

Kew Scientist

Spring 2009 Issue 35

NEWS FROM THE LIVING COLLECTIONS, THE HERBARIUM AND THE LABORATORIES AT KEW & WAKEHURST PLACE

250 YEARS OF SCIENCE AT KEW, AND BEYOND



HM The Queen with Tony Kirkham (Head of Arboretum & Horticultural Services) planting a specimen of *Ginkgo biloba* on 5 May 2009 to mark Kew's 250th anniversary. A nearby historic specimen of *G. biloba* was planted in the 1760s soon after Kew's inception as a botanic garden.

A. McRobb

taxonomic research and flora writing, and a global network of collaborators eclipsing anything that the enterprising Banks imagined.

Sir Joseph Hooker succeeded his father as Director and became the most decorated of all who have occupied this illustrious post. Sir Joseph is renowned as Charles Darwin's scientific confidant and primary botanical advisor leading up to Darwin's publication of *The Origin of Species* in 1859. Like Banks, Sir Joseph became President of the Royal Society and had a global influence on taxonomic and economic botany for decades. He also moved Kew into fundamental plant science, establishing the Jodrell Laboratory for this purpose. Science at Kew gradually diversified as the disciplines of plant anatomy, physiology and cytogenetics became part of the early 20th Century's New Botany.

More recently, under Professor Jack Heslop-Harrison's directorship in the 1970s, Kew science contributed to pioneering disciplines associated with plant conservation biology, including reproductive biology, seed physiology and storage, and a focus on threatened plants. Subsequently, Professor Sir Iain Prance brought a much-needed focus on rainforest conservation biology to Kew in the 1990s and he helped to reinvigorate global taxonomic research through appointing Professor Mark Chase to lead a molecular phylogenetics team at Kew.

Today and in the future, Kew's Breathing Planet Programme integrates science across a range of strategies and disciplines, including a new venture into restoration ecology, to ensure science-based plant conservation worldwide, ultimately aimed at improving the quality of life of people through the study and conservation of plants and fungi.

Science, combined with World Heritage collections and programmes, remains Kew's strength at a time of global environmental change when problem-solving was never more urgently needed, and plant-based solutions never more important.

Prof. Stephen D. Hopper FLS, Director

Kew 250th

PLANTS PEOPLE POSSIBILITIES

DIRECTOR'S MESSAGE



Today the Royal Botanic Gardens, Kew, is one of the world's leading plant diversity science powerhouses. How did this come to be? Allen Paterson, in his recently published *The Gardens*

at Kew, highlighted the intersection of serendipity and science during the history of the organisation: 'these gardens have persisted and evolved over 250 years from fashionable pleasure grounds ... and the random, albeit surprisingly extensive plant collections, into an internationally renowned centre for the study of the world of plants ... by design, by foresight and even by sheer luck, with the right person being in the right place at just the right time.'

From a scientific perspective, it was fortunate that Sir Joseph Banks became a friend of King

George III on returning from Cook's Endeavour expedition in the 1770s. Sir Joseph became *de facto* director of the Royal Gardens at Kew for three decades, until his death in 1820. Banks's extraordinary commitment to botanical science and empire, especially relating to economic botany, ensured Kew's global reach and the foundations of its taxonomic and horticultural breadth, under the highest level of patronage and political influence.

It was also exceptionally fortuitous that Sir William Hooker was appointed as Kew's foundation Director in 1841. Sir William brought to Kew a large personal herbarium and botanical library, each purchased for the nation to support research at the Royal Botanic Gardens. With characteristic Victorian energy and vision, Sir William established aspects of Kew that remain with us today – the much enlarged area of gardens with their extraordinarily rich horticultural collections, inspirational glasshouses and museums,

AWARDS

Dahlgren Prize

Paula Rudall visited Sweden in December 2008 to be awarded the 2008 Dahlgren Prize in Botany (she is the 7th Dahlgren prize winner). This prize is awarded every three years by the Royal Physiographic Society of Lund for outstanding contributions to the systematics and evolution of flowering plants. To mark the award, Paula attended a banquet and awards ceremony, and presented invited seminars in Lund (Sweden) and Copenhagen (Denmark).



Paula Rudall collecting Hydatellaceae in Northern Territory, Australia, in May 2008.

Literature Awards

David Mabberley is the 2009 recipient of the James A. Duke Excellence in Botanical Literature Award for *Mabberley's Plant-Book: A Portable Dictionary of Plants, their Classification and Uses, 3rd edition* (Cambridge University Press; 2008). The award, from the American Botanical Council (ABC), is for a book that provides a significant contribution to literature in the fields of botany, ethnobotany, phytomedicine, and/or other disciplines related to medicinal plants. The announcement was made at the 4th ABC Awards Ceremony on 10 March 2009.

At the Garden Media Guild Awards ceremony on 20 November 2008, Oliver Whaley won the Environmental Award category and Paul Little won Features Photographer of the Year for articles that appeared in *Kew* magazine (www.kew.org/kewmagazine/).

Honorary Appointments

David Mabberley and Susyn Andrews have been appointed as Trustees of the National Botanic Garden of Wales. Hugh Pritchard has received honorary professorships at the Chinese Academy of Sciences' Kunming Institute of Botany (KIB) and the University of Sussex (2009-2011), and David Roberts has become an honorary research fellow also at the University of Sussex (2009-2011).

Lecturing Award

Stephen Graham, the Jodrell Laboratory manager, was awarded a distinguished sessional lecturer award in recognition of his high-quality teaching at the Faculty of Lifelong Learning, Birkbeck College (University of London).

PHDs

The following PhD students, co-supervised by Kew staff, have successfully defended their theses recently:

Karl Duffy, 'The reproductive biology and conservation of rare orchid species in Ireland' (June 2008).

Simona Birtic, 'Biochemical and Molecular Aspects of Seed Ageing' (October 2008).

Lidia Cabrera, 'Molecular phylogeny and classification of Araceae and Lemnaceae (monocotyledons: Alismatales)' (October 2008).

Yohan Pillon, 'Biodiversity, origin and evolution of Cunoniaceae: implications for the conservation of the flora of New Caledonia' (December 2008).

Stephan Gale, 'Population ecology and conservation of *Nervilla nipponica*, an endangered orchid in Japan' (January 2009).

Richard Waterman, 'Orchid diversity and symbiosis in the Cape of South Africa' (February 2009).

Kate Warner, 'Environmental control of sepalness and petalness in waterlilies' (March 2009). Kate showed that the development of petaloid and sepaloid regions in *Nuphar* and *Nymphaea* is partly controlled by the environment of the developing organ. *Taxon* 57, 1096 (2008).

FIELDWORK



Forests on Mount Mabu in Mozambique.

Important Forest Areas Discovered on Mount Mabu

In October 2008, possibly the largest mid-altitude forest remaining in southern Africa was discovered by a Kew-led field trip to Mt Mabu in northern Mozambique. Covering an estimated 7,000 hectares, the forest ranges from 1,000–1,600 m altitude across a series of granite peaks. Scientists from Kew, BirdLife International, Mozambique Agricultural Research Institute, Mulanje Mountain Conservation Trust, Forest Research Institute of Malawi and the African Butterfly Research Institute spent three weeks on Mt Mabu and found three new species of butterfly, four new reptiles and significant populations of five globally-threatened birds. Over 500 plant specimens are now being identified at Kew with help from Mozambican botanists, and they are expected to include new records for the country, some new species, and to extend distributions of species previously thought to be endemic elsewhere.

Other expeditions under this Darwin Initiative project have been to Mts Namuli and Chipirone in northern Mozambique and to Mt Mchese, part of Mulanje Mountain in southern Malawi. A national workshop is planned for June 2009 in Mozambique where the project's findings on the conservation values of such montane areas will be presented to senior government officials, with the hope that action will follow for these, at present, unprotected areas.

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Vegetation Survey Training Course

RBG Kew is running a two-week Vegetation Survey Training Course (14 – 25 Sept. 2009) that provides an opportunity to learn vegetation survey methodologies and techniques for practical applications.

Details: <http://tinyurl.com/rbgkew-veg>

Subantarctic Survey

In January 2009, a team of Kew botanists crossed the Southern Ocean to survey introduced plants on South Georgia. This remote island is a globally-important breeding area for seals and seabirds such as the grey-headed albatross. The vegetation consists of only 25 native vascular plants, which form distinctive plant communities. However, more than 50 introduced plants have been recorded on the island, and with climate change these species could become invasive, threatening the native flora. The results of the survey work indicate that a number of introduced plants have potential to spread under the current climatic conditions. For example, in the 1960s and 1970s botanists recorded a single persistent plant of *Anthriscus sylvestris* (cow-parsley), but no ripe seed or seedlings were observed. In 2009 three adult plants and numerous seedlings are flourishing. The survey is part of a wider EU-funded programme to control invasive species in the South Atlantic.

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Recording transect data at St Andrews Bay, South Georgia.



Scientific Celebrations

Science at Kew in its anniversary year is being celebrated with an exhibition, sculptures, books and a conference.

Conference

RBG Kew is hosting a celebratory scientific conference 'Plant Conservation for the Next Decade' (12-16 October 2009). Talks to showcase Kew's conservation research will be given alongside invited papers from leading international conservation scientists. Details: www.kew.org/science/anniversary-conference.

Orchids

As part of the 250th anniversary, the wildflower area near Kew's main gate has been planted with British orchids to display native species to visitors. The establishment of the species planted, *Anacamptis morio* (green-winged orchid), *Dactylorhiza fuchsii* (common spotted orchid), *Dactylorhiza purpurella* (northern marsh orchid), *Ophrys apifera* (bee orchid) and *Orchis mascula* (early purple orchid) will be monitored over the coming months – all are of UK provenance.

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Books

Two publications will commemorate Kew's 250th anniversary. *The Plant Hunters* (by C. Fry; Andre Deutsch in collaboration with RBG Kew) contains removable facsimiles of rare historical documents from Kew's Archives. The material includes a letter written by Carl Linnaeus, extracts from the notebooks of Joseph Hooker, a record of the breadfruit transported by HMS Bounty and extracts from the ancient herbals of Gerarde and Culpeper. ISBN 978 0 233 00244 6; £30.

A special double issue of *Curtis's Botanical Magazine* (Volume 26, parts 1 and 2 combined) was published in April to mark Kew's 250th anniversary and Darwin's bicentenary. It includes an article by Sam Berry on the relationship between Darwin and Joseph Hooker and the influence of their voluminous correspondence on Darwin's thinking. Twelve plant portraits illustrate the importance of Kew's work around the world.



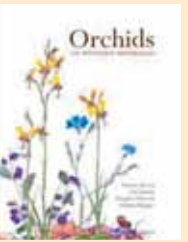
Sculpture of a fruit of *Aesculus hippocastanum* (horse chestnut) by Tom Hare.

Seeds

The Millennium Seed Bank Project aims to reach its target of collecting and banking seeds from 10 per cent of the world's plant species by the end of Kew's anniversary year. To mark this, an exhibition in the Nash Conservatory called 'Banking for Life' (open until September 2009) tells the story of the project through interactive displays, examples of unusual seeds and a mock-up of a seed growth room, all set around a centrepiece sculpture of devil's claw seed capsules by Tony Gibas. Outside, a series of sculptures of fruits and seeds by Tom Hare will be in place until the end of 2009, and the artist will be on site during the summer producing more works.

New Books

Orchids of Western Australia (by A. Brown, P. Dundas, K. Dixon, S. Hopper; UWA Press; ISBN 978 0 980296 457) is the first modern text cataloguing all known orchid species of Western Australia and contains over 200 full-page illustrations. It focuses on the state's two orchid regions – the South-West and the Kimberley – and presents a selection of hybrids often mistaken for new species.



Plant Resources of Tropical Africa 7(1) Timbers 1 (eds. D. Louppe, A.A. Oteng-Amoako, M. Brink; PROTA Foundation; ISBN 978 90 5782 209 4) published in December 2008 is the first of two volumes on timbers and deals with 511 timber species (see www.prota.org). Included are wood anatomical descriptions of more than 200 of the major commercial timbers, prepared by African trainees and five senior IAWA wood anatomists including Kew's Peter Gasson. The descriptions are also in the InsideWood database (<http://insidewood.lib.ncsu.edu/>).

The Genus Jasminum in Cultivation (by P. Green & D. Miller; Kew Publishing; ISBN 978 1 84246 011 5; £33) is the latest *Botanical Magazine Monograph* and details the historical and cultural use of jasmine, its role in perfumery and medicine, cultivation in temperate and tropical gardens, and taxonomy including a key to cultivated species.



World Checklist of Myrtaceae (by R. Govaerts et al.; Kew Publishing; ISBN 978 1 84246 391 8; £72) is a much needed work that lists all validly published names of Myrtaceae, a family with a complex nomenclatural history resulting in notorious difficulties in basic identification. The book indicates which names are currently accepted and which are synonyms.

Pharaoh's Flowers: The Botanical Treasures of Tutankhamun (by N. Hepper; KWS Publishers; ISBN 978 0 9817736 3 6; £23) is a fully updated second edition containing descriptions of the plants and flowers found or represented in Tutankhamun's tomb.

