

KEW LAUNCHES NEW SCIENCE STRATEGY



Professor Katