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Kew Scientist

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News from The Living Collections, The Herbarium and The Laboratories at Kew & Wakehurst Place

Farmers planting seedlings of *Carapa procera*, *Gardenia sokotensis*, *Khaya senegalensis* and *Senna alata* in a communal garden in Mali for use as natural pesticides.

M.Sacande

Tree planting in Africa

Save seed and prosper

The United Nations has declared 2011 as the International Year of Forests to raise awareness of sustainable management and conservation of forests. In Africa, as in many parts of the world, communities are highly and directly dependent on a diverse range of useful forest products and services for food, health and a variety of livelihood activities. These wild resources are often over exploited, so the domestication and cultivation of forest species is necessary to address the needs of the local people and reduce the pressure on natural populations. However, the complexity of this process, requiring biological and ecological research on candidate species, has long been a factor limiting the planting programmes of many forestry and horticulture departments in developing countries.

The Millennium Seed Bank Partnership (MSBP) is a repository for the seed of over 10% of the world's flowering plants, and by 2020 the MSBP intends to conserve 25% of plant species as seed and make seed available for sustainable use in agriculture, horticulture, forestry and habitat restoration (Strategy 5 of Kew's new Breathing Planet Programme — 'Save seed and prosper'). One use of the scientific knowledge generated from the MSBP seed collections is to solve impediments to wild plant propagation. In a recent initiative the MSBP, through its African partners, has been using its expertise in seed handling and germination to support local, government and NGO-led tree propagation and planting schemes by the provision of advice and training.

During 2010, nearly 62,000 seedlings of 203 tree species were produced in the initiative, and over 90% of these seedlings have been planted out. In Mali tree seedlings were planted in village woodlands, sacred forests, schools and home gardens to mark the 50th anniversary of independence of the country from France, and in Ghana (where the VodaFone Foundation has helped support the MSBP programme) seedlings were planted in cocoa farms. Species planted in these countries included *Securidaca longepedunculata*, *Erythrina senegalensis*, *Garcinia kola*, *Tetrapleura tetraptera*, species of *Terminalia* and *Spondias mombin*. Some schemes resulted in certain tree species, such as *Pseudocedrela kotschyi*, *Pterocarpus santalinoides* and *Gardenia nitida*, being cultivated for the first time.

M.Sacande

Farmers in Mali receiving training in nursery techniques for seedling production.

The planting schemes will enable communities to benefit from their native useful tree species in a sustainable way. Following the initial success of MSBP involvement, discussions are underway to scale up the initiative. This would consolidate the opportunity for the MSBP to play a significant part in the afforestation, restoration, preservation of biodiversity and sustainable use of wild tree species, and contribute to the International Year of Forests 2011.

Contact: Dr Moctar Sacande (m.sacande@kew.org)

Researchers at Kew, the Natural Resources Institute (UK) and the World Agroforestry Centre (Southern Africa Programme) have reviewed the roles that phytochemical screening and in vitro propagation techniques have to play in reducing over-harvesting of medicinal and pesticidal plants and generating income for the rural poor. *Plant Cell Rep.*, in press, doi: 10.1007/s00299-011-1047-5.

Contact: Dr Viswambharan Sarasan (v.sarasan@kew.org)

Kew
ROYAL BOTANIC GARDENS

INTERNATIONAL YEAR OF FORESTS · 2011

Direction

Conserving trees and forests

The newly created Directorate of Conservation, Living Collections and Estates at the Royal Botanic Gardens, Kew offers an opportunity to bring together science, horticulture and policy to address the big issues effecting plant conservation. None could be bigger than the need to conserve our trees and forests.

Kew is well known for its extensive collection of living trees. Kew Gardens has 14,000 trees, representing some 5,000 different species, and Wakehurst Place about the same again.

These trees include rare and threatened species, representative selections from various families and regions of the world, and horticulturally challenging species that need a helping hand. This is a vast resource for science and conservation, backed up by the Millennium Seed Bank's swelling collection of woody plant seeds.

In coming months we will establish the Millennium Seed Bank as the UK national hub for the long term storage of forestry seed – part of the evolution of the seed bank from a storage vault to a service-delivery facility. It means that Kew will have one of the strongest collections of tree germplasm on the planet.

In this International Year of Forests, we are forging ahead with research in restoration at home and abroad, seed banking and germination and mapping and survey projects around the world. Our conventions and policies group continue to make sure legal protection is available for trees under threat, while we also make sure we can still provide the science needed to improve conservation and management.

From the perspective of the new Directorate and its responsibilities, we also need to find ways to reflect this commitment to tree conservation in our plant displays and landscapes. Every visitor to our estates, or our website, should leave with no doubt that trees are essential to life on earth – whether as carbon sinks, oxygen producers or sources of food, timber or pharmaceutical products.

Of course trees are more than a survival toolbox for our species. Many other plants and animals depend on them, and anyone who can't draw inspiration and hope from a majestic forest tree isn't looking hard enough.

Dr Tim Entwisle, Director of Conservation, Living Collections and Estates

(Tim commenced in 2011 as a recent appointment to the Executive Board of RBG Kew)

Awards

Paul Smith was named in a list of the 100 most important contemporary figures in British science published by *The Times* in its *Eureka* magazine.

The Kew Plant Glossary (by Henk Beentje; Kew Publishing, 2010) won Reference Book of the Year at the Garden Media Guild 2010 Awards (1 December, 2010). Other Kew books, *Kew Magazine* and Kew's website were finalists.

PhDs

The following students, co-supervised by Kew staff, passed their PhD vivas recently:

Jennifer Ison, 'Pollination of *Echinacea angustifolia*: effects of flowering phenology and spatial isolation' (October 2010).

Sharon Zytynska, 'The genetic basis to species interactions in model and natural ecosystems' (November 2010)

Cynthia Sothers, 'Systematics of *Couepia* (Chrysobalanaceae)' (November 2010).

Elizabeth McCarthy, 'Biosystematics of *Nicotiana* (Solanaceae) (November 2010).

Yael Kisel, 'Evolutionary studies in Neotropical orchids' (November 2010).

Henk Beentje (left) receiving the Garden Media Guild Award.

Mike Wyatt/GMG

Seeds and stress

C. Seal

Germinating seed of *Suaeda maritima*, model species used to study seed responses.

A recent 'Tansley Review' in *New Phytologist* addresses the lack of attention given to stress concepts of seeds and plants. Ilse Kranner and Charlotte Seal (Kew) together with Farida Minibayeva (Kazan Institute of Biochemistry and Biophysics, Russia) and Richard Beckett (University of KwaZulu-Natal, South Africa) have taken the General Adaptation Syndrome (GAS), one of the most widely accepted stress concepts in medicine, to the molecular level and modified it for seeds, identifying three stages of stress response.

In the 'alarm phase', a stress factor is perceived by a signalling network of seed hormones and various other small molecules. Under continuing stress, the 'resistance phase' is reached when the stress response is sufficient for cellular protection and repair, maintaining seed viability. If these mechanisms fail, the final 'exhaustion phase' leads to the breakdown of essential molecules and, ultimately, seed death.

This modified GAS also has relevance to plants generally as many stress causes and response systems are common to both. Stresses that impact upon seeds can affect plant reproduction and productivity. Therefore, understanding how seeds cope with stress is important in relation to food security and the effects of climate change on biodiversity. *New Phytologist* 188, 655 (2010).

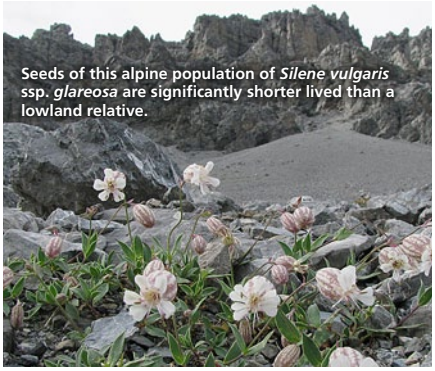
Contact: Dr Ilse Kranner (i.kranner@kew.org)

Short-lived alpine seed

Recent research by the Millennium Seed Bank Partnership had shown that seed structure and climate of origin correlate with seed longevity. Seeds with small embryos from cool wet regions of the world are more likely to be short lived compared to seeds with large embryos from warmer, drier regions. Now studies by international partners at the University of Pavia (Italy) and Kew's seed conservationists have extended this evidence by comparing seeds of alpine species and their lowland relatives.

Controlled ageing experiments on 63 species revealed that seeds of alpine species and populations were consistently shorter lived than their lowland counterparts. The results cannot be explained by differences in seed maturity, and further work is needed to confirm the extent that these differences are due to genetic makeup resulting from selection pressure for seed survival after dispersal. Seed banking will be an important strategy for the conservation of alpine floras but extra care will be needed in setting viability monitoring intervals, and for some species cryopreservation may be needed in order to maximise seed longevity. *Ann. Bot.* 107, 171 (2011).

Contact: Dr Robin Probert (r.probert@kew.org)



Seeds of this alpine population of *Silene vulgaris* ssp. *glareosa* are significantly shorter lived than a lowland relative.

A. Mondoni

New frontiers in herbarium science

Nicholas Hind in the Compositae vault of Kew's new herbarium wing.

A. McRobb/RBG Kew

Herbarium reorganisation

The new wing E of Kew's Herbarium, Library, Art & Archives was officially opened in November 2010. The second floor is custom built to house the Leguminosae and Compositae collections (transferred from wings A and B respectively) in state-of-the-art temperature-controlled vaults accommodating herbarium specimens in labelled storage boxes on compactor shelves. Relocation of the Compositae took place between April and November 2010. Transfer of the Leguminosae was completed in April 2011. All material was frozen at -40°C for three days as part of the move. Together the two plant families have transferred approximately 1.5 million specimens (or about 20% of the total herbarium holdings); these represent c 45,000 species in 2,365 genera and now occupy 19,500 boxes on just over 6 km of compactor shelving in an insect-free environment. Noteworthy is that the genera in both families have been rearranged by the latest science in new classifications that radically update the previous Bentham & Hooker system.

In January 2011 the next phase of the herbarium collection rearrangement started. All other plant families are being moved around to reflect the APG III system – a gargantuan logistics operation expected to take the next two to three years. This is a once in a generation opportunity to align Kew's herbarium specimens with the latest botanical research.

Contact: Dr Gwilym Lewis (g.lewis@kew.org)

Linear orders

Phytotaxa 19 (2011), edited by Maarten Christenhusz (Finnish Museum of Natural History), Mark Chase and Mike Fay (Kew), presents the linear sequence, classification, synonymy and bibliography of vascular plants in three articles. Two papers on the linear orders for families of lycophytes, ferns and gymnosperms follow the 'Linear APG' of Haston and colleagues in 2009. The third paper presents synonyms of the orders and families recognised in the Angiosperm Phylogeny Group classification and related papers.

Contact: Dr Mike Fay (m.fay@kew.org)

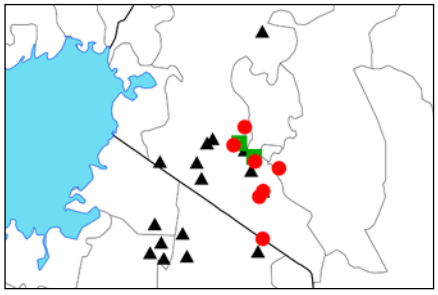
Herbaria hold 50% of undiscovered species

A study has revealed that 84% of new plant species described between 1970 and 2010 were from herbarium specimens collected more than five years prior to publication, and nearly 25% of new species were from specimens over 50 years old. Extrapolation of these results suggest that, of the estimated 70,000 plant species still to be described, more than half have been collected already and are stored in herbaria. *Proc. Natl. Acad. Sci. USA*, 107, 22169 (2010).

Contact: Terry Pennington (t.pennington@kew.org)

Specimens document habitat change

Herbarium specimens are not just for taxonomists. They are a treasure trove of data on historic plant distributions, often recording the ecological environment and vegetation type seen at the time of the collection. In May 2009, Maria Vorontsova and a team from the National Museums of Kenya, the Natural History Museum (London) and Kew were in Kenya hunting for rare species of *Solanum* subgenus *Leptostemonum* (wild spiny aubergines), revisiting 17 localities recorded on 40 collections made between 1922-1985. Comparison between specimen notes and the current environment was combined with knowledge of local people to decide whether significant environmental change has occurred. Species were successfully recollected in only four of the sites, and clear evidence of vegetation change was seen in 24% of the sites. Many localities no longer constitute suitable habitat for these species. Vegetation clearance and increased grazing are commonplace across East Africa but such land use changes are not recorded and nobody knows how much vegetation is being lost. Dedicated studies of vegetation change should consider using herbarium collections as an information source on past vegetation cover. *Systematic Botany* 35, 894 (2010).



P. Fičinski

Historical collection sites of *Solanum polhillii* in Kenya and Tanzania showing those at which it was (green squares) and was not found (red circles) in 2009, and sites not visited (black triangles).

Contact: Dr Maria Vorontsova (m.vorontsova@kew.org)

Neotropical Malvaceae – Malvoideae

In February 2011, the Neotropikey project moved into its second phase with the launch of its first on-line, multi-access genus-level key, covering the 78 genera of Malvoideae (or Malvaceae s.s.) that are native or introduced in Latin America. From the start of the Neotropikey project, Malvoideae has been used as a model for the production of electronic keys to genus level, with the intention of engaging plant taxonomists in the creation of genus-level Lucid keys for many other Neotropical plant families. The working title of the key is 'Neotropical Malvoideae-key' (www.kew.org/science/tropamerica/malvaceae.htm), but the team are keen to receive suggestions of a more catchy title.

Neotropikey itself was launched on-line in July 2010 as a free, multi-access and illustrated identification key to the flowering plant families present in the Neotropics. It is constantly being improved via feedback from users, and more and better images are added. The project follows the APG III classification system and recognises a total of 319 Neotropical angiosperm families. To complement the family-level key, 221 family websites have now been contributed by more than 100 botanical specialists worldwide, and 57 of these include traditional dichotomous keys to genera. A CD has also been published for use in the field or in areas with no or slow internet access.

Contact: Dr Bente Klitgaard (b.klitgaard@kew.org)

Diversity of the legume giants of Tropical Africa

Diversity challenge

Forests contain 80% of terrestrial biodiversity. The importance to mankind of their sustainability has been highlighted by the UN's International Year of Forests. The forests of Tropical Africa contain more species of Leguminosae (legumes) than any other flowering plant family, and tree species of legume subfamily Caesalpinioideae often dominate the rainforest. Yet conservation of Africa's forests is hampered by the lack of taxonomic knowledge of these legume giants.

This taxonomic impediment is being addressed through a series of revisionary studies produced by RBG Kew's Tropical African Caesalpinioid Legume research program, which is undertaken in partnership with the Wageningen Branch of the National Herbarium of the Netherlands and with other international collaborators. A monograph of the caesalpinioid genus *Berlinia* has just been published (*Systematic Botany Monographs* 91, 117 pp; 2011) and follows a recently published revision of *Talbotiella* (*Kew Bulletin* 65, 40; 2010), another caesalpinioid African forest genus. The next publication in this series will be a revision of the genus *Hymenostegia*.

Together these three taxonomic works alone document in detail 47 legume tree species, 28 of which are threatened and 12 of which are new scientific discoveries. They contribute to Strategy 1 of Kew's BPP ('Diversity challenge'), which intends to speed up the discovery of new plants and fungi under threat.

Contact: Dr Barbara Mackinder (b.mackinder@kew.org)

X. van der Burgt

***Hymenostegia* sp. nov. collected in Korup National Park, Cameroon, by Laura Pearce.**

A new book, *Champion Trees of Britain and Ireland: The Tree Register Handbook* (by O. Johnson; Kew Publishing, 2011) describes over 5,000 trees and all species in Britain and Ireland, and provides a guide to the finest specimens.

Contact: Lydia White (l.white@kew.org)

The Miombo woodlands in Malawi are a source of natural pesticides.

P. Stevenson

2011 INTERNATIONAL YEAR OF FORESTS

The United Nations General Assembly declared 2011 as the International Year of Forests to raise awareness of sustainable management, conservation and sustainable development of all types of forests. Research on forests at Kew is aligned with these goals through the seven strategies of Kew's wider Breathing Plant Programme (BPP).

GIS surveys in New Guinea

Search & rescue

New Guinea has one of the largest remaining blocks of tropical forest, and the island has been identified as a one of the world's major tropical wilderness areas. The region is in need of greater study and in November and December 2010, a combined group from Kew's South-East Asia team (Tim Utteridge) and GIS team (Justin Moat and Steve Bachman) visited Indonesia to undertake a series of training workshops and to survey the vegetation of Biak Island off the north coast of New Guinea.

Supported by the Bentham-Moxon Trust, the team worked with counterparts from Herbarium Bogoriense (Java) to train botanists in IUCN Red Listing techniques, before moving to New Guinea to work at Universitas Negeri Papua (UNIPA, West Papua) to teach basic vegetation mapping skills to students and staff, including practical training in the field in the Gunung Meja reserve in Manokwari.

Mangrove vegetation on the north coast of Biak.

T. Utteridge

After teaching, the Kew team and UNIPA counterparts moved to the island of Biak in Geelvink Bay to conduct a vegetation survey. Biak is an uplifted coralline island originally covered with lowland rainforest, but large areas have now been cleared of natural vegetation. The Geelvink Bay area is known for its endemism and is a conservation focus for UNIPA scientists and foresters. The team surveyed most of the vegetation types across Biak and will produce a preliminary map of the island later this year. Further collaborative work in New Guinea will build from this trip, including mapping new areas and working towards a Red List for the island. The work will contribute to Strategy 2 of Kew's BPP ('Search & rescue') which aims to identify the species at greatest risk and those regions likely to lose their wild species soonest.

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Pesticidal woodlands

Local plants for local people

The Miombo woodlands of Southern and Eastern Africa, which are dominated by *Colophospermum mopane* and *Brachystegia* species, are an important resource of non-food plant products, particularly for the rural poor. Contributing to Kew's BPP Strategy 4 ('Local plants for local people'), farmer surveys have been conducted in Malawi and Zambia about the local uses of pesticidal plants in Miombo woodlands. The surveys were part of the EU-funded Southern African Pesticidal Plants Project and the African Dry Land Alliance for Pesticidal Plant Technologies (www.nri.org/adappt), under which the University of Greenwich, Kew and numerous African partners collaborate.

One species identified through these surveys was *Lippia javanica*, a woody Miombo shrub which is popular as a healthy green tea. This species was shown to be effective at controlling cattle ticks that cause morbidity and spread fatal blood diseases in livestock. The chemical evaluation of another pesticidal Miombo tree *Bobgunnia madagascariensis* identified saponins and flavonoid glycosides in the pods that constituted up to 20% of the dry weight. The saponins are important in the biological activity of the plants, and their identification is important for the selection of elite material for propagation and replanting programmes where overharvesting is threatening local populations. *Tet. Lett.* 51, 4727 (2010); *Int. J. Pest Manage.* 57, 41 (2011); *Trop. Anim. Health Prod.* 43, 481 (2011).

Contact: Dr Phil Stevenson (p.stevenson@kew.org)

Forest Thinking Walk for schools

The Great Plant Hunt (GPH), launched in 2009 and supported by the Wellcome Trust, resulted in GPH treasure chests being sent to all state schools in the UK. The chest contains resources and a guide for teachers with a range of activities for years 1 to 6 that get children out and about and inspired by plants. This year a Thinking Walk to support the International Year of Forests has been added to the GPH web site (www.greatplanthunt.org). This activity involves making a Forest Finder, a collecting device so that children can collect fallen items relating to the crown, trunk and base and roots of trees whilst out on a Thinking Walk. The Forest Finders created can then be used to create forests back in the classroom. Raising public awareness of the importance of plant and fungal diversity is Strategy 7 of Kew's BPP ('Wonders & marvels').

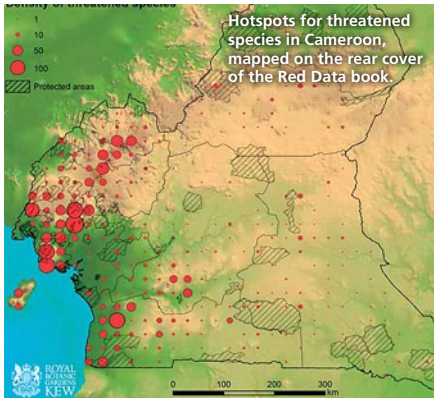
Wonders & marvels

Contact: Sue Allen (s.allen@kew.org)

Help for habitats

Cameroon Red List

The UK Darwin Initiative Project on the Red List Plants of Cameroon has come to fruition with the production of the *Red Data Book: The Flowering Plants of Cameroon IUCN Global Assessments* (by J. M. Onana & M. Cheek; Kew Publishing, 2011). The book, resulting from a collaboration between the IRAD National Herbarium of Cameroon and Kew, lists 815 plant species that are assessed as being globally threatened with extinction. It is the first Red Data book for a tropical African country and most species are listed for the first time. Such information is essential to national authorities responsible for managing the environment in Cameroon. For example, plant diversity was cited as justification



for the creation of a new national park in 2008 to protect forests in the Bakossi Mountains. Previous surveys by the National Herbarium and Kew had showed the area to be a top centre of diversity. Providing 'Help for habitats' in this way is central to Kew's BPP Strategy 4.

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TREE RESEARCH

Trees influence epiphyte and invertebrate communities

Studies in temporate regions have demonstrated that genetic differences between trees affect associated ecological communities and ecosystem processes. Now scientists at Manchester University and Kew have examined the extent to which this phenomenon occurs based on genetic variation within a single tree species in a diverse complex ecosystem such as a tropical forest. The team assessed the influence of within-species genetic variation in the tree *Brosimum alicastrum* (Moraceae) on associated epiphytic and invertebrate communities in a Neotropical rainforest and found a significant positive association between genetic distance of trees and community difference of the epiphytic plants growing on the tree, the invertebrates living among the leaf litter around its base and the invertebrates found on the trunk. The more genetically similar trees were host to more similar epiphyte and invertebrate communities. This has implications for whole ecosystem conservation management, since maintaining sufficient genetic diversity at the primary producer level will enhance species diversity of other plants and animals. *Phil. Trans. R. Soc. B* 366, 1329 (2011).

Contact: Dr Mike Fay (m.fay@kew.org)

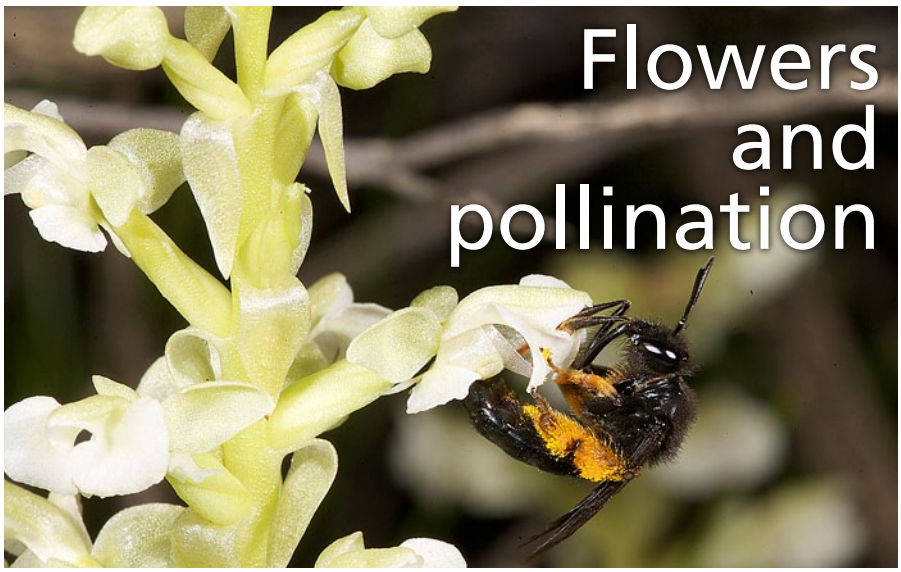
14 New palm species from Madagascar

Dypsis gronophyllum, one of 14 new palm species recently described from Madagascar. J. Dransfield

Mijoro Rakotoarinivo, at Kew's Madagascar Conservation Centre, is using GIS-based species distribution modeling to identify priority areas for exploration for rare palms. In addition to finding many new localities for previously poorly known palms, Mijoro has discovered many species new to science, including 14 species of *Dypsis* and *Ravenea* recently published in *Kew Bulletin*. This brings the total number of Madagascar palm species described by Kew scientists to 101, which is 57% of the total Madagascar palm flora of 188 species. Among the new species are *D. metallica*, so-named because of its thick, steely-blue leaves, and *D. dracaenoides*, which resembles a spiky dragon tree (*Dracaena* species). All of the new palms are threatened in the wild, with seven rated as critically endangered. This highlights the plight of Madagascan plant biodiversity and the urgency of plant exploration to underpin conservation. *Kew Bull.* 65, 279 (2010).

Contact: Dr Bill Baker (w.baker@kew.org)

A. Pauw



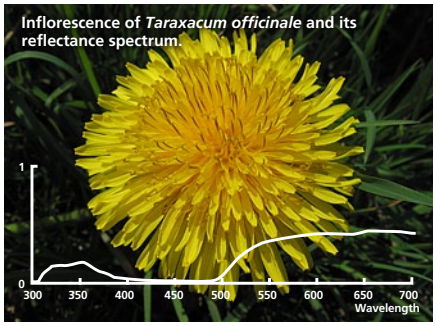
The oil-collecting bee *Rediviva longimanus* on the orchid *Pterygodium schelpei*.

Floral reflectance

Flower colour is of great importance in various fields relating to floral biology and pollinator behaviour. However, subjective human judgement of flower colour may be inaccurate and is irrelevant to the ecology and vision of the flower's pollinators. For precise, detailed information about the colours of flowers, a full reflectance spectrum for the flower of interest should be used rather than relying on such human assessments. Vincent Savolainen (Imperial/Kew) and Lars Chittka's team at Queen Mary (University of London) have developed The Floral Reflectance Database (FReD), which makes an extensive collection of such data available to researchers. The database allows users to download spectral reflectance data for flower species collected from all over the world. These could, for example, be used in modeling interactions between pollinator vision and plant signals, or analyses of flower colours in various habitats. The database contains functions for calculating flower colour loci according to widely-used models of bee colour space, reflectance graphs of the spectra and an option to search for flowers with similar colours in bee colour space. FReD is a valuable new tool for researchers interested in the colours of flowers and their association with pollinator colour vision, containing raw spectral reflectance data for a large number of flower species. FReD is freely available at www.reflectance.co.uk. *PLoS ONE* 5, e14287, (2010).

Contact: Prof. Vincent Savolainen (v.savolainen@kew.org)

G. K(te/FReD



Why are orchids so successful?

In terms of diversity, orchids are one of the most successful groups of flowering plants with over 22,000 species. Both pollinating animals and mycorrhizal fungi are believed to have been important in the diversification of orchids (and other flowering plants), but the mechanism by which these above- and below-ground mutualisms affect speciation remain obscure. In studying a group of 52 orchid species in a small region of South Africa, researchers found that recently diverged species either used different pollinators or placed pollen on different parts of the same species, consistent with the role of pollination-mode shifts in speciation. In contrast, fungal partners were conserved between closely related species, and orchids recruit the same fungal species even when transplanted to different areas. However, co-occurring orchid species tend to use different fungal partners, consistent with their expected role in reducing competition for nutrients. The results demonstrate that the two dominant mutualisms in terrestrial ecosystems can play major but contrasting roles in plant community assembly and speciation. *Amer. Nat.* 177, E54 (2011).

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

...and rare?

Scientists have studied orchids in southwest Australia to gain an insight into the causes of intrinsic rarity in Orchicaceae. They found the greatest number of rare taxa in naturally fragmented edaphic environments with limited opportunities for dispersal and colonization. Taxa pollinated by sexual deception had higher incidence of rarity than food-rewarding taxa, which could be due to either low fruit set or the risk of specializing on a single pollinator species. However, rarity was not correlated with the site at which the mycorrhizal fugus infected the orchid. *J. Biogeogr.* 28, 487 (2011).

Contact: Prof. Stephen Hopper (s.hopper@kew.org)

Bee nutrition

Kew is a partner on a new BBSRC-funded Insect Pollinators Initiative project. The Initiative aims to understand the reason for pollinator decline in Britain. The project with Newcastle University, University of Sydney, University of Pretoria and Hebrew University (Israel) will ask if bees can meet their nutritional needs in the current UK landscape, which is dominated by a few large-scale, short-lived crops that provide less diversity in food source for pollinators than in the past. The project will determine the optimum nutrition for honeybees and bumblebees, and whether temperature, disease, toxins, or stress change the bees' nutritional needs. The project will also determine how nutrition influences bee foraging behaviour and whether nutritional deficits or plant toxins influence bee communication within the colony. The project will build an online pollen and nectar nutrient database that will help to predict nutritional shortfalls when they occur and advise stakeholders about the best plant species to cultivate. The nutritional information on pollen and nectar will be used to develop an optimal bee food supplement.

Contact: Dr Phil Stevenson (p.stevenson@kew.org)

www.wellcome.ac.uk/News/2011/Features/WTVM050684.htm

G.Wright

Bee welfare

The Laboratory of Apiculture and Social Insects (LASI) at The University of Sussex is currently in its second year in collaboration with Kew at Wakehurst Place on projects to examine the effects of hive moving on bee welfare and to determine the best methods to keep bees in urban gardens. LASI is offering two free workshops on 'Decoding Honey Bee Waggle Dances' (17 or 18 June, 2011) and 'Garden Plants for Bees' (15 or 16 July, 2011).
For details visit
www.sussex.ac.uk/lasi/newsandevents/events

Contact: Iain Parkinson (i.parkinson@kew.org)

The Orchids of Mount Kinabalu (by J.J. Wood, T.E. Beaman, A. Lamb, C.L. Chan & J.H. Beaman; Natural History Publications (Borneo), 2011) documents, in two volumes, 866 orchid taxa known from Mt Kinabalu—a staggering number for an area of only 1,200 km^2, which may be unparalleled in the world. About 90 taxa are endemic, with 21 only known from a single collection.

J. Manning

***Gladiolus carinatus* provides insights into speciation in biodiversity hotspots.**

Hotspot speciation

There has been much debate over the origin of species diversity in biodiversity hotspots, particularly the rate of speciation over extinction and the geographic mode of speciation. In a new study, researchers have looked at speciation in the *Gladiolus carinatus* species complex (Iridaceae), which exhibits varying degrees of sympatry, in the biodiversity hotspot of the Cape Floristic Region in southern Africa. They investigated the mechanisms involved in population and species differentiation through a combination of ecological and genomic approaches. Lineages were estimated to have diverged after the establishment of available habitat in the Cape littoral plain. Shifts in flowering time and morphology have developed to varying degrees over the last 0.3–1.4 million years. An amplified fragment length polymorphism genome scan revealed signatures of divergent and balancing selection, although half of the loci consistently behaved neutrally. These results indicate that the *G. carinatus* complex represents a continuum of recent speciation, providing further evidence for ecological adaptation in the face of gene flow. *Mol. Ecol.* 19, 4765 (2010).

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P.P. Lowry II/Missouri Botanical Garden

***Cossinia trifoliata*, an endemic Sapindaceae from New Caledonia.**

Arecoid palm phylogeny

Over 50% of palm species fall within a single subfamily, the Arecoideae. Arecoid palms are widespread throughout the tropics and subtropics, displaying exceptional levels of endemism in the Neotropics and Indo-Pacific region. Many are keystone species in tropical forest ecosystems, influencing forest structure and composition, as well as biotic interactions. The subfamily also contains the most economically important of all palms, *Elaeis guineensis* (oil palm) and *Cocos nucifera* (coconut). Bill Baker and collaborators have recently published the most comprehensive phylogeny of Arecoideae based on analyses of the low-copy nuclear DNA regions PRK and RPB2 from 190 species in almost all the 103 genera. The study supports the classification presented in *Genera Palmarum* (J. Dransfield et al.; Kew Publishing, 2008), but also highlight remaining ambiguities, notably among Indo-Pacific groups, that will only be resolved with data from new sources. *Ann. Bot.*, in press, doi:10.1093/aob/mcr020.

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Kew is collaborating in an exhibition 'The World of Palms' at the Botanic Garden and Botanical Museum Berlin-Dahlem (20 May 2011 to 26 February 2012). The exhibition covers the diversity, biology and uses of palms across the world. Many of the artefacts and images provided by Kew are being displayed in public for the first time.

Sapindaceae

Research led by Kew, with colleagues from Spain, Switzerland and Sweden, has used the family Sapindaceae in two comparative studies of phylogenetic methods. The first assessed the performance of supertree reconstruction techniques. Of the various algorithms available, MinFlip, Matrix Representation with Parsimony and MinCut methods outperformed the others in several respects, especially for the commonly used supermatrix approach. The second study considered two biogeographical reconstruction methods, Dispersal–Extinction–Cladogenesis (DEC; a parametric method) and Dispersal–Vicariance analysis (DIVA; a parsimony-based method). The benefits and limitations of each were assessed, and a worldwide palaeogeographic model spanning the last 110 million years was proposed to constrain the DEC biogeographic reconstruction. Such model could be applied to any cosmopolitan plant group. Sapindaceae prove to be an ideal model for these comparative analyses and work on the systematics, and evolution of the family continues at Kew. *Syst. Biol.* 60, 32 (2011); *J. Biogeogr.* 38, 531 (2011).

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NEW BOOKS

The Last Great Plant Hunt: The Story of Kew's Millennium Seed Bank (by C. Fry, S. Seddon & G. Vines; Kew Publishing, 2011; ISBN: 978 1 84246 432 8) describes the importance and process of seed collecting and storage, the uses of banked seed and the future of seed conservation, through the work of the Millennium Seed Bank Project.

Flowering Plants: A Concise Pictorial Guide (by V.H. Heywood, R.K. Brummitt, A. Culham & O. Seberg; Kew Publishing, 2011; ISBN 978 1 84246 438 0) graphically illustrates over 100 of the most important plant families, giving key diagnostic features, distribution and economic uses.

Aloes: The Definitive Guide (by S. Carter, J.J. Lavranos, L.E. Newton & C.C. Walker; Kew Publishing in assoc iation with the British Cactus and Succulent Society, 2011; ISBN 978 1 84246 439 7) is the first comprehensive account of this important genus since the standard works of G.W. Reynolds over 40 years ago.

Guide to the Flowers of Western China (by C. Grey-Wilson & P. Cribb; Kew Publishing, 2011; ISBN 978 1 84246 169 3) describes and illustrates over 2,400 plants, providing a guide to many of the commoner and colourful elements of the flora, and constitutes the largest collection of photographs of Chinese plants ever published.

The Plants of Mefou, proposed National Park, Yaoundé Cameroon: A Conservation Checklist (by M. Cheek, Y. Harvey & J.M. Onana; Kew Publishing, 2011; ISBN 978 1 84246 400 7) provides a flora of the Mefou area, with a Red Data chapter giving conservation assessments and colour photographs of the most threatened species.

Field Guide to Plants of East Sabah (by R. de Kok & T. Utteridge; Kew Publishing, 2010; ISBN 978 1 84246 378 9) features the 84 most commonly encountered families in the low land rainforest of Danum Valley, Maliau Basin and Imbak Canyon.

Inquire

Kew's education staff are starting work on a three-year EU project 'Inquire', within the FP7 Science in Society framework. The project, co-ordinated by Botanic Gardens Conservation International, is a collaboration between 17 institutes across 11 countries, the majority being botanic gardens. It will support the development of an in-country teacher training course, to be run annually, that will help embed 'science enquiry' methodology in science lessons for 9-14 year olds. The content for the course will use the themes of 'Impact of Climate Change' and 'Biodiversity Loss'. It is hoped that this work will encourage more schoolchildren to 'think and work' like scientists and offer an excellent role model for the teaching of science across Europe. Botanic garden educators will also be enrolled on the training courses, to support better educational delivery within their respective gardens.

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Ancient mycorrhiza-like symbiosis

It has long been hypothesized that mutualistic symbiotic soil fungi assisted land plants in their initial colonization of terrestrial environments. However, there has been a lack of evidence demonstrating if and how the earliest land plants might have cooperated with fungi for mutual benefit in the early Palaeozoic era (over 470 million years ago).

Scientists from the University of Sheffield, Kew, Imperial College London and the University of Sydney recently obtained insights into the evolving dynamic behaviour of the first land plants and fungi by studying the interaction between the thalloid liverwort *Marchantia paleacea* (a representative of the most ancient extant clade of land plants) and arbuscular mycorrhizal fungi (AMF). They found that colonization of *M. paleacea* with AMF significantly promoted photosynthetic carbon uptake, growth and asexual reproduction. Each plant supported 100–400 m of AMF mycelia, and their fitness increased through fungal-enhanced acquisition of phosphorus and nitrogen from soil. When the researchers simulated a CO_2-rich atmosphere, similar to that of the Palaeozoic, they found that the benefits of AMF were significantly amplified, providing likely selection pressures for establishment of the symbiosis.

The analyses provide essential missing functional evidence supporting AMF symbionts as drivers of plant terrestrialization in early Palaeozoic land ecosystems. *Nature Communications* 1, 103, doi:10.1038/ncomms1105 (2010).

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S D Hopper

Fire in a *Eucalyptus gomphocephala* woodland in Kings Park and Botanic Garden, Perth. Many eucalypts are fire resistant and can resprout from lignotubers or from epicormis buds below bark but are killed by extremely hot fire.

Evidence for fire-adapted traits questioned

In an opinion article in *Trends in Plant Science*, researchers from Australia and Kew have challenged traditional views of the role of fire in the evolution of the flora of Mediterranean climate regions. These regions cover only 5% of the land surface of the Earth but are home to approximately 20% of flowering plant species.

A question underpinning this debate is whether fire resistant traits arose in direct response to the appearance of fire in the landscape (adaptation), or may have pre-dated or evolved independently from fire but nonetheless enhance survival and reproduction in today's fire-prone environment (pre-adaptation or exaptation). The authors suggest how to identify true adaptations and provide evidence that throws doubt on the status of many plant characteristics that have been widely assumed to be prime examples of adaptation to living with fire. These include re-sprouting, serotiny (the retention of seeds until an environmental trigger such as fire causes release), seed and fruit dormancy, post-fire flowering and smoke-induced germination.

The authors conclude that the only trait that has the potential to be a true adaptation is post-fire flowering. If the authors' assertions are correct, then the current regime of frequent burns in the management of Mediterranean landscapes may be placing many vulnerable plant species under threat. It is certainly time to re-assess the role of fire in the evolutionary history of these regions and to encourage further study to avoid unnecessary extinctions of plant species that may simply not be adapted to a life with fire. *Trends Pl. Sci.* 16, 69 (2011).

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Natural products for dementia

Dementia is an epidemic of unprecedented proportion and crisis in modern medicine, with cost estimates exceeding a billion euros in Europe alone. However, effective symptomatic treatments or preventive strategies for dementia, including Alzheimer's disease (AD), are limited. The few drugs available to alleviate cognitive symptoms include two acetylcholinesterase inhibitors derived from plants. A range of other drugs is often prescribed incidentally to alleviate behavioural and psychological symptoms of dementia, including agitation. During a recent trial, sponsored by the Alzheimer's Society, investigating whether *Melissa officinalis* oil could treat agitation in AD, scientists at Kew collaborated by investigating the authenticity, quality and stability of *M. officinalis* oils (*Dement. Geriatr. Cogn. Disord.* 31, 158; 2011).

Kew scientists have also worked with colleagues from Newcastle University to investigate *Withania somnifera* root extract for pharmacological activities relevant to dementia (*Phytother. Res.* 24, 1567; 2010).

The potential for natural products to provide drug leads for AD has been reviewed by Melanie Howes (Kew) and colleagues at the University of Hawaii. Over 180 compounds, including those currently in clinical use for symptomatic treatment in AD, are discussed, in addition to the status of natural products in drug development programs (*Nat. Prod. Rep.* 28, 48; 2011). Elaine Perry (Newcastle University) and Melanie Howes have also reviewed the role of natural products in the treatment and prevention of dementia, with an emphasis on clinical trial evidence, and from the perspective of available epidemiological data (*CNS Neurosci. Ther.*, in press, doi: 10.1111/j.1755-5949.2010.00202.x; *Drugs & Aging* 28, in press).

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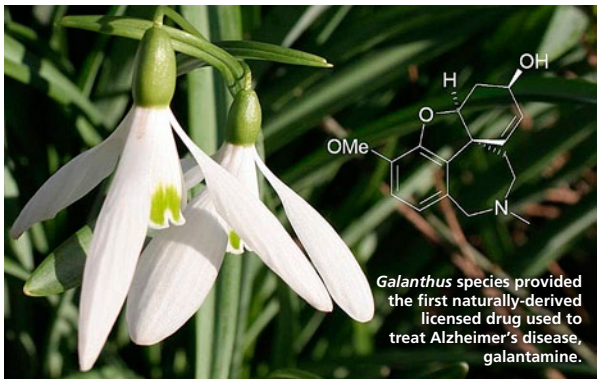

R. Fang

***Galanthus* species provided the first naturally-derived licensed drug used to treat Alzheimer's disease, galantamine.**

Kew Scientist

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