Oxford Plant Systematics

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

OPS 27 **August 2021**

Foreword

This year is the quadricentennial of the foundation of the Oxford Physic Garden in 1621. Botanical illustrations by five members of the Oxford Florilegium Group celebrate the Garden as a treasured open space in the university and city. A public exhibition, based on objects in Oxford University Herbaria and the Sherardian Library, reflects on the botanical contributions of all those who have worked in the Garden. However, most importantly, the anniversary is an opportunity to consider future directions, laying foundations for activities in the next 50 years. One major physical change will happen over the next five years. The departments of Plant Sciences and Zoology will join and move to a new home, which will include a purpose-built herbarium to accommodate botanical specimens, books and manuscripts.

The merger of past and future underlies most of the articles in this issue of *Oxford Plant Systematics*. Henrietta McBurney presents eighteenth-century naturalist Mark Catesby and his associations with Oxford botanists. Keith Kirby considers long-term ground flora change at Wytham Wood, near Oxford. Caroline Pannell presents collaborative research on Australian *Aglaia elaeagnoidea*. Denis Filer and Andrew Liddell present developments in the long-term BRAHMS project. Whilst William Hawthorne's new chorological map of the tropical African flora extends former Herbaria curator Frank White's work from the 1980s. Consequences of past decisions on current concerns are the focus of John Wood's article on indigenous names in taxonomy. However, it is with the work of the students and postdocs that future directions lie.

After another tough year under restrictions associated with the Covid pandemic, I hope you find the current issue of *Oxford Plant Systematics* of interest.

Stephen A. Harris
Curator of Oxford University Herbaria

Front cover images:
Top left, clockwise: watercolour illustration of *Berkheya purpurea* (DC.) Benth. & Hook.f. ex Mast. by Rosemary Wise; watercolour illustration of *Sorbus domestica* L.f. *pomifera* (Hayne) Rehd. by Maura Allen; coloured pencil illustration of *Juniperus drupacea* Labill. by Anne Girling; and watercolour illustration of *Lamium orvala* L. by Penny Land.

Typesetting and layout of OPS by Serena Marner

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Department of Plant Sciences, University of oxford, South Parks Road, Oxford, OX1 3RB, U.K. Tel. +44 (0) 1865 275000

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

News

Pablo Muñoz-Rodríguez, elected President of the Systematics Association

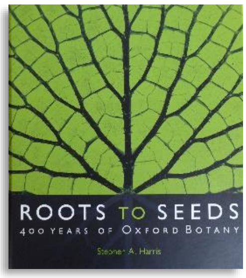
Pablo Muñoz-Rodríguez is president-elect of the Systematics Association (from December 2020) until he takes over the full presidency for three years from November 2021. The Association, committed to furthering all aspects of taxonomy and systematic biology, was founded in 1937 and has over 450 members worldwide at different stages in their research career. The association organises various events and activities throughout the year, as well as an international biennial conference —the 2015 edition was held at the Oxford University Museum of Natural History. For more information on the association, please visit https://systass.org/.

Rosemary Wise awarded the Engler Medal in Silver

Many congratulations to Rosemary Wise, botanical artist in the Department of Plant Sciences, for the award of the Engler Medal in Silver. The medal is awarded annually by the International Association of Plant Taxonomy for an outstanding monograph in systematic botany, mycology or phycology. Rosemary was awarded this medal as joint author with Terry Pennington for the monograph on *The Genus Sloanea (Elaeocarpaceae) in America* (2017). Rosemary prepared over 100 detailed illustrations for the monograph including 20 new species discovered by Terry.

Roots to Seeds exhibition

The foundation stone of Oxford Botanic Garden was laid in 1621. To mark this anniversary, objects from the botanical collections of Oxford University Herbaria, the Sherardian Library of Plant Taxonomy and the Department of Plant Sciences are on exhibition at the Weston Library. The exhibition, entitled *Roots to Seeds*, reflects on four centuries of botanical research and teaching in the University. It is curated by Stephen Harris and runs from 18 May to 24 October 2021. The book that accompanies the exhibition, *Roots to seeds: 400 years of Oxford botany*, is published by the Bodleian Library.



Wytham Woods – a new collection and a new book

Plant collecting is somewhat out of fashion in Britain and most of the specimens from Wytham Woods (near Oxford) are from the 1970s or earlier. During the summer of 2020, Keith Kirby and colleagues started a new collection of material, with about 70 species brought in. Only about another 450 to go, assuming that all that are on the historic list can be found again. The Wytham Management Committee also agreed with Oxford University Press to produce a new book about the research that has gone on over the Wytham Estate, during the next three years, to celebrate 80 years of University stewardship.

Keith Kirby's *Woodland flowers: colourful past, uncertain future?* on British woodland plants, their ecology and conservation, was published in August 2020 by Bloomsbury.

The Florilegium Project, update from Rosemary Wise

With the gradual lifting of Covid restrictions, the Florilegium group can now finally meet and continue recording the plants of the Oxford Botanic Garden and Arboretum. Apart from the months last summer between lockdowns, it has been a frustrating time for us, all anxious to continue but unable to. We have sadly lost Maura Allen who now lives in Tasmania. The fourteen or so members remain as enthusiastic as ever.

It is good to have two working in mediums other than watercolour, Anne Girling produces the most beautiful illustrations using coloured pencils and Graham Furze astounds us with his pencil drawings (see front cover images and image below).

Graphite illustration of *Gleditsia triacanthos* L. by Graham Furze.

Publications 2020

Adhikara, B. & **Wood, J.R.I.** (2020). *Thunbergia kasujuana*, a new species from Nepal. *Kew Bulletin* **75**: 26.

Bui Hong Quang, Tran The Bach, Sangmi Eum, Do Van Hai, Nguyen Sinh Khang, Le Ngoc Han, Tran Duc Binh, Nguyen Thu Thuy, Vu Anh Thuong, Ngo KienTrung, Ya-Ping Chen, Fritsch, P.W., Hu, Chi-Ming, Ngan, Lu Thi, Parnell, J.A.N., Sennikov, A.N., **Wood, J.R.I.**,Yi Yang, Kuznetsov, A.N., Kuznetsova, S.P., Nuraliev, M.S. (2020). Towards a floristic inventory of Bat Xat Nature Reserve, Vietnam: thirteen new national records of vascular plants. *Wulfenia* **27**: 233-250.

Cámara-Leret, R. et al. (99 authors including **Pannell, C.M., Scotland, R.W. & Wood, J.R.I.**) (2020). New Guinea has the world's richest island flora. *Nature* **584**: 579-583.

Carruthers, T., Muñoz-Rodríguez P., Wood, J.R.I., Scotland, R.W. (2020). The temporal dynamics of evolutionary diversification in *Ipomoea*. *Molecular Phylogenetics and Evolution* **146**: 106768.

Carruthers, T., Muñoz-Rodríguez P., Scotland, R.W. (2020). Evolutionary biology: a new phylogenetic framework for an iconic plant radiation. *Current Biology* 30(24): R1473-R1476.

Carruthers, T., Sanderson, M.J., **Scotland, R.W.** (2020). The implications of lineage-specific rates for divergence time estimation. *Systematic Biology* 69(4): 660-670.

Carruthers, T., Scotland, R.W. (2020). Insights from empirical analyses and simulations on using multiple fossil calibrations with relaxed clocks to estimate divergence times. *Molecular Biology and Evolution* 37(5): 1508-1529.

Carruthers, T., Scotland, R.W. (2020). Uncertainty in divergence time estimation. *Systematic Biology*: 12 December 2020.

Darbyshire, I., Goyder, D.J., **Wood, J.R.I.**, Banze, A., Burrows, J.E. (2020). Further new species and records from the coastal dry forests and woodlands of the Rovuma Centre of Endemism. *Plant Ecology and Evolution* **153**(3): 427–445.

Ditchburn, B., Wilson, T., Henderson, K., **Kirby, K.J.**, Steel, P. (2020). *NFI woodland ecological condition in England: classification results*. Edinburgh: Forestry Commission.

González-Gallegos, J. G., Bedolla-García, B. Y., Cornejo-Tenorio, G., Fernández-Alonso, J. L., Fragoso-Martínez, I., García-Peña, M., Harley, R.M., Klitgaard, B., Martínez-Gordillo, M.J., **Wood, J.R.I.**, Zamudio, S., Zona, S., Xifreda, C.C. (2020). Richness and distribution of *Salvia* Subg. *Calosphace* (Lamiaceae). *International Journal of Plant Sciences* **181**(8): 831-856.

Goodwin, Z.A., **Muñoz-Rodríguez P.**, Harris, D.J., **Wells, T., Wood, J.R.I., Filer, D., Scotland, R.W.** (2020). How long does it take to discover a species? *Systematics and Biodiversity* **18**(8): 784-793.

Harris, S.A. (2020). Physical and digital, not either or: making Oxford University Herbaria virtual. *Quarterly Journal of Forestry* 114: 123-128.

Nevado, B., **Harris, S.A.**, Beaumont, M.A., Hiscock, S.J. (2020). Rapid homoploid hybrid speciation in British gardens: the origin of Oxford ragwort (*Senecio squalidus*). *Molecular Ecology* **29**: 4221-4233.

Jara, E., **Muños-Rodríguez, P., Wood, J.R.I.,** Beltrán, H. (2020). *Ipomoea noemana* (Convolvulaceae) a new species from Ancash eastern slope in Peru. *Phytotaxa* **461**(4): 286-294.

Kirby, K.J. (2020). *Woodland flowers: colourful past, uncertain future.* Bloomsbury: London.

Kirby, K.J. (2020). The ash population in Wytham Woods. *Fritillary* **8**: 98-106.

Kirby, K.J. (2020). Tree and shrub regeneration across the Knepp Estate in Sussex, Southern England. *Quarterly Journal of Forestry* **114**: 230-236.

Marner, S.K. (2020). Investigating the history of the botanical collections made by William Dampier in 1699 from 'New Holland'. *Studies in Western Australian History* **35**: 5-20.

Wood, J.R.I., **Muñoz-Rodríguez, P.**, Williams, B.R.M., **Scotland, R.W.** (2020). A foundation monograph of *Ipomoea* (Convolvulaceae) in the New World. *Phytokeys* **143**: 1-823.

Wood, J.R.I. & Wise, R. (2020). *Salvia raymondii* subsp. *mairanae*. *Curtis's Botanical Magazine* **37**(1): 103-116.

Wood, J.R.I. & Wise, R. (2020). *Strobilanthes glutinosa*. *Curtis's Botanical Magazine* **37**(1): 117-130.

Student reports

Ben Jones (M.Sc. Res., 3rd year) **Bioquality and forest plantations in Japan**

Supervised by Professor Stephen Harris (Oxford) and Dr William Hawthorne (Oxford)

The primary aim of my research has been to investigate whether areas containing assemblages of globally rare plant species are adequately protected by Key Biodiversity Areas (KBAs) across Shikoku, and how species occurrence data can be utilised for conserving plant diversity.

To identify globally important sites and species, for the purpose of aiding plant conservation across Japan, the two main goals are:

1. To build an occurrence database of the Japanese flora, and to demonstrate its utility for identifying floristic regions and prioritising globally important sites and species for plant conservation.
2. To focus such analyses on Shikoku and determine if hotspot areas are adequately protected within the existing network of KBAs, leading to recommendation of candidate areas for increased protection.

Significant effort was spent assembling and cleaning the database. Data were compiled of 4,857,630 occurrence records, with 6,659 accepted species. Species and place names were cleaned and geolocated and analysed using a MS Visual FOXPRO database (Geophila). The database used the RBG Kew taxonomic backbone.

Occurrence records were divided into four samples units at four different resolutions. Data were analysed using ordination and classification methods in R, PCORD and ArcGIS to produce general vegetation-type maps. Revised bioquality maps were generated using standard functions in Geophila, and the main conclusions of this research can be summarised as follows:

1. Working within the Bioquality concept, assemblages of globally rare species, and thus areas of high conservation value have been identified across the island of Shikoku.
2. Areas of high conservation value are not sufficiently protected and candidate KBAs should be proposed to incorporate newly identified hotspot regions.
3. Further fieldwork is required to define precise boundaries for proposed KBAs.
4. Species occurrence data can be utilised for conserving plant diversity.

This research has been conducted in collaboration with the Shikoku Regional Forestry Agency (SRFA), the Kochi Prefectural Makino Botanic Garden, the University of Oxford's Botanic Garden & Arboretum, and the Key Biodiversity Area Partnership. There are ongoing discussions with partners in Japan as to how this research can inform forest management policy and support broader plant conservation efforts, and also with the Key Biodiversity Partnership for establishing a multi-species approach to establishing KBAs where plants act as trigger species.

Alex Sumadijaya (D. Phil., final year) **Systematics of *Stictocardia* Hall.f.**

Supervised by Professor Robert Scotland (Oxford). Funding: LPDP (Indonesia Endowment Fund for Education).

I am in the final stages of writing and compiling the results of my thesis. This thesis contains multiple lines of evidence, morphology and DNA sequences, assessed by phylogenetic inferences to discuss critically seven species previously recognized within the genus *Stictocardia.*

Tom Wells (D.Phil., 3rd year) **Using bioinformatics to further explore systematics of sweet potato wild relatives**

Supervised by Professor Robert Scotland (Oxford). Funding: Interdisciplinary Biosciences DTP (BBSRC)

The pandemic has meant the cancellation and ongoing postponement of planned fieldwork in Ecuador and Mexico, with Latin America particularly badly affected by Covid-19. It has also led to the closure of herbaria in the UK and the impossibility of visiting those abroad.

Partly as a result of these disruptions, the focus of my DPhil has shifted to the analysis of DNA sequence data from previously collected herbarium and germplasm material of wild relatives of sweet potato (*Ipomoea batatas* (L.) Lam.). Whole Genome Sequencing of a selection of material from across Latin America was designed to fit within the existing phylogenetic framework developed for *Ipomoea*, while also allowing for further genomic analysis. Of particular importance is accounting for repeated polyploidization and likely hybridization between closely related species.

The aim is to test hypotheses of relatedness among these specimens and *I. batatas*, which were developed from the morphological and palynological worked carried out in the first half of my DPhil. With any luck fieldwork may be possible early next year, and these analyses will help to improve the basis for future collecting priorities.

News from the Herbaria

Fielding-Druce (OXF) and Daubeny (FHO)

The year 2020, covered by this report, started on a positive note in the Herbaria. However due to the coronavirus pandemic, on the 19th March normal activities and working patterns ceased as we were instructed to work from home from then on. Fortunately, home working was made possible in this modern 'digital' age, even for people working on collections, by remote desktop access to computers in the work place, where information, images and databases are accessible. However as most, if not all, other herbaria around the world also experienced onsite closures due to the pandemic, sending physical specimens on loan either way was not practical or even possible for many months. Nevertheless, sending digital images of specimens as loans, or for publications, was possible in many cases. This highlighted the importance of being able to have digital images of material in the herbaria available for researchers in any situation. The mounting of new specimens could also be achieved outside the workplace with prior gathering of materials needed for the task and of course a strict regime of freezing specimens on return.

Digitisation and databasing

Technicians, Alistair Orr and Kate Loven, continued working throughout 2020 on the digitisation project described in the last volume of OPS. Fortunately, before the national lockdown was enforced, many thousands of specimen images had already been captured. This enabled work on the transcription of data from specimen labels from those images to be undertaken from home. When government restrictions eased in the summer, staff were able to resume work in the Herbaria on a restricted person basis, and in a Covid-secure way. This then allowed more specimens to be retrieved from the collections for digitisation so the work flow was sustained.

New accessions

Several hundred miscellaneous *Ipomoea* and *Jacquemontia* (Convolvulaceae) specimens comprising material collected in the Americas, mostly in South America, were sent as gifts from the Herbarium at the University of Arizona (ARIZ). The consignment included former gifts which had originally been sent to the late taxonomist Dan Austin at FAU (Florida Atlantic University), and subsequently been transferred to ARIZ with permissions. All the specimens have now been identified by John Wood and material is currently being mounted ready for digitisation before being incorporated into OXF. In addition, several miscellaneous Convolvulaceae specimens collected in Myanmar were sent as a gift for identification from New York Botanical Garden Herbarium (NY).

Three new accessions of miscellaneous Acanthaceae specimens, two of which were sent from the New York Botanical Garden Herbarium and comprised 77 specimens collected in Myanmar, were also sent as gifts for identification by John Wood. These will be incorporated in FHO.

The large collection of British specimens donated from the personal collections of Jim Bevan the previous year, approximately 2,500, were steadily incorporated into the Druce Herbarium. A continuation of the databasing and incorporation of many British specimens collected and presented by John Killick, was also undertaken. This included many interesting records.

Visitors

There were just eleven weeks from January to the middle of March when visitors had access to the Herbaria. During that time 73 visits were made which included four group visits. Seven students studying pharmacog-nosy, with their tutor Christina Stapley from the School of Herbal Medicine, visited in January. Returning to the origins of the study of plants for medicinal purposes, the book herbarium compiled by the Capuchin monk Gregorio da Reggio in 1606 (see OPS 13: 9-10) and used at the time to record and identify plants growing around Bologna, was displayed. Apart from several European species selected from historic collections in OXF, other material from various parts of the world was selected as requested, including woody plants from South Africa, Nigeria, India and Ecuador from the FHO collections. The group were also interested in how these plants had been preserved. Fifteen members of the West Oxfordshire Natural History Club were introduced to the work and functions of the herbaria. Several under-graduate Biology students, plus a number of undergraduate biologists from Oxford Brooks University, were also given general tours as an introduction. Jim Bevan, who has been studying the genus *Hieracium* (Asteraceae) for many years, continued to make visits one day a week until early March to continue his work on the Druce Herbarium holdings of the genus.

Over the last year we have adjusted to having meetings with colleagues online. The internet even made possible an event to celebrate the launching of a new volume of a journal (*Studies in Western Australian History* 35) on the other side of the world, at the University of Western Australia. It was good to be invited to join this event, seeing and listening to colleagues so far away, which would not have been feasible otherwise. However, we are looking forward to resuming meeting and working in person and welcoming back visitors to the Herbaria when safe to do so.

Serena K. Marner
Assistant Curator

‘Restoring indigenous names in taxonomy’

A recent paper by Gilman and Wright in *Nature Communications Biology* entitled ‘Restoring Indigenous names in taxonomy’ (https://www.nature.com/articles/s42003-020-01344-y.pdf) argues that established plant names should be changed to reflect indigenous knowledge. They argue that the principle of nomenclatural priority should be abandoned in specific cases as many currently accepted names are eurocentric and reflect the imbalance of cultural power in the colonial era.

I should state clearly that I am opposed to any attempt to change the principle of priority with reference to plant names. Clearly there are plant names which are unsatisfactory in many ways – they may be geographically or morphologically incorrect, they may have been sold to a narcissistic bidder with no botanical connection or commemorate an individual, political entity or ideology which is unsavoury today. However, any attempt to change names in the interests of morphological, ecological, geographical or political correctness is fraught with difficulties, inconsistencies and controversy. This Pandora’s box should only be opened in very exceptional cases to maintain nomenclatural stability, not to undermine it.

My interest in Gilman and Wright’s paper is partly personal as I was involved in the publication of one the names they wish to change, *Breonadia salicina* (Vahl) Hepper & J.R.I.Wood, a combination I made with the late Nigel Hepper of Kew in 1982. They propose replacing it with the name *Breonadia matumi*, based on a vernacular name used in parts of Africa. In this paper I explore some of the implications in the case of *Breonadia salicina* and the use of Latinised Arabic names by Pehr Forsskål, the Swedish botanist and student of Linnaeus who discovered this plant before his death in 1763.

Breonadia salicina was first collected in Yemen at Hadiyah (‘Hadie’) in 1763. The collection is sterile so Forsskål did not name it but described it using the diagnosis ‘Nerium foliis ternatis’ and recorded the name used in Hadiyah, ‘*Daerah*’, which remains in use today (Wood, 1997). Forsskål’s collection eventually ended up in Copenhagen where it was examined by Martin Vahl who described it formally under the name *Nerium salicinum* Vahl. This is the basionym of the combination *Breonadia salicina* which I made with Nigel Hepper, the plant having been placed wrongly in the genus *Nerium* L. (Apocynaceae), rather than in *Breonadia* Ridsdale (Rubiaceae).

The epithet ‘*salicina*’ is eminently appropriate as the leaves are similar in shape to many common willows, such as the Crack Willow, *Salix fragilis* L., and the species is often riparian like willows generally. Of course, Vahl could have made use of the indigenous name *Daerah* and named the plant *Nerium daerah*. However, this would have raised problems. *Breonadia salicina* is not only native to Yemen but also to Madagascar and Tropical Africa, where its range extends from Mali and Sudan south to South Africa with different indigenous names in different parts of its range. Even in Yemen *Daerah* (or *Dirah*) is only used in some areas whereas *Dundul* is used in the Shafei regions further south. Thus, the name *Breonadia daerah* would only be meaningful in a restricted geographical part of its total distribution. The epithet ‘*salicina*’ at least gives an indication of its distinct morphology and habitat as well as hinting at its medicinal properties. Clearly, Vahl would have been unaware of the name *matumi* but, even if he had been, there would have been no reason to choose an African name over an Arabian one.

Breonadia salicina (Vahl) Hepper & J.R.I Wood © B.T. Wursten

Forsskål (1775) himself was, in fact, outstanding in his use of indigenous names, even if their etymology is not obvious to most botanists today. Nearly all the generic names he coined were based on Arabic names from Egypt or Yemen including *Adenia* Forssk., *Aerva* Forssk., *Arnebia* Forssk., *Cadaba* Forssk., *Cadia* Forssk., *Catha* Forssk. ex G.Don, *Caucanthus* Forssk., *Digera* Forssk., *Maerua* Forssk., *Maesa* Forssk., *Oncoba* Forssk., *Sehima* Forssk., *Suaeda* Forssk. and *Themeda* Forssk., besides several others which were synonyms of genera published earlier (Hepper & Friis 1994: 26 ff.). Forsskål was very aware that he was making use of indigenous knowledge in coining these generic names: ‘In Yemen, as in Europe, each province often uses ‘nomina trivia’ which are formed on the basis of common names recognized in the entire region. These common names are in no way of recent date but have come about through a long development and can be found in the works of learned people and in the oral tradition’ (quoted by Hepper & Friis 1994: 27). He rarely made use of place names (*Melhania* Forssk. is an exception) or names of technical botanical origin (*Alternathera* Forssk. and *Pteranthus* Forssk. are exceptions).

Forsskål clearly set a fashion for subsequent authors as several used the vernacular names he had recorded to coin additional generic names including *Adenium* Roem. & Schult., *Dobera* Juss. and *Kanahia* R. Br. Whether botanists or other users of these generic names are aware of their origin is moot. Nonetheless, they are all now part of the botanical canon and accepted everywhere.

Forsskål, also but less commonly, used indigenous names as species epithets in the manner suggested by Gilman and Wright. Amongst names accepted today are *Celtis toka* (Forssk.) Hepper & J.R.I.Wood, *Commiphora kataf* (Forssk.) Engl., *Debregeasia saenab* (Forssk.) Hepper & J.R.I.Wood, *Ficus sur* Forssk., *Senegalia asak* (Forssk.) Kyal & Boatwr. and *Vachellia oerfota* (Forssk.) Kyal & Boatwr., all based on the vernacular names used in Yemen. However, the meaning of these epithets in widely distributed species is opaque, as when someone in Nepal or China is discussing *Debregeasia saenab* or someone in South Africa or Cameroon is considering *Ficus sur*. These examples indicate that the use of epithets for widespread species derived from a restricted region has disadvantages, which need to be balanced with the supposed advantages. The proposal to adopt the name *Breonadia matumi* would exemplify these difficulties.

An example of where the use of vernacular epithets works well is with plants endemic to a particular area such as *Commiphora kataf*, mentioned above. Indeed, later authors, including this writer, have done this when possible as in *Euphorbia ammak* Schweinf., *E. qarad* Deflers and *E. uzmuk* S.Carter & J.R.I.Wood. The risk in the practice described here is twofold. In the first place, the person preparing the original description may not be aware of the total distribution of the putative new species. However, a greater problem today is that most new species are rare and lack indigenous names or bear a generic name applied to both the new taxon and several other congeneric species. Although I took advantage of the Arabic name *Uzmuk* to name *Euphorbia usmuk*, I did not use local names for the dozen or so other plants I described from Yemen so resorted to other devices like phenology (*Plectranthus hyemalis* J.R.I.Wood), historical connections to a Yemeni queen (*Helichrysum arwae* J.R.I.Wood), geographical distribution (*Aloe yemenica* J.R.I.Wood), habitat (*Saponaria umbricola* J.R.I.Wood), morphology (*Melhania stipulosa* J.R.I.Wood) or the recognition of someone who had studied Arabian plants (*Barleria hillcoateae* J.R.I.Wood). In only one case could I have adopted a local name (*Irdhib* for *Plectranthus hyemalis*, but chose not to do so because of uncertainty about its wider application within the genus *Plectranthus*.

While every effort should be made to take indigenous knowledge into account when naming species, this should be done with awareness of the wider implications. Efforts to overturn the principle of priority should be undertaken in only very rare and exceptional circumstances.

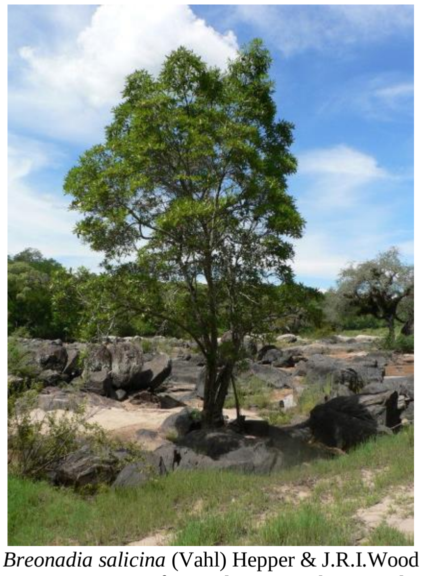
References

Hepper, F.N. & Friis, I. (1994). *The Plants of Pehr Forsskål's Flora Aegyptiaco-Arabica.* Royal Botanic Gardens, Kew.

Wood, J.R.I. (1997). *A handbook of the Yemen flora.* Royal Botanic Gardens, Kew.

Forsskål, P. (1775). *Flora Aegyptiaco-Arabica*. Moller, Copenhagen.

John R.I. Wood
Research Associate



Breonadia salicina (Vahl) Hepper & J.R.I.Wood
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www.africanplants.senckenberg.de

Five decades of ground flora change

When I worked for the Natural England and its predecessors, we often had to judge which woods were more important to protect than others. The information available might be very limited, but usually there would be some sort of botanical survey (Kirby and Hall, 2019). So, we might start by looking at the overall plant species-richness; then perhaps how the flora was split between generalists and specialist woodland plants; and finally, whether there were any particularly interesting or rare species involved. This is obviously a fairly crude approach, but it usually worked well enough as a first approximation and decisions could be made on the next steps. A similar approach might be taken to assessing change in the ground flora, although if we want also to understand how the wood works, the commoner species will also need to come into play.

As an example we have been analysing patterns of change in the ground flora in 164 permanent 10x10 m vegetation plots set up in Wytham, near Oxford, by Colyear Dawkins between 1973 and 1976 (Dawkins and Field, 1978). These have been re-recorded since in 1991, 1999, 2012 and 2018 (Kirby, 2010).

Over the five decades of the study there has been a small decline in overall species richness and in the mean number of species found per plot. However, this has mainly been in the 'non-woodland' species and 'woodland generalists'. The records for 'woodland specialists' have increased. The declines in richness are partly a consequence of succession towards a woodland ground flora in the stands planted on open ground in the 1950s and 1960s; a desirable change.

Individual plots showed a variety of different patterns in species-richness over time: stands opened out following a tree fall increased in richness, with perhaps 20-30 species present, while where the tree canopy was densest at the thicket stage there might be no ground flora species in the plot at all. Management, such as thinning and felling, had similar effects. The ground flora richness of the whole set of plots at any one time therefore depends on how many plots are in the species-rich part of the cycle, how many in the species-poor decades.

The structure of the ground flora changed through the impact of deer pressure: *Rubus fruticosus* L. declined under high deer pressure but has been increasing now the pressure has eased; *Brachypodium sylvaticum* (Huds.) P.Beauv. has shown the reverse pattern. The vegetation was becoming more homogenous - fewer

Recording the plots at Wytham

Photo © Keith Kirby

Well-developed flora in a thinned stand at Wytham

Photo © Keith Kirby

Impatiens parviflora – an invasive species at Wytham

Photo © Keith Kirby

differences between plots - in the first 25 years, but as the deer numbers have been reduced, so the plot records are becoming more dis-similar. So what sort of woodland flora do we want? If we leave the deer population to its own devices, grasses are likely to dominate; if we want a more structured understorey, the deer need to be culled: we have to intervene.

One surprising finding was just how important a small number of common species were in terms of their contribution to the vegetation structure and composition. Over the five recordings of the plots just 12 of the 235 species recorded contributed 47% of all species occurrences in the plots, 82% of the recorded vegetation cover and 87% of the modelled biomass. These were in descending order of frequency in the plot records: *Rubus fruticosus**, *Poa trivialis* L., *Mercurialis perennis** L., *Brachypodium sylvaticum*, *Urtica dioica** L., *Deschampsia cespitosa* (L.) P.Beauv., *Circaea lutetiana* L., *Glechoma hederacea* L., *Hyacinthoides non-scripta* (L.) Chouard ex Rothm., *Geum urbanum* L., *Galium aparine* L. and *Pteriidum aquilinum** (L.) Kuhn. Those marked by an asterisk are four of the five native species whose 'over-dominance' may have a strong effect on patterns of species richness in British broadleaved woodland (Marrs *et al.*, 2013). The fifth of Marrs's over-dominant species (*Hedera helix* L.) has started to become more common since the 1990s with the reduction in deer grazing impacts. None of these are of particular conservation concern in their own right, but changes in their abundance will likely have more significant effects on the functioning of the system than (say) a decline in the rarer orchids in the Woods.

There is one plot every 2 ha, which is quite a dense sampling network in British nature conservation monitoring practice, but even so, it has its limitations if we are interested in the rarer species. Casual observations of *Hypopitys monotropa* (Crantz) and *Cephalanthera damasonium* (Mill.) Druce, two of the most notable species in the Woods, suggest their populations are stable, but they have never been recorded in any of the plots. We suspect that *Paris quadrifolia* L. and various *Epipactis* species were reduced in the period when deer pressure was very high, but with only five occurrences for *Paris* (spread over three recording times), and two for *Epipactis* the numbers are too small for meaningful conclusions to be drawn. The same problem arises if we wanted to use the records to assess invasive species: one such, *Impatiens parviflora* DC., has been picked up in the last two recordings but only in one plot each time. Casual observation suggests it is spreading but if we wait for there to be enough plot records to provide a statistically significant trend, we may have missed the opportunity to control it easily.

The Dawkins plots provide one of the longest running and most detailed records of vegetation change in British woods, but they can only be one part of a wider integrated approach to monitoring woodland vegetation. Nevertheless that the data collected from them, five decades after they were set up, is still seen as relevant to today's concerns is a tribute to the farsightedness of the originators, particularly H.C. Dawkins, of the Commonwealth Forestry Department as it then was.

References

Dawkins, H.C.D. & Field, D.R.B. (1978). *A long-term surveillance system for British woodland vegetation. Commonwealth Forestry Institute Occasional Paper* 1. Oxford: Commonwealth Forestry Institute.

Kirby, K.J. (2010). The flowers of the forest. In: Savill, P.S., Perrins, C., Kirby, K.J., Fisher, N. (eds.) *Wytham Woods, Oxford's ecological laboratory.* Oxford: Oxford University Press.

Kirby, K.J. & Hall, J.E. (2019). *Woodland survey handbook: collecting data for conservation in British woodland*. Exeter, Pelagic Publishing.

Marrs, R.H., Kirby, K.J., Le Duc, M.G., Mcallister, H.A., Smart, S.M., Oksanen, J., Bunce, R.G.H., Corney, P.M. (2013). Native dominants in British woodland - a potential cause of reduced species-richness. *New Journal of Botany* 3(3): 156-168.

Keith Kirby
Woodland Ecologist

What's in a date?

Beginnings are frequently difficult to determine, yet foundation and establishment dates have, in the argot of the moment, become 'unique selling points' – means of attracting attention, perhaps even implying worth, value or importance. A walk along any high street soon reveals myriad organisations proudly displaying the earliest dates to which they can trace their establishment. Yet determining such dates is confusing, as can be seen with plant sciences in the University of Oxford, the Botanic Garden and the celebration of centenaries.

In the 1850s, natural sciences in Oxford University began to congregate around the University Museum (now Oxford University Museum of Natural History) and the University Parks. Despite arguing in the 1820s that sciences in the University were best served by being concentrated at a single site, the dynamic fifth Sherardian professor of botany, Charles Daubeny (1795-1867) decided botany's future lay where it had always been – at the Botanic Garden, just over one kilometre away from the Museum. Following his appointment in 1834, Daubeny had made regular improvements to the estate of the Garden, largely at his own expense, so that botany could 'be studied in this place without requiring any further augmentation to our existing means of instruction' (Daubeny, 1853: 13).

Portrait of Charles Daubeny
© Department of Plant Sciences

By the 1870s, sciences at the Museum were flourishing, but without Daubeny's energy, botany was floundering at the Garden. The University was faced with a choice following a proposal that botany join its intellectual allies in the Museum, and that part of University Parks be used to create a new, freehold botanic garden (Gunther, 1912). The sixth Sherardian professor, Marmaduke Lawson (1840-1896), eventually concurred with Joseph Dalton Hooker (1817-1911), director of Kew, that the Garden would cost more to move than to improve.

Lawson divided his arguments to the University Council into the 'Real' and the 'Sentimental' (Lawson, 1875-76). Among his 'Real' arguments were the good growing conditions for plants and low population density at the Garden – he was concerned about poor soil at the Parks and the detrimental effects of urbanisation in affluent North Oxford on plant growth. Sentimental arguments, to which he attached little value, included the Garden's age, architecture and setting. The University accepted Lawson's arguments, although the architect of the unification of the natural sciences, Henry Acland (1815-1900), thought the decision misplaced, asserting that botany was 'on a leasehold, apart for the rest of the Scientific apparatus of the university' (Gunther, 1912).

The respite was short lived, as it gradually became clear to all that the Garden was too confining a stage for the development of botany in the early twentieth century. In 1951, botanical research and teaching moved from the Garden to its present location in purpose-built accommodation on the edge of the Parks (Harris, 2021).

The sentimentality of age apart, 25 July 2021 marks the quadricentenary of the official foundation the Oxford Botanic Garden; it is the oldest British botanic garden still to occupy its original site. Four centuries earlier, senior members of the University, regaled in their ceremonial finery, had processed from the University Church of St. Mary the Virgin, approximately half a kilometre west of the Garden site, along the High Street, to a low-lying, boggy field (5 acres; c. 2 ha) leased from Magdalen College. The young physician Edward Dawson (d.1635; Lincoln College) spoke an 'elegant Oration', whilst the Regius Professor of Medicine, Thomas Clayton (1575-1647; later first Master of Pembroke College) 'spake another', before coins were cast upon a foundation stone (Vines and Druce, 1914: xi).

Within the University, 'motions were made for the founding of a … Garden for Physical Simples' a year earlier (Gutch, 1796: 335). The wherewithal to make an academic dream physical reality came from Henry Danvers, earl of Danby (1573-1644), with the donation of £5,250 (*c.*£690,500 in 2021) to purchase the lease and secure the future of a physic garden. With the ceremonial complete, the work of spending Danvers's money began as 'well fair and sufficient' walls and gates were built to surround the plot (Gunther, 1912: 2). The elaborate Danby Gate, named to honour Danvers, which was completed in 1632, cost £500 (*c.*£61,000 in 2021). The gate's inscription, 'Gloriae Dei Opt. Max. Honori Caroli Regis In Usum Acad. et Reipub. Henricus Comes Danby D.D. MDCXXXII' [To the Glory of God the best and greatest, to the Honour of King Charles, to the Use of the university and the State. Henry, Earl Danby 1632], emphasised the glory of God and Charles I, and the utility of the garden for the University and Britain, whilst immortalising the name of Danvers. Walls were completed a year later, and the site raised above the adjacent river with the help of Mr Windiat, the university's official scavenger, who provided '4000 loads of mucke & dunge' (Gibson (1940: 108). Danvers donation was however exhausted – there were no funds to plant and staff the Garden site.

By 1636 the gardener to Charles I, John Tradescant the elder (1570-1638), was confirmed as gardener, but he appears never to have taken up the post, else his influence was minimal (Gutch, 1796: 897; Potter, 2007: 251). With the appointment of the Brunswick-born soldier and publican Jacob Bobart the Elder (c.1599-1680) in 1642, the Garden finally began to be populated with plants (Harris, 2017).

This outline of the Garden's history in the mid-seventeenth century is replete with dates. Dates, compounded by the shift from the Julian to Gregorian calendar, which have led to Garden's foundation dates ranging between 1621 and 1642. It was Vines and Druce (1914: ix-xiii) who finally tracked down evidence that established the Garden's foundation date as 25 July 1621.

The confusion around dates, together with anniversaries coinciding with periodic low points in the Garden's fortunes and the general lack of interest in celebrating centenaries in the early 1700s and early 1800s, probably contributed to the Garden's centenary and bicentenary being ignored. More surprising is the unexplained 'somewhat belated Celebration of the Tercentenary' on the 23 June 1923, given George Claridge Druce's (1850-1931) involvement in establishing 1621 as the Garden's foundation year (Druce, 1924: 335). In 1971, the 350th anniversary was celebrated in the correct year with the publication of a guide to the Garden (Darlington and Burras, 1971). The quadricentenary has coincided with the Covid-19 pandemic, precipitating the Garden's senior management to postpone formal celebrations of the Garden's foundation until 2022. The Garden, Department of Plant Sciences and Bodleian Libraries have collaborated in holding a public exhibition – *Roots to Seeds* – of four centuries of plant sciences in the University in 2021. Perhaps the Garden's quincentenary will be celebrated in the correct year – 2121.

Lecture Room 1894 at the Botanical Gardens Oxford
Photo © Department of Plant Sciences

More significant than the sentimentality of institutional anniversaries is the opportunity they provide to reflect on the past, highlight current work and build for the future. Despite its ups and downs, plant sciences' research and teaching in the University is thriving – it is probably stronger and more important today than at any point in the past four centuries. At the start of the next one hundred years of its history, plant sciences is preparing to combine with its sister discipline, zoology, in a biology department. As in the past, the future of plant sciences in the University will be determined by people being actively engaged in high-quality plant-based research and teaching.

References

Darlington, C.D. & Burras, J.K. (1971). *Guide to the Oxford Botanic Gardens.* Oxford: Clarendon Press.

Daubeny, C. (1853.) *Address to the members of the University, delivered on May 20, 1853.* Oxford: Botanic Garden.

Druce, G.C. (1924). Oxford Botanic Garden – foundation and tercentenary. *Botanical Exchange Club Report* 1923: 335-366.

Gibson, S. (1940). 'Brian Twyne'. *Oxoniensia* 5: 94-114.

Gunther, R.T. (1912). *Oxford gardens based upon Daubeny's Popular Guide of the Physick Garden of Oxford: with notes on the gardens of the colleges and on the University Park.* Oxford: Parker & Son.

Gutch, J. (1796). *The history and antiquities of the University of Oxford in two books: by Anthony à Wood, M.A. of Merton College, vol. 2.* Oxford: Printed for the editor.

Harris, S.A. (2017). *Oxford Botanic Garden and Arboretum: a brief history.* Bodleian Library, Oxford.

Harris, S.A. (2021). *Roots to seeds. 400 years of Oxford botany*. Bodleian Library, Oxford.

Lawson, M.A. (1875-76) Internal papers for the University Council by Marmaduke Lawson dated 20 November 1875 and 14 February 1876 (Sherardian Library of Plant Taxonomy, Bodleian Library).

Potter, J. (2007). *Strange blooms: the curious lives and adventures of the John Tradescants.* London: Atlantic Books.

Vines, S.H. & Druce, G.C. (1914). *An account of the Morisonian Herbarium in the possession of the University of Oxford*. Clarendon Press, Oxford.

Stephen A. Harris
Curator of Oxford University Herbaria

The 1930's Plant Physiology Research Laboratory
Photo © Department of Plant Sciences

Early eighteenth-century botanical friendships

A little-known treasure in the Department of Plant Sciences at Oxford is a copy of Johann Jakob Dillenius's (1684-1747) *Hortus Elthamensis* (1732) with its plates hand-coloured by Dillenius himself (figure 1). The full Latin title of the book translates as 'The Eltham Garden, or Of the Rare Plants Growing in the Garden of the esteemed James Sherard and his brother William'. The work is a record of the friendship of four early eighteenth-century plant lovers - the wealthy apothecary, James Sherard (1666-1738), his brother, the botanist, Consul William Sherard (1659-1728), the German-born botanist and protégé of William Sherard, Dillenius, and the naturalist, artist and author, Mark Catesby (1683-1749).

Published in 1732, the book contains 324 uncoloured plates of 417 plants engraved by Dillenius after his own drawings. Three rare coloured copies of the book exist, of which that in the Oxford Plant Sciences, distinguished by its sumptuous embossed endpapers, was Dillenius's personal copy. Dillenius was first holder of the Sherardian chair of botany, founded by William Sherard in 1728. An oil portrait of him holding a watercolour of a Jacobean lily (*Sprekelia formossisima* (L.) Herb.) hangs in the Department of Plant Sciences (figure 2).

Several of the plates in Dillenius's book feature plants grown from seeds collected by Catesby during his visits to Virginia (1712-19) and to South Carolina and the Bahama Islands (1722-26) (figure 3). James Sherard's garden in Eltham, Kent, then a small village around nine miles outside London, included hothouses for exotics and became renowned as one of the finest gardens in England for rare and valuable plants, with 'many species new to science or little known and never before illustrated'.

In addition to seeds and living plants, Catesby sent hundreds of preserved plants to Dillenius as well as to William and James Sherard. These dried plant specimens now

Figure 1: Hand-coloured copper engraving by Johann Dillenius of 'Aloe Africana maculata spinosa major' (*Aloe perfoliata* L.) from Dillenius' *Hortus Elthamensis* (1732) (Plate XIV; Sherard 643 © Sherardian Library of Plant Taxonomy).

Figure 2: Oil portrait of Johann Jakob Dillenius by unknown German artist © Department of Plant Sciences

form the core collections of the Oxford University Herbaria (figure 4). In his letters to William Sherard from South Carolina, Catesby includes detailed descriptions of his methods of collecting and preserving plants. Some plants were more difficult to preserve than others. The humid climate of Charleston caused particular difficulties; on one occasion acorns started to germinate while they were laid out to dry in his room: '*The live Oke Acorns to my surprise sprout as they lye spread in my Chamber which makes me suspect their good success by the way*[.]' The trumpet shaped leaves (or 'pitchers') of *Sarracenia* in which insects were trapped needed particular treatment: '*At the bottom of its hollow leaves are always lodged Catterpillars*[,] *worms*[,] *bugs or other insects which is the cause I have cut them open to prevent rotting ye paper.*' Some fungi and fleshy plants defied preservation altogether; when Catesby found it impossible to preserve the flower of the American lotus (*Nelumbo lutea* (Willd.) Pers.) he sent a drawing instead of the specimen. On the reverse of his pen and ink sketch of the leaf with its flower, he wrote: '*The flowr I could not preserve so have sent his Scetch*'. The folded sheet of paper bearing the sketch was discovered by chance tucked behind the mount sheet bearing the leaf specimen by Stephen Harris while he was cataloguing Sherard's herbarium (figure 5).

Catesby also describes the packing methods he developed through trial and error to ensure his dried specimens and live plants survived their three-month sea passage from Charleston to London. A letter written to the Hoxton nurseryman Thomas Fairchild (1667-1729) in around 1724 includes advice about transporting living plants from England to America:

> *Put the Tubs in the Ballast, which keeps them moist and moderately warm. So managed, I have had the best success with Plants from England; for on the Quarter-Deck they are often wetted with Salt Water, and require the greatest Tendance from bad Weather, and even with the greatest Care they miscarry, as they did with me. It is so hot in the Hold in Summer, that they spend their Sap at once, and dye, so that is not a Time to send any Thing.*

William Sherard kept a close eye on the progress of the seeds Catesby sent for the Eltham garden. In April 1724 he wrote to Richard Richardson (1663-1741), another garden-loving friend and garden owner, that he was '*going to Eltham, to see what product there is of our Carolina Seeds; when I was there last, a good number were up; and the weather having been since very seasonable, I hope to see them past their Seed-leaves.*' It was the successful flowering of some of these that Dillenius illustrated in the *Hortus Elthamensis* (see figure 3).

Figure 4: *Sarracenia minor* Walt., leaf and flower (right) and *S. flava* (left), collected by Catesby, 1722-25. Plant specimen with Catesby's and Sherard's labels, Sher-1086.3 © Oxford University Herbaria

Figure 3: Hand-coloured copper engraving by Johann Dillenius of 'Magnolia lauri folio subtus albicante' (*Magnolia virginiana* L.) from Dillenius' *Hortus Elthamensis* (1732) (Plate CLXVIII; Sherard 644 © Sherardian Library of Plant Taxonomy).

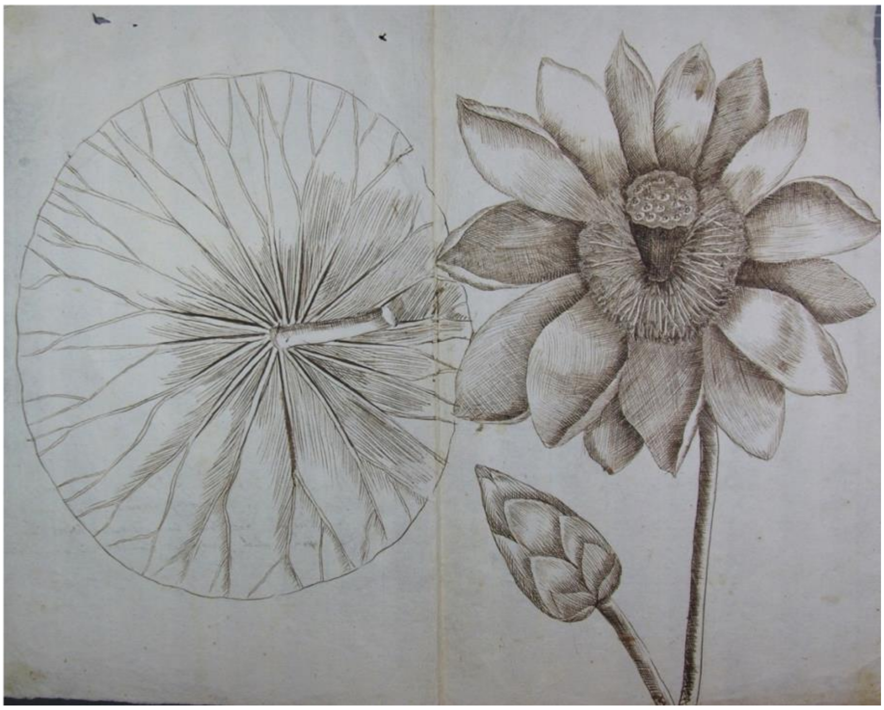


Figure 5: Mark Catesby, 'Egyptian Bean' (American lotus, *Nelumbo lutea* (Willd). Pers., Sher-1090-10, 1722-5. Pen and ink © Oxford University Herbaria

During his stay in South Carolina, William Sherard had been Catesby's chief advisor for the identification of the new species of plants Catesby was collecting, and on his return to London in 1726 the two botanists continued to work together closely. After Sherard's death in 1728 Catesby turned to Dillenius for botanical advice. Following his publication of the *Systema naturae* in 1735, Linnaeus's system of binomial nomenclature began to replace the long Latin polynomials in use up until then. But Catesby was half-way through publishing his *Natural History of Carolina, Florida and the Bahama Islands* (1731-43) and continued to use the old system. Dillenius, an early convert to the binomial system, felt he should defend himself to the Swedish naturalist and wrote to him:

> *In your last letter you advert to Catesby's names, as if I were particularly conversant with, or had perhaps communicated them to that author. I assure you he is indebted to me for but few, and those of the shorter kind. I had no hand in his long descriptive names.*

Catesby, nonetheless, continued to be respected as an authority in North American and West Indian trees and shrubs. Two of his letters to Dillenius preserved in the Department of Plant Sciences are evidence of the two friends' ongoing discussions about botanical matters. In the first letter, dated 1736, Catesby answers Dillenius's 'inquisitive demands' about the variations he had observed in the same species of cedar tree (*Juniperus* sp.) which he attributed correctly to differences in habitat and soil:

> *I find that in some written observations I made when [in the Bermudas] that their stems grow to a greater heigh[t] without leaves, their heads not so spreading and being generally taller & handsomer trees than those on the Continent [South Carolina], all which difference may proceed from a very different soil which is throughout the Island a white chalky Rock.*

Catesby's second letter to Dillenius written the following year recalls that he had watched how Native Americans used the 'Cassena' plant (yaupon, *Ilex vomitoria* Aiton) as a diet-drink, making '*a strong decoction of it, drinking it and disgorging it with ease*'. He, himself, however, had '*an hundred times made an agreable breakfast of it but with milk and sugar*'. He adds that on his return to England, '*I brought a large quantity of it over prepared, & I remember to have produced some of it at the Consul's*.' Catesby's correspondence with Dillenius thus ends with his evocative memory of drinking tea with their shared friend and mentor, William Sherard.

Catesby's life and work are the subject of *Illuminating Natural History. The Art and Science of Mark Catesby*, by Henrietta McBurney, published by the Paul Mellon Centre, London 22 June 2021.

Henrietta McBurney
Art Curator and Art Historian

BRAHMS developments

The last year has seen a range of innovations with the BRAHMS software package for managing natural history collections, botanic gardens, field surveys, taxonomic research and biogeographic study. Details of system updates are published on https://herbaria.plants.ox.ac.uk/bol/brahms/software/revisions with news items posted on https://herbaria.plants.ox.ac.uk/bol/brahms/news.

Due to uptake by botanic gardens and our collaborative work with Kew Gardens this last year, much of our recent focus has been on living collections management: processing new and existing stock, plant imagery, name verifications and changes, vouchering, documenting restrictions and the legal aspects associated with plant acquisitions and distribution. As is so often the case, the devil is in the detail. For example, the business of managing garden labels in itself brings special challenges. Labels must be produced for new plants; moved or split plants; plants where names have been recently verified; and where labels are lost or simply need to be replaced. Labels of different formats may be sent to a range of devices for immediate printing, for example, potting and nursery labels, or dispatched to a label engraver. Labels may also be queued to a requests table and these requests may require approval prior to production. Engraved labels are costly!

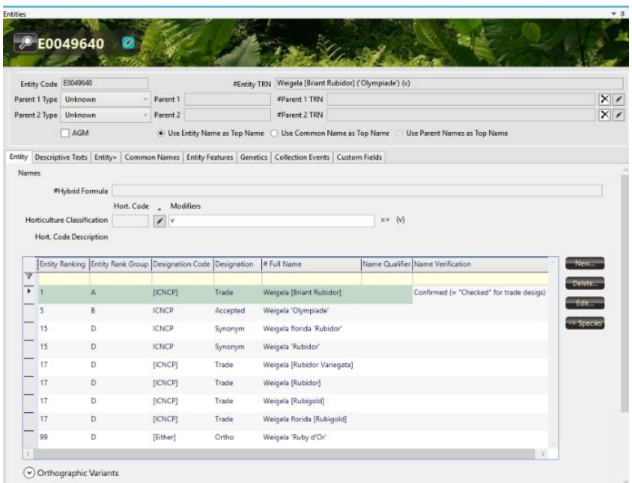
In collaboration with the Royal Horticultural Society (RHS), we have developed a new approach for managing plant names and how these names are linked to something growing in a pot. The RHS refer to these as 'Entities'. Effectively, an Entity encompasses one or more plant names which refer to the same thing. For example, a cultivar may have an accepted name, trade names and synonyms.

Names of cultivated plants and hybrids can quickly become complicated. The Entity system is developed so that the properties and features used to describe the Entity remain consistently with that Entity even when there are adjustments and nomenclatural changes to species names. The names attached to an entity are ranked using a newly developed prioritizing system, based on the ICN and ICNCP, with a concept of a Top Ranked Name to guide people on which name to use. The Entity approach can optionally be run together with standard species naming in BRAHMS.

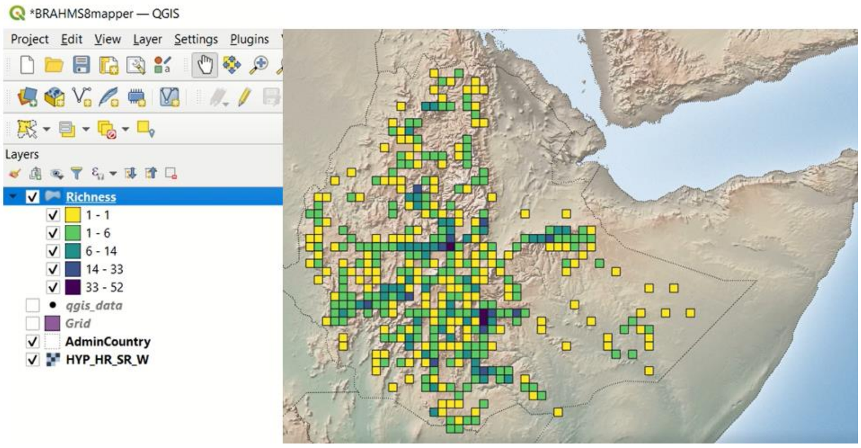
We have also developed BRAHMS online tools that gather current plant stock details from over 500 nurseries. These data contribute to the *RHS Plant Finder*. The nursery submissions are assembled centrally by the RHS where the many submitted names are reviewed against their Entity names list. The challenge the RHS has is to streamline these to provide a single 'correct' name, while ensuring all the names are captured.

Also this year, a series of training videos is gradually building up on https://herbaria.plants.ox.ac.uk/bol/brahms/software/v8videos. Examples include how to use Rapid Data Entry, filter and query data, design report templates and display your data on maps.

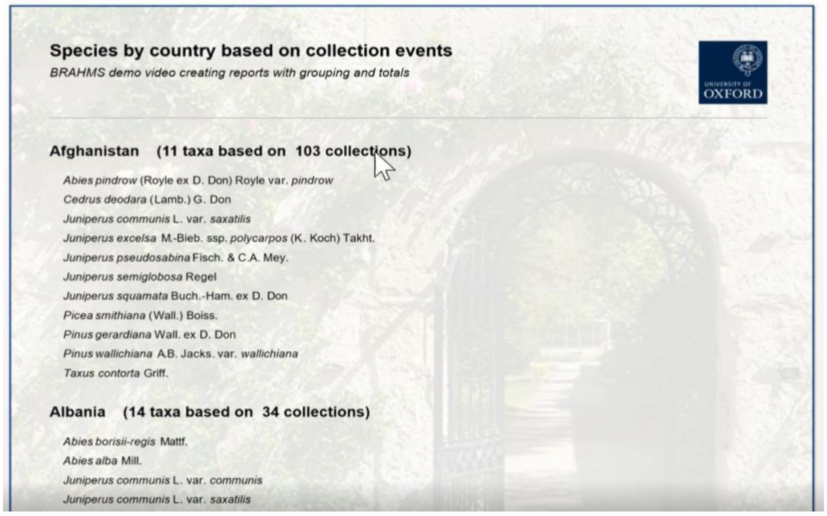
In July this year, we published the long-awaited garden inventory app for use on tablets and other mobile devices. The app currently runs on Android with an iOS version to be published later this year. It can be used offline – and thus in areas with no online signal. Data from BRAHMS are selected, often by garden area, and exported to the app by Bluetooth or cable connection. In the field, the user can open the data in a flexible grid with column selection and filter options. Records can be selected individually on in tagged groups and the processed with options to check or update plant status, edit the location, adjust stock, request labels, add notes, verify plants or create any other standard event or request, for example, record flowering, add a DBH measurement or request a maintenance visit. Images can be taken and linked directly to plants and the app has a suite of map function to display, add and edit plant locations. The data and images are then submitted to BRAHMS, updating the central database.



The BRAHMS Entity form showing an example Weigela *with a good selection of superseded trade names and other names. The entity top ranked name here is a combination of the trade name but also includes the cultivar of the accepted name. Each entity has a unique code. Data provided by Richard Sanford, RHS.*



The steps taken to create species richness maps by passing data from BRAHMS to QGIS are detailed in one of our new videos. This example map, prepared by Tim Pearce (Kew), is based on a database for Ethiopian endemic taxa. Data provided by RBG Kew and the National Herbarium of Ethiopia.



Procedures to create a checklist of taxa per country with totals for collection events and taxa are described in one of the new BRAHMS videos. Such lists could easily be altered to list taxa by collector, family or any other available field and extended to include details about each species. The inclusion of name authors is optional.

The BRAHMS botanic gardens app for mobile devices works offline with any data exported from BRAHMS desktop. A screen shot based on data from The Morton Arboretum database.

Denis Filer, *Plant Sciences*

Phylogeography of *Aglaia elaeagnoidea* in Australia

Aglaia is a genus of at least 120 species, the largest genus in the mahogany family (Meliaceae). Most species of *Aglaia* are trees of closed canopy tropical rain forest. It is distributed throughout the Indo-Australasian Archipelago, reaching its easternmost limit on the islands of Tonga and Samoa in the western Pacific. It is equally well represented on both sides of Wallacea, with Lydekker's Line being the most distinct boundary between western and eastern species. Only 13 species are found on both sides of Lydekker's Line. Ten of these are geographically widespread and morphologically variable. With the exception of the mangrove species, *A. cucullata*, most of these are likely to be resolved into two or more species when further molecular investigation is carried out. Most of the segregate species are expected to be confined to one side of Lydekker's Line or to transgress it only into the eastern part of Wallacea.

Aglaia elaeagnoidea (A.Juss.) Benth. is the first species in the genus to be the subject of a molecular phylogeographic study. As currently circumscribed, it is the most widespread species in the genus. It differs from most other species of *Aglaia* by its preference for coastal and open habitats, including exposed limestone outcrops. It is one of only two species in Australia to occur outside the tropical forests of Far Northern Queensland. The second species is *Aglaia brownii* Pannell. Both are found in Western Australia. It has a disjunct distribution across northern Australia, on the Cape York Peninsula of Queensland and the Kimberley Plateau of Western Australia, but is not found in the Top End of the Northern Territory. Records of *A. elaeagnoidea* in the Northern Territory are based on misidentifications. Bentham, in *Flora Australiensis* (1863), inexplicably included a distinct, unrecognized and unnamed species in his circumscription of *Aglaia elaeagnoidea*. The confusion persisted until this species, *Aglaia brownii* Pannell, was named and published (Pannell, 1992). This, together with the existence of a comprehensive monographic treatment of the genus throughout its range and in Australia (Pannell, 1992, 2013) made *Aglaia elaeagnoidea* an ideal candidate for an investigation into floristic exchange tracks between Southeast Asia and Australia (Joyce *et al.* 2021).

Elizabeth Joyce of James Cook University, Cairns, Australia and I sampled 247 herbarium specimens of *A. elaeagnoidea* and outgroup species in herbaria in the UK, Europe, US, SE Asia and Australia. To these were added seven samples collected from living plants in Australia and dried in silica gel. Lizzy succeeded in extracting good

Image left: *Aglaia elaeagnoidea* (A.Juss.) Benth. in flower © John Elliot

Image above: Pied imperial pigeons (*Ducula bicolor* Scopoli. 1786) © Elizabeth Joyce

quality DNA from 153 of these samples. The oldest herbarium specimen sampled was collected in 1835 by Robert Wight, in the Western Ghats of India. It is the oldest specimen in the herbarium of the New York Botanic Garden (NY) from which DNA has been sequenced. A photograph of the specimen features in Barbara Thier's, *Herbarium*, and in Robin Lane Fox's (2021) review of the book.

This study is one of the first to use DArTseq (a restriction enzyme-based reduced representation sequencing method) on herbarium material for a phylogeographic study. 176,331 single nucleotide polymorphisms (SNPs) across 90,456 loci obtained by DArTseq were analysed. The taxonomic results are yet to be published. The explanation for the disjunct distribution of *A. elaeagnoidea* in Australia is that it almost certainly arrived in Australia by two separate migration tracks, between Australia and Asia from different source regions in Asia. They do not form a single genetic group; each of the two Australian populations is more similar to a different Asian population than they are to each other. The Kimberley populations were established from Timor-Leste and likely migrated when the northwestern shelf of Australia and Timor-Leste were at their closest during the low sea levels of the Last Glacial Maximum. The evidence suggests that this track of migration is historical and that gene flow between the Kimberley and Timor-Leste is not ongoing. The Cape York Peninsula populations were established from New Guinea, and show little genetic differentiation from the New Guinea populations, indicating that this migration track is contemporary and that geneflow is ongoing.

There is a record of pied imperial pigeons (*Ducula bicolor* (Scopoli. 1786) feeding on *A. elaeagnoidea* fruits in the Kimberley district of Western Australia. Although these birds are sedentary in Western Australia, they are strong fliers and regularly fly over the sea in other parts of their range. They migrate between Far Northern Queensland to New Guinea and may, in the past, have flown over a narrower Arafura Sea. This could be one explanation for why geneflow between the Cape York Peninsula populations and New Guinea is ongoing, while the Kimberley-Timor-Leste track is historical.

Our paper concludes that 'This study provides the first molecular phylogeographic evidence for two floristic exchange tracks between northern Australia and Southeast Asia. It also highlights the influence of Quaternary climate fluctuations on the complex biogeography of the region, and supports the idea that the Kimberley Plateau and Cape York Peninsula in northern Australia have separate biogeographic histories.' The existence of a comprehensive morphological treatment of the genus enabled us to carry out informed sampling of accurately identified herbarium specimens and to achieve reliable and informative results from molecular sequencing and biogeographical analysis. A second publication, on the taxonomic resolution of *A. elaeagnoidea* arising out of the molecular data generated by this project, is expected to follow.

References

Joyce E.M., Pannell C.M., Rossetto M., Yap, J-Y.S., Thiele, K.R., Wilson, P.D. and Crayn, D.M. (2021). Molecular phylogeography reveals two geographically and temporally separated floristic exchange tracks between Southeast Asia and northern Australia. *Journal of Biogeography* 48: 1213-1227.