Order books published by Kew Publishing from www.kewbooks.com

Kew Scientist

Kew Scientist is now printed on uncoated 100% recycled paper. The move to uncoated paper has been made because it consumes more energy to manufacture coated paper than uncoated and the chemicals used also make recycling the paper more difficult. For a paperless version of *Kew Scientist*, visit www.kew.org/kewscientist.

Local People Engage in Forest Restoration

As funding from the Darwin Initiative ends, the habitat restoration and sustainable livelihoods project in Peru has successfully secured further funds for Peruvian partners: the Watershed Foundation has provided \$20,000 for A Rocha Peru, and Trees for Cities have now confirmed £6,000 and aim to raise £11,000 per year for ANIA (Association for Children and their Environment in Lima). This means that a programme to plant native trees in schools and a large reforestation project will have on-going support while able to draw on the skills of the Darwin-trained team and the manuals produced. The Darwin project is now analysing data sets from restoration monitoring at three large agro-industrial sites and several community settings. Initial results show some significant results from low-tech subsoil watering, crop by-product mulches and use of untreated sewage water, all of which should help this hyperarid and impoverished region.

As part of the engagement process for local people and government, the project has organised three huarango festivals. These help to promote Miskyuaranga, a sustainable forest product made of highly nutritious huarango (*Prosopis limensis*) sweet flour that was developed by the project. Although huarango flour was used 5,000 years ago by Nazca culture, only now has it been given the



O. Whaley

phytosanitary permits needed to sell it on the open market. The huarango festivals have been well supported, as people flock to sample free food and drink derived from the region's dry forest, and the government has announced an official day for these events (17 April). Miskyuaranga is sold by the Darwin-trained group together with a co-operative of producers who harvest from relic forests where huarango is being replanted. It is hoped that this food will ensure a sustainable future for the forests. The main relic forest ('Tunga y Usaca') has now been set up by the project as a 500 ha reserve with the local bird conservation group (GAP), and another is awaiting government approval. The reserve supports the threatened slender-billed finch, which depends on huarango; this bird is used on the Miskyuaranga label.

Contact: Oliver Whaley (o.whaley@kew.org)



Enjoying a *Prosopis* fruit at a huarango festival.

O. Whaley

Neotropical Plant Key

The NEOTROPIKEY project, led by Kew, is developing a free, on-line, multi-access, illustrated identification key to the flowering plant families of the Neotropics. The project website has been launched with 77 individual family web pages giving descriptions, images and hints on identification or keys to genera, with more being uploaded at regular intervals. Later in 2009 a family-level key, developed with LUCID software, will be available. NEOTROPIKEY will provide specialist taxonomic knowledge in an accessible form and will be a valuable resource for everybody wishing to identify Neotropical plants. It is a collaborative project involving taxonomic specialists world-wide, reflecting the most accurate and up-to-date taxonomic thinking. More than 130 contributions have already been submitted from about 100 family specialists. Visit NEOTROPIKEY at www.kew.org/science/tropamerica/neotropikey.htm

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Brazilian Fuelwoods

Fieldwork on the joint Kew/APNE fuelwood project has now been completed and data collection, analysis and paper writing have begun in earnest. A total of 5,280 trees of four native species (*Caesalpinia pyramidalis*, *Mimosa ophthalmocentra*, *M. tenuiflora* and *Croton sonderianus*) from two different sites in the caatinga of Pernambuco were coppiced or pollarded in 2002, and after three or six years their regrowth was collected and measured. The quantity and quality of the regrowth are now being assessed in relation to the size of the original tree and quality of the original wood for the purpose of fuelwood and charcoal. Results so far show that a higher percentage of the trees survive after cutting in the dry season than those cut in the wet season. These and other findings will be disseminated in the form of a leaflet during a workshop planned in Brazil for 2010 to involve local people, government and non-government organisations, policy makers and scientists, so that the findings of this project can be applied to sustainable management of trees in the care of local people. A detailed study using SEM is also underway on the anatomical changes on charring of the two *Mimosa* species, with the collaboration of Claudia Leme (UFBA) and Caroline Cartwright (British Museum).

Contact: Dr Peter Gasson (P.Gasson@kew.org)



Darwin students planting a habitat restoration trial in Peru, and (photo above left) the same site after one year.

O. Whaley

LATIN AMERICA



Daniela Zappi (left) and Nicky Biggs collecting in Cristalino.

W. Milliken/BGC Kew

The varied work with partners in Latin America embodies Kew's Breathing Plant Programme. Neotropikey will accelerate global access to plant information, fieldwork is identifying threatened regions and assisting conservation projects, and the study of useful plant species in Peru and Brazil involves and benefits local communities.

Conservation in the Brazilian Amazon

On the Amazon's southern 'arc of deforestation' Kew is working with Brazilian partners to address urgent conservation priorities. Three private protected areas have now been registered with support from the project 'Programa Flora Cristalino', which has also raised local biodiversity awareness by developing public educational materials and programmes. Local students and botanists have been trained, and the collections made during the project have formed the core for a new herbarium in the local university. A checklist of well over 1,000 species is nearing completion, filling a geographical 'black hole' in our knowledge of the Amazon's flora; it includes at least six species new to science.

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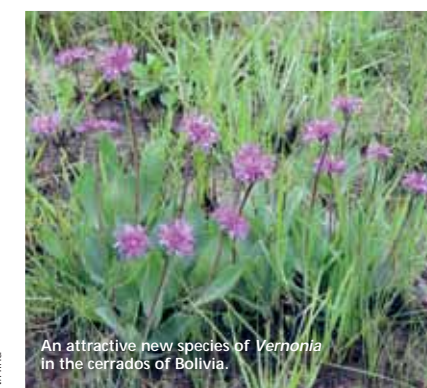
'Campo rupestres' in Santana do Pirapama.

D. Zappi



Nicotianthus lorentzii.

N. Hind



An attractive new species of *Vernonia* in the cerrados of Bolivia.

J. Wood

Bolivian Compositae

An *Annotated Preliminary Checklist of the Compositae of Bolivia* by Nicholas Hind was published on-line in February 2009. It records 1,044 species in 223 genera in 13 tribes, including 285 endemic species — about 28% of the total, comparing favourably with the rich Compositae floras of Argentina, Peru and Ecuador. Interestingly, there are no genera endemic to the Bolivian Compositae flora. The checklist was begun in 2006 during preparations for fieldwork in Bolivia, and a near final version was available for a second field trip in 2008, both trips to Darwin Initiative project areas. With new species being described and continuing determinations being made from these Darwin project collections and those of other institutes, the totals in the checklist continue to rise and updates will be made available on a regular basis. www.kew.org/science/tropamerica/boliviacompositae.

Contact: Dr Nicholas Hind (n.hind@kew.org)

Fieldwork in Campos Rupestres

RBG Kew is collaborating with the University of São Paulo and the Botanic Garden of Rio de Janeiro in a new project to study the vegetation within the Fazenda Toucan Cipó, Municipality of Santana do Pirapama, Brazil. During the first field trips to the area in March 2009 over 1,000 plant collections were made and over 6,000 digital photographs were taken. Three species new to science were discovered: two new *Encholirium* sp. (Bromeliaceae) and one *Pilosocereus* (Cactaceae).

The Fazenda Toucan Cipó is in the Serra do Espinhaço, an area supporting a mosaic of vegetation formations with extensive ecotonal areas, including campos rupestres and cerrado. The campos rupestres are thought to support more than 4,000 vascular plants, with high levels of endemism. Threats to the area include fire, cattle-grazing, mining and charcoal-making. The project will produce a species checklist that will support proposals to create protected areas, a vegetation map (showing land use, vegetation types and existing environmental pressures) and an illustrated plant guide to include information on traditional plant uses. Two more field trips will take place in 2009/2010.

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Bolivian Cerrados

Kew is one of the partners in the current Darwin Initiative project for the Conservation of the Cerrados of Eastern Bolivia. This is a collaborative project based in Oxford (UK) and Santa Cruz (Bolivia) focussed on the relatively unknown cerrados of Bolivia. The project aims to identify priority areas for conservation and promote awareness of the flora and the need for its conservation as well as providing support and training for Bolivian scientists. Initial results indicate the presence of many rare species, including several new to science and at least three areas of outstanding plant diversity and importance for conservation.

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Cactus Seed Biology Database

Published research into the seed biology of Cactaceae is biased towards a limited number of species and traits, with detailed, regional studies often inaccessible as institutional reports and theses. To produce a more comprehensive summary of cactus seed biology, a research project was set up between the Millennium Seed Bank Project and 11 institutes from Argentina, Chile, Mexico, Peru and USA. Led by Hugh Pritchard and Charlotte Seal, *The Cactus Seed Biology Database* contains information on over 350 species with up to 15 traits including seed germination, seed mass, uses and species distribution. Formed from a review of published and grey literature together with new germination data for 86 species/sub-species, the database is available as a CD to researchers and conservationists.



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Caatinga Legumes

Leguminosae da Caatinga, by Luciano Paganucci de Queiroz (Brazil's leading authority on the legumes of the caatinga) has just been published with support from Kew as part of the Anglo-Brazilian Plantas do Nordeste programme. The book is based on herbarium, library and field data compiled over 16 years by the author in collaboration with other legume specialists. A total of 86 legume genera and 311 species are now known to occur in the caatinga biome, and the volume is both a practical field guide to caatinga legumes and a detailed taxonomic account.



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B. Schrire

Indigofera

The third-largest legume genus, *Indigofera* with c. 750 species, is widely known for the production of indigo, a blue dye used in the textile industry. Brian Schrire and an international multidisciplinary team of researchers have analysed over one-third of the species and found significant phylogenetic structure within *Indigofera*, imposed by morphology, ecology and geography. Such structure reveals useful evolutionary data about a group and is indicated by species clustering around certain environmental (biome), geographical (area) or morphological (character) parameters. All species of *Indigofera* comprise just four main clades, each diagnosable by morphological synapomorphies and ecological and geographical predilections. A rates analysis of nucleotide substitutions also confirms that the ages of the oldest subclades are mostly younger than 16 Ma, implicating dispersal in explaining the worldwide distribution of the genus. *Am. J. Bot.* 96, 816 (2009).

Contact: Dr Brian Schrire (b.schrire@kew.org)

DNA BARCODING & SEQUENCE NEWS

TreeBOL

The first workshop of the European section of the TreeBOL (tree barcode of life) project, which aims at barcoding all the tree species of the world, took place at Kew on 15 February 2009. Several researchers from around Europe (France, Italy, Poland, Finland, Germany, UK) were present and discussed various scientific and logistical aspects of the project. Funds to produce the barcodes of the c. 400 species of trees found in Europe have already been secured.

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ECONOMIC PLANTS

Remarkable New Coffee Species

Botanical exploration in Madagascar has unearthed six new species of coffee belonging to the baracoffea alliance, a morphologically unique group of nine species restricted to the seasonally dry forests of western Madagascar. The new species are some of the most remarkable in the genus, looking totally different to most coffees. *Coffea labatii* and *C. pterocarpa* are remarkable for having distinctly winged fruits and *C. ambongensis* and *C. boinensis* have the largest seeds of any coffee species, their 'coffee beans' being more than twice the size of those of *C. arabica*. *Coffea pterocarpa* and *C. namorokensis* were only discovered in 2000, after an expedition to the isolated Namoroka Reserve, and *C. ambongensis* was rediscovered in 1999 after not been seen by scientists since 1852. To our knowledge, none of the new species has been tried as a beverage but as with all other coffee species the fruit contains the characteristic coffee bean. These six new species bring the total number of coffee species to 103. *Bot. J. Linn. Soc.* 158, 355 (2008).

Contact: Dr Aaron Davis (a.davis@kew.org)

National Tulip Collection

In November 2008 the collection of *Tulipa* species at Kew was awarded National Plant Collection status by Plant Heritage (the National Council of the Conservation of Plants and Gardens). This is the second National Plant Collection held by the Alpine Nursery at Kew, the other being *Iris* subgenus *Scorpiris* (the 'Juno' irises), and one of ten such collections held by the Royal Botanic Gardens, Kew.

Tulipa forms part of Kew's extensive petaloid monocot collections that are used for research in the Jodrell Laboratory and Herbarium, as well as being an important part of Kew's spring display in the Davies Alpine House. Among the 90 or so taxa of *Tulipa* are some dating from the 1960s, together with more recent additions

Barcoding Fungi

Biologists often identify fungi obtained from soil, plants, animals and other substrates by comparing their DNA sequences with those in GenBank. However, the number of 'unknown fungi' sequenced only from the environment is significant. Are these unknown fungi truly new species? With support from The Royal Society, a team from Imperial College London, the Natural History Museum London and Kew estimated that c. 70% of the fungal species in the Kew Fungal Herbarium are not represented in GenBank, and they demonstrated that many Kew fungi are these 'unknown fungi', including well-known *Gastrum* earthstars and *Hygrocybe* waxcaps of conservation importance. *New Phytol.* 181, 719 (2008).

Contact: Dr Martin Bidartondo (m.bidartondo@kew.org)



A. Davis

Coffee Seed Germination

Peter Toorop and co-workers have studied coffee seed germination in detail. They found that radicle protrusion is the result of endosperm elasticity and embryonic isodiametric cell growth. It coincides with accumulation of B-tubulin, a component of the microtubular cytoskeleton that controls the shape of the embryonic cells. Moreover, transversal organization of the cytoskeleton is essential for cell elongation and division. Thus, cytoskeleton formation is initiated during germination and controls this event. *Ann. Bot.* 102, 425 (2008).

Contact: Dr Peter Toorop (p.toorop@kew.org)



R. Wilford

donated by Arnis Seisums at Salaspils Botanic Garden in Latvia, and Mehdi Zarrei of Shahed University in Tehran. They include the rarely grown Central Asian *Tulipa lehmanniana* and the distinctive *T. regelii* from the Lake Balkash region of Kazakhstan.

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Curating DNA sequences

The public DNA database GenBank is a fundamental resource for molecular biology, evolutionary biology and ecology. At the moment, only the original depositors of a DNA sequence accession in GenBank can modify the data associated with that DNA (e.g., species name). Martin Bidartondo (Imperial College London/Kew) led a group of 256 scientists to petition that the current annotation model should begin to follow the one long in use by public specimen collections where open cumulative annotation retains all original data but additional opinion is appended and used for filing and retrieval. *Science* 319, 1616 (2008).



Afrothismia hydra.

ANOMALOUS TAXA

Anomalous taxa often hold the key to understanding evolutionary processes and so they attract the attention of Kew's scientists.

Key to Grass Evolution

Early-divergent grasses may hold the key to studies of grass evolution. Researchers from Brazil (Maria das Graças Sajo and Hilda Longhi-Wagner) and Kew (Paula Rudall and Carol Furness) have undertaken comparative studies of reproductive morphology and development in the Brazilian grass *Streptochaeta spicata*, which represents an early-divergent grass lineage. Although *Streptochaeta* possesses many typical grass features, the study found that its pollen development is relatively unusual among grasses and their allies, and its inflorescence can be considered as morphologically intermediate between the true spikelet of grasses and reproductive units of close grass relatives. *Plant Syst. Evol.* 275, 245 (2008); *Grana* 48, 27 (2009)

Contact: Dr Paula Rudall (p.rudall@kew.org)

Relationships of Duckweeds and Aroids

A family-wide analysis of Araceae, including nearly all genera plus alismatid outgroups, was conducted by Lidia Cabrera and colleagues from Universidad Nacional Autónoma de México (UNAM), Joseph Bogner from Germany and Simon Mayo and Mark Chase from Kew. They used five regions of plastid DNA, which produced a well-supported analysis. The position of *Lemna* and relatives, often referred to their own family, were a major focus, as well as the subfamilies, particularly Gymnostachydoideae and Orontioideae, both of which have morphological traits cited as

Plant-Fungal Coevolution

Mycorrhizas are ancient nutritional mutualisms between the vast majority of plants and some groups of fungi. About 50 million years ago, species of *Afrothismia* began 'cheating' one of these mutualisms, the arbuscular mycorrhizas. Ever since then, these plants have been closely following the evolution of their target *Glomus* fungi.

Vincent Merckx (University of Leuven) and Martin Bidartondo (Imperial College London/Kew) have used a novel molecular evolutionary ecology approach to untangle the history and the ecology of plants and *Glomus* fungi in southwest Cameroon. They found that extreme fidelity for fungi has led cheater plants to lengthy evolutionary codiversification and, remarkably, the plants' evolutionary history closely mirrors that of their mycorrhizal fungi but with considerably more recent divergence times. *Proc. Roy. Soc. B* 275, 1029 (2008).

Contact: Dr Martin Bidartondo (m.bidartondo@kew.org)



G. Prenner

Orchid-like Legume

Duparquetia orchidacea is a monotypic caesalpinoid liana from tropical West Africa. Its unusual, orchid-like flowers are consistent with its isolated phylogenetic position among the early-branching lineages of legumes. A detailed study using scanning electron microscopy by Gerhard Prenner and Bente Klitgaard of the floral morphology and development of this species revealed highly unusual developmental patterns that provide clues to legume floral evolution. For example, alternating left-right symmetries in floral development could indicate spiral organ formation in ancestral legume taxa. Early asymmetry of the young carpel in *Duparquetia* helps to interpret the asymmetric 'mirror-image' flowers of other legume species. The unusual 'cochlear-descending' type of petal arrangement that occurs in both *Duparquetia* and papilionoid legumes is based on different developmental pathways, and therefore could have evolved separately in the two groups. *Am. J. Bot.* 95, 1349 (2008).

