and leaves



Agalia odorata, type species of the genus



Aglaia forbesii, fruits opened to show arillate seeds

e) *Digital images of type specimens* housed in the Daubeny Herbarium, Oxford, have been linked to the relevant specimen in the FHO database.

Future development

Aglaia specimens from additional herbaria such as Edinburgh (E), are being prepared for inclusion in BOL. The addition of reliably determined specimens, including those of specimens associated with phytochemical and molecular investigations, will continue as they become available. Similarly, nomenclatural changes, new publications and further images will be added to the website periodically.

Acknowledgements

We are grateful to FRP for financial support for the preparation of the addition of *Aglaia* to BOL, to the Tree Flora project for funding Caroline Pannell's three-week visit to Malaysia and to the Directors and Curators of the three Malaysian Forestry herbaria, KEP, SAN & SAR for giving us permission to publish their databases in BOL.

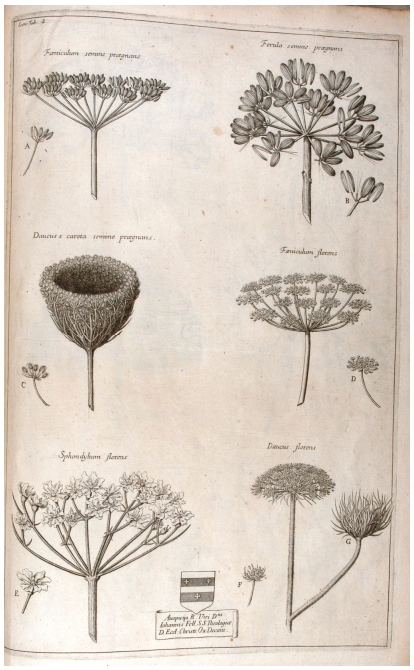
Caroline Pannell

Robert Morison, the first Professor of Botany at Oxford

Robert Morison (1620–1683), was appointed as the first Professor of Botany at the University of Oxford in 1669, after the Restoration of Charles II in 1660 when he was appointed Royal Physician. The University allowed him a stipend of forty pounds a year, and 'caused' him to read in the Physic Garden, at appropriate times of the year.

From then on, with the encouragement of powerful patrons in the University, notably Dr. Fell of Christ Church and Obadiah Walker of University College, both founder delegates of the Clarendon Press (later to become the Oxford University Press), Morison's chief occupation was the planning of his ambitious *Plantarum Historiae Universalis Oxoniensis seu Herbarum distributio Nova per Tabulas Cognationis & Affinitatis ex Libro Naturae Observatae & Detectae*. This was to be published in three parts, but the 1680 volume, *Pars secunda*, was the only one completed in Morison's lifetime. Completion of the work on the third volume, *Pars tertia*, was entrusted, by Dr. Fell, to Jacob Bobart the Younger who succeeded his father as Keeper of the Oxford Physic Garden. This was eventually published in 1699. The first part, intended to categorise trees and shrubs, was never published. There is however an enumeration of species of trees and shrubs in manuscript form in the hand of Jacob Bobart in the Sherard Manuscript Collection, Plant Sciences Library, plus corresponding specimens in the herbarium, which could have formed the basis for another volume. Morison intended that this work would illustrate, in every sense of the word, his taxonomic theories which principally used differences in the fruit to group plants into the 'genera' of pre-Linnaean botany (see illustration on back page). All parts of the *Historia* are fully illustrated by fine copperplate engravings, and corresponding contemporary herbarium specimens of the plant species illustrated and described in the work survive in the Morisonian Herbarium today.

In order to promote this vast publishing enterprise an illustrated Folio Monograph, *Plantarum Umbelliferarum Distributio Nova*, was published by the Clarendon Press in 1672. It is a kind of early example of fundraising, intended to encourage prospective patrons to subscribe to the *Historia* which would be thirty times as large and to introduce them to a practical working of Morison's taxonomic theories. This monograph is especially interesting as the earliest systematic monograph of a group of plants in Western botanical



Plantarum Umbelliferum Distributio Nova (1672) Icon Tab. 2

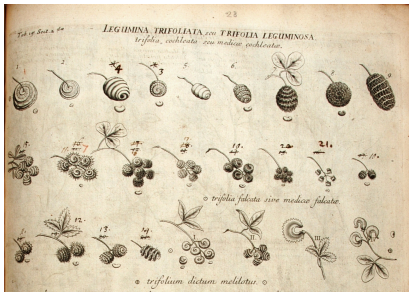
literature. In the Preface to the Reader, and brief introduction, Morison states the nature of his method: this is illustrated by eight diagrams ("tabulas cognationis and affinatatis") and by twelve copperplates, the first of which presents a series of figures of the fruits of the plants described, summarising the evidence upon which the arrangement of them is based. As Druce points out - the arrangement of umbelliferous plants and still more the illustrative diagrams "betray a remarkable sense of the relationships of the plants constituting a group" (Vines & Druce 1914: xli).

Possibly this monograph represents the most consistent account of Morison's theories for, as Druce also points out, when Morison departs from his principles in the 1680 *Historia*, *Pars secunda*, the mistakes can be quite serious. The only complete published statement of his principles "is to be found in an anonymous tract of twelve pages, the *Historiae Naturalis Sciagraphia* (1720) which is attributed to Bobart, though not published until after his death". This work is now in the Sherard Collection, Plant Sciences Library. Bobart recast Morison's treatment of Umbelliferae (Apiaceae) for *Pars tertia* of the *Historia*; "but, also both in *Pars tertia* and the *Sciagraphia* he did not hesitate to alter Morison's system; it must be admitted that such alterations as can be traced, are decided improvements" (Vines & Druce 1914: li).

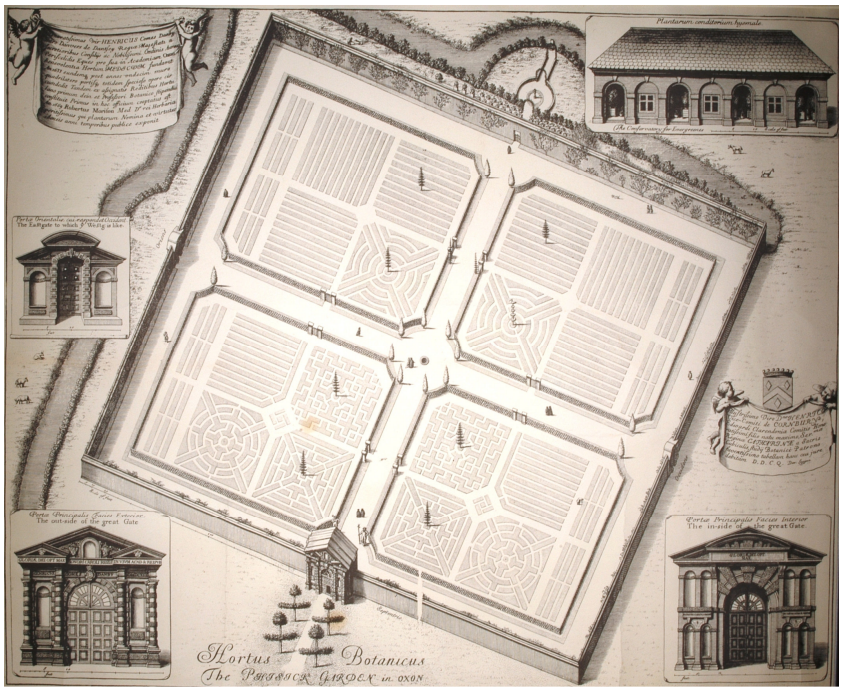
The *Plantarum Umbelliferarum Distributio Nova* (1672) is also possibly the first taxonomic monograph to be illustrated by copperplate engravings, none of them signed but all bearing the names and arms of the subscribing University patrons, headed by Obadiah Walker and Dr. Fell of Christchurch. Obadiah Walker had a folding plate specially printed from Morison's monograph as an illustration of logical subdivision for his book *Artis Rationis* (1673); and, according to Anthony Wood (*Fasti Oxoniensis* ii: 315) the Umbelliferae in the Physic garden were laid out in an order to further illustrate Morison's taxonomic theory.

Unfortunately none of the original copperplates for the monograph appear to have survived; but, seemingly miraculously, all the 126 original copperplates for the 1680 *Historia Pars secunda* have survived, plus all 167 for the 1699 *Pars tertia.* In 1996, Peter Foden, then archivist of the Oxford University Press, and I discovered these plates in use as counterweights to a lift in the Radcliffe Science Library – perhaps some indication of the present disregard for Morison and Bobart's work? Fortunately they were all wrapped in acid-free sugar paper and so perfectly preserved that they could still be printed from today. At present they are in the care of the Radcliffe Science Library. These copperplates are designed by distinguished artists, and finely engraved, mainly by David Loggan, appointed archeotypographus to the Press and the University, and by Michael Burghers who succeeded him.

Every plate in Part 2 (*Pars secunda*) of the *Historia* has the name, title and heraldic arms of the donor arranged in a kind of pecking order of class and occupation: the Royal family, with the exception of the King, and the premier aristocratic families come first, including, James Duke of Monmouth, and Prince Rupert, one of the founders of the Royal Society; then other members of the Royal Society not included in the first category like John Evelyn and Sir Christopher Wren. They are followed by members of the Royal College of Physicians, then by Pharmacists, including Jones, a pharmacist in Abergavenny, and finally John Rose 'hortulanus' to the Queen. As the order of the plates had to follow the order of Morison's system, a very distinguished patron is often associated with what might be thought a quite lowly



Part of Tab. 15 Sect. 2 from Morison's *Historia Pars secunda* (1680) showing fruits of leguminous species, drawn by Francis Barlow and engraved by David Loggan



Plan of the Oxford 'Physick Garden' 1675, by David Loggan

vegetable: for instance, the noble and honourable George Berkley, Baron de Berkley is patron of a plate, designed by the foremost animal artist of the day, Francis Barlow, illustrating "Legumina Scandentia capreolo".

A fascinating network of politics, patronage and professional interests in the turbulent times of Charles II can be traced through the dedications on these plates, for, as can be deduced from detailed study, Morison was able to enlist the favour of many very distinguished and powerful patrons. This was, probably, principally through his Royalist connections. During the Civil War Morison was severely wounded fighting for Charles I under Montrose at the Brig of Dee in 1644; he then fled to France, studied medicine in Paris and was made Doctor of Medicine at Angers. Through the recommendation of Vespasian Robin, Botanist to the King of France, he was appointed to manage the gardens of Gaston, Duke of Orleans, uncle of the future Charles II, at Blois with Abel Brunyer and Nicholas Marchant as his colleagues.

This background is significant when considering the career and work of Morison, not only for the connections he made, for it was while he was at Blois that he developed his interest in taxonomy rather than in medicine. He became acquainted with the work of continental taxonomists like Caesalpino (*De Plantis* 1583) and the Bauhin brothers, Caspar (*Pinax* 1623) and John (*Universalis Plantarum* 1650). Without going into too much detail here, it is clear that Morison is indebted to these men for the development and organisation of his taxonomic principles of classification, a debt he is reluctant to acknowledge; indeed he devotes a whole section in his first published work the *Praeludia Botanica* (1669) to a criticism of the Bauhins' theories which he called 'Halluciationes'. He continues these criticisms of the Bauhins and others in the lengthy Halluciationes sections of the1680 *Historia, Pars secunda*. Also in the *Praeludia* he casts aspersions on the classification system of John Ray's Botanical Tables which were included in Bishop Wilkin's *An Essay towards a Real Character and a Philosophical Language* (1668). Though Morison does not name John Ray (1627-1705), the criticism went home and caused bitter offence. Apparently Ray hesitated to publish again and so gave Morison's theories precedence of publication. This arrogance and refusal to acknowledge the achievements of others is not the way to win friends and influence people and probably accounts in a great part to the almost complete neglect of Morison's work today.

Ray had another reason to take offence for, as the title of the *Historia* makes plain, Morison justifiably prided himself on the fact that he worked from the Book of Nature. He took his duties of lecturing in the Physic garden very seriously. Anthony Wood records in the Annals of the Oxford of his time that Morison used to read "in the middle of the garden, with a table before him on herbs and plants thrice a week for five weeks space, not without considerable auditory". But unfortunately it is also on record that Morison used to remark frequently that Dr. Ray studied plants more in his closet than in gardens and fields. Although this remark would probably not cause great offence in research today, this slight seems to have caused enduring offence to Ray and his followers.

Richard Pulteney in his *Historical and Biographical Sketches of the Progress of Botany in England* (1790) considers that the credit of introducing systematic botany into England belongs to both Morison and Ray. As he expresses it, "Caesalpinus laid a foundation stone, on which, if our British architects raised a Gothic structure, their successor have improved it to a style of greater symmetry and elegance." This opinion was generally accepted by Linnaeus and his contemporaries, but today, though most botanists have heard of Ray, few, even in Oxford, have heard of Morison.

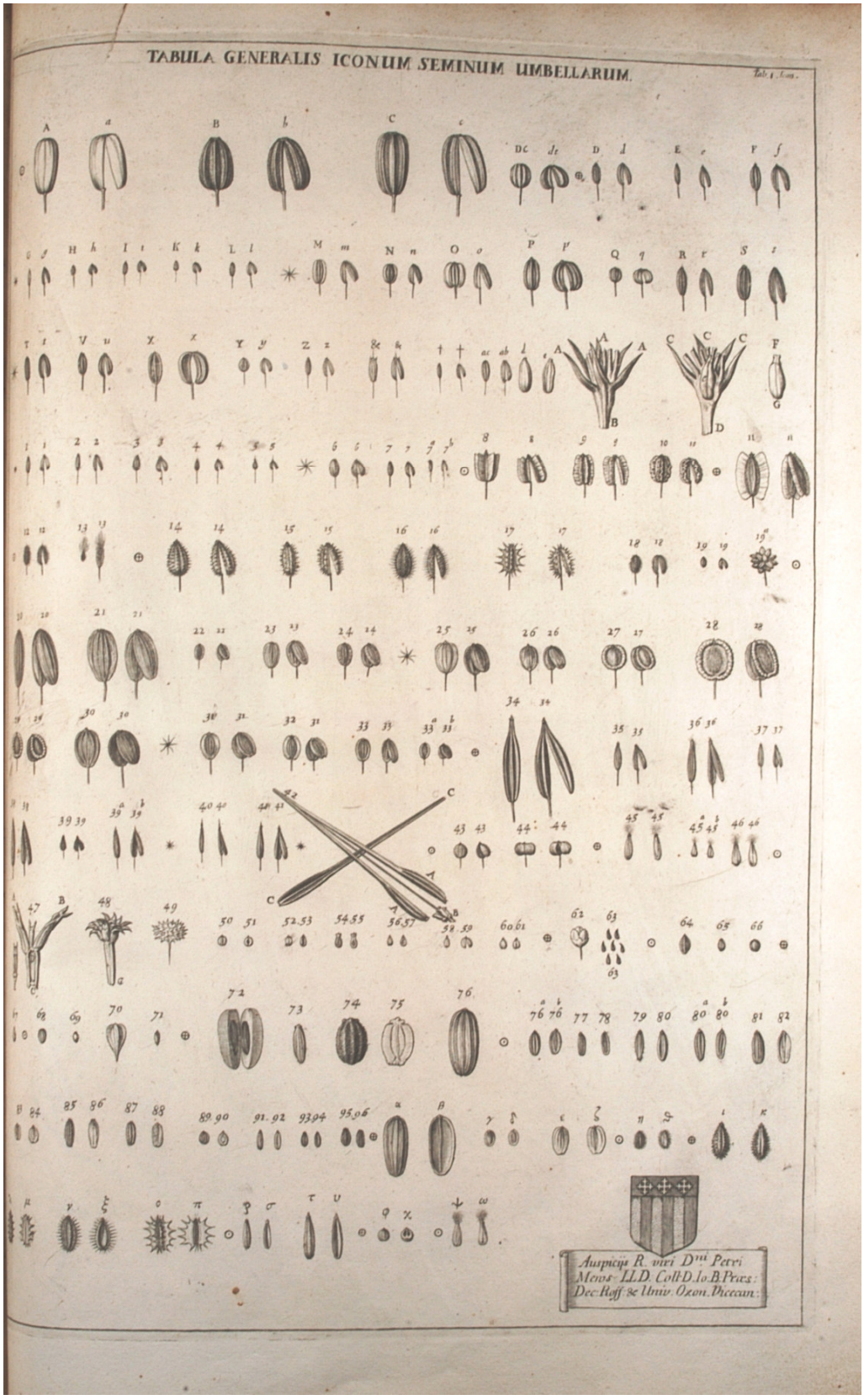
It is therefore to be regretted that these pioneers should have quarrelled, and though the fault is Morison's, so is the subsequent near obliteration of his reputation and achievements. Jacob Bobart the Younger, who continued Morison's work in the *Historia* and in the Herbarium, is clearly a very different character. He did not hesitate to learn from others, omitted all the Halluciationes sections, was on excellent terms with Ray and exchanged plants with Sloane, the Duchess of Beaufort and other leading botanists. He paid scrupulous attention to the accuracy of the illustrations, commenting on the proofs sent to him by Michael Burghers who is the principal artist and engraver in Part Three (*Pars tertia*), published in 1699. However, Bobart had to carry on Morison's work in a very different political climate. By 1699 the Stuarts were out of favour and there were few patrons for the plates.

Although the publication of the *Historia* was a financial disaster and placed a heavy burden on the early University Press, it represents a significant achievement in the history of printing and publishing – not just in Botanical literature, nor just in the history of the Oxford University Press, but also in the history of publishing in Great Britain. The illustrations particularly, which speak to the eye when laboured description fails (Pulteney 1790), represent a significant legacy from Morison to posterity: especially now that the Botanic Gardens are being laid out in "the New Order" (see article by Timothy Walker in *Oxford Plant Systematics* **12**: 10) and, most pertinently, the Herbaria are enjoying a new lease of life in contemporary research.

References

Vines, S.H. & Claridge Druce, G. (1914). *An account of the Morisonian Herbarium in the possession of the University of Oxford together with Biographical and Critical Sketches of Morison and the two Bobarts and their Works and the Early History of the Physic Garden 1619-1720.* Oxford Clarendon Press.

Anne Hancock
University of Bristol



Tab 1 from Robert Morison's *Plantarum Umbelliferum Distributio Nova* (1672), showing different fruits of umbelliferous species to illustrate the principle of his system of classification
Reproduced from Sherard 726, Plant Sciences Library, Oxford University Library Services

Oxford Plant Systematics printed by Parchments of Oxford