Lane Fox, R. (2021). The big data of botany. *Financial Times*, 15 February 2021.

Pannell, C.M. (1992). A taxonomic monograph of the genus *Aglaia* Lour. (Meliaceae). HMSO, London.

Pannell, C.M. (2013). *Aglaia* (Meliaceae). In A.J.G. Wilson (ed.) *Flora of Australia* 26: 33
-42. ABRS, Canberra/CSIRO Publishing, Melbourne.

Thiers, B.M. (2020). *Herbarium. The quest to preserve and classify the world's plants.* Timber Press, Oregon.

Caroline Pannell
Research Associate

A. elaeagnoidea in fruit © John Elliot

African specimens from OXF

Rhus tomentosa L. (= *Searsia tomentosa* (L.) F.A. Barkley) collected by F.W. Sieber No. 155 in the Cape region of South Africa

Crotalaria cephalotes Steud. ex A.Rich. collected by W. Schimper No. 695 in 1838 from Ethiopia

Helipterum phlomoides (Lam.) DC. (= S*yncarpha milleflora* (L.f.) B.Nord.) collected by J.F. Drège in South Africa

A new chorological map of the tropical African flora

Phytochorology, or simply chorology as it is mainly botanists that use the term, is the study of patterns of plant distribution. A more specific pursuit than biogeography, it is related to regional vegetation classification and fundamental to global biodiversity studies. Compared to most parts of the tropics, the chorology of Africa is relatively well known, but even here the holes in the available data layer far outspan the fabric. Oxford Herbaria has had a long involvement, particularly with African chorology, notably through the efforts of Frank White. The vegetation map of Africa came with an associated textual memoir as a comprehensive legend for a wall-sized, continent-wide map of vegetation type and chorology (White, 1983). It was a landmark publication drawing together local vegetation maps, herbarium and other published data and continues to be an important foundation for studies of plant biodiversity. However, data available at that time were very limited and there have been various attempts to define the chorological patterns using the 'big data' from online herbaria and similar resources.

Recently, a new approach has been published by Marshall et al., (2020), making use of a particularly comprehensive and well-cleaned plant species distribution database for tropical Africa (24°N to 24°S), combining herbarium and plot data records. A chorology map is a cartographic hypothesis about which species one is likely to meet where. We have shown that a machine learning model can be trained, using herbarium data and physical environmental variables, to predict floristically defined vegetation units with very high accuracy at a variety of resolutions. For most tropical African vascular plant species, we provide predictions of which species will occur within mapped districts and regions of tropical Africa.

To achieve this, a dissimilarity matrix of records for 31,046 vascular plant species and infraspecific taxa at one- degree square resolution was clustered to derive a hierarchical biogeographic framework. The clusters were interpolated using a machine learning approach to provide a phytogeographical map with continuous coverage across the continent. Whilst such interpolation methods are commonly applied to fill in map detail, their use for interpolating regions derived from species distribution data is novel. The approach is possible because of the very strong correlation revealed between species distributions at this scope and resolution, and the physical environmental variables used in the interpolation analysis, particularly water availability and temperature. In this way, gaps were filled over the large expanses of land where herbarium collections are too sparse, with very high confidence (>90%). The resulting map is a geographically complete quantitative phytogeographic framework for tropical Africa that can be used to predict which plant species occur at regional to more local scale across the study area. This should be useful for future studies in ecology, evolution and conservation in Africa, and the approach could be pursued for other incompletely sampled taxa and areas outside of tropical Africa.

Although any number of regions could have been defined at various levels of similarity, we chose to recognise 19 (major) regions to facilitate comparison to White's major regions and, within them, 99 districts, a similar number to WWF's ecoregions. Compared to other attempts to define similar sized regions, geographic coherence of plant distribution patterns is much higher in the current map, and a novel arrangement is described for the arid regions. Regional subdivision within the savanna biome is more or less as depicted by White and others, with minor variation to borders. Within the forests of west and central Africa, however, our regionalisation supports the divisions identified by one previous analysis of trees only, with Upper Guinea extending across the Dahomey Gap. White's single Zambezian region could not be recognised: it is replaced by four distinct regions covering the former belt south and east of the Congolian region.

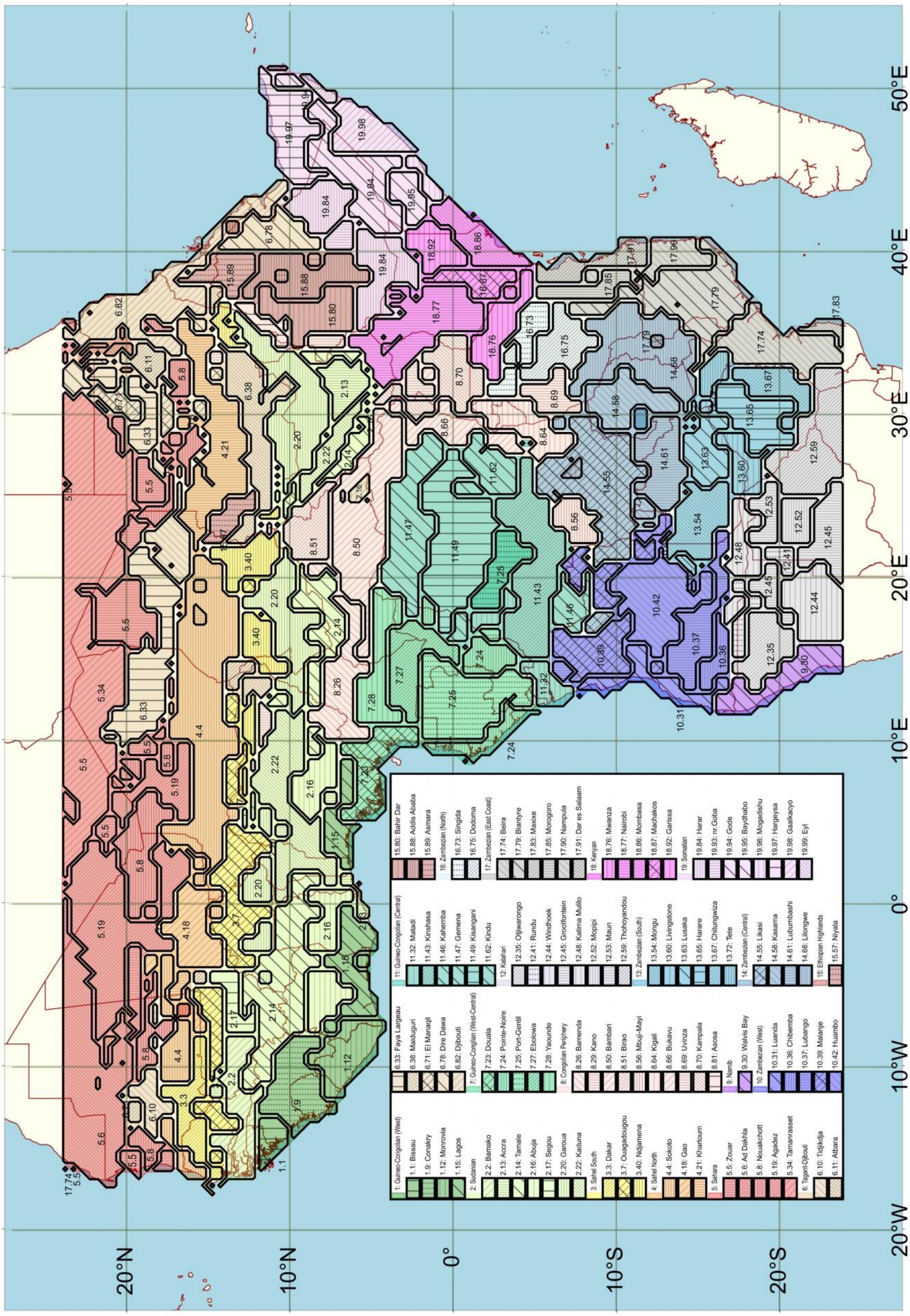
One of the limits to this approach is the one-half degree grid cell resolution: some distinctive biomes are invisible, such as the small fragmented east African coastal forests, or the patches of Afroalpine vegetation on the highest mountain peaks: drowned out by the other biomes mixed in the same cells (a problem discussed by Hawthorne & Marshall, 2019). In some of these cases White also was unable to resolve the patches, but rather used the term regional mosaic. We are currently developing a method to help resolve this weakness – watch this space.

References

Hawthorne, W. D. and Marshall, C. A. M. (2019). Rapid botanic survey, bioquality and improving botanical inventory in the tropics by integrating across spatial scales. *Gardens' Bulletin Singapore* 71 (suppl.2): 315-333.

Marshall, C.A.M., Wieringa, J. and Hawthorne, W.D. (2020). An interpolated biogeographical framework for tropical Africa using plant species distributions and the physical environment. *Journal of Biogeography* 48(1): 23-36.

White, F. (1983). *Vegetation of Africa – a descriptive memoir to accompany the Unesco/AETFAT/UNSO vegetation map of Africa.* U. N. Educational, Scientific and Cultural Organization, Paris, France.



A new chorological map of the tropical African flora

William Hawthorne
Research Associate