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CATE

The CATE project (Creating a Taxonomic E-Science), set up by a NERC grant and carried out by Kew, the Natural History Museum London and University of Oxford, has completed its first three years. The two model websites created provide detailed revisionary content for Araceae (www.cate-araceae.org) and SpHINGidae (www.cate-sphingidae.org). Benjamin Clark is now aligning the software with the Common Data Model of the EDIT Cybertaxonomy programme, while Anna Haigh and Simon Mayo continue to develop the taxonomic content for Araceae.

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While the evolutionary ancestry of the flower remains a mystery, the origin of this member of the early-divergent angiosperm order Nymphaeales is not. *Nymphaea* 'Kew's Electric Indigo' is the world's first hybrid between a day and night-flowering *Nymphaea*. The hybrid, produced by Kew horticulturist Carlos Magdalena, flowered for the first time at Kew on 16 January 2009.

C. Magdalena

ANATOMY OF THE "ABOMINABLE MYSTERY"

Since Charles Darwin famously judged the evolutionary origin of the flowering plants to be an "abominable mystery", the origin of the flower has remained highly topical.

An international team from Kew (Paula Rudall, Gerhard Prenner and Chrissie Prychid), Russia (Dmitry Sokoloff and Margarita Remizowa) and Australia (Renee Tuckett) explored this subject using *Trithuria*, the sole genus of the early-divergent angiosperm family Hydatellaceae, in which the inflorescence-flower boundary is ambivalent. They tested various hypotheses,

partly using data from immunolocalization of the floral meristem identity gene *LEAFY* which indicated protein expression at different hierarchical levels in reproductive meristems.

This work is published in a special Darwin issue of the *American Journal of Botany*, and in May 2009 Paula Rudall will present some of the research at a Royal Society meeting on 'Darwin and the Evolution of Flowers', co-organised by former Kew Director, Peter Crane. *Am. J. Bot.* 96, 67 (2009).

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Bottleneck "Checks Unlimited Multiplication"

Charles Darwin was so baffled by the prolific seed production of the helleborine orchid *Cephalanthera* and the rarity of adult plants that in 1862 he resignedly concluded "What checks unlimited multiplication cannot be told." As a result of a Natural Environment Research Council grant, Martin Bidartondo (Kew/Imperial College London) and David Read (University of Sheffield) determined that a bottleneck of narrow specificity to *Tomentella* mycorrhizal fungi during early orchid germination drastically reduces the number of *Cephalanthera* seedlings that can reach maturity at field sites in Anglesey, Hampshire (UK) and Franconia (Germany). Because the fungi are also mycorrhizal with forest trees, the habitat requirements for the establishment of helleborine orchids in nature depend on the presence of trees associated with *Tomentella*. *Mol. Ecol.* 17, 3707 (2008).

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Cephalanthera damasonium.

M. Bidartondo

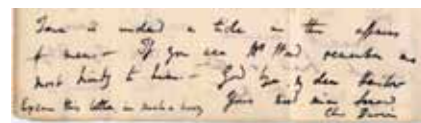
Darwin's Science

Sir Joseph Hooker (former Director of Kew) was a close friend of Charles Darwin and supported his theories on evolution. Two hundred years after Darwin's birth and 150 years after the publication of the Origin of Species, present-day Kew scientists are still studying the botanical issues about which Darwin thought and wrote.

Darwin Letters

Kew's Archives hold 44 letters from Charles Darwin to Prof. John Henslow. These rare letters provide an insight into Darwin's developing theories and discussions with his mentor at a seminal time in his life. They cover the period from 1831, when Darwin was first accepted onto the Beagle voyage, until 1837 when, back home, he was working on his collections. They include many fascinating letters written during the voyage. Funds are being sought to help conserve these letters and make digital versions available on the web.

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"The Species Question"

Darwin was preoccupied with how one species changed into another — "the species question" — and speciation still preoccupies Kew's scientists. Vincent Savolainen (Imperial College London/Kew) has been awarded a 2.5m euro European Research Council Advanced Investigators Grant to study the origin of species on islands. Vincent and an international team of scientists have also recently studied the process of diversification in Mediterranean biodiversity hotspots (*Proc. Natl. Acad. Sci. USA* 106, 221; 2009). Christian Lexer (Kew) and Alex Buerkle (Univ. Wyoming) have reviewed one approach to the study of speciation: how admixture mapping can be used to investigate inheritance in wild organisms (*Trends Ecol. Evol.* 23, 686; 2008). Lastly, Ovidiu Paun, Félix Forest, Mike Fay and Mark Chase have examined the hypothesis that hybridization and polyploidy has regularly stimulated speciation in angiosperms (*New Phytol.*, in press, doi:10.1111/j.1469-8137.2009.02767.x).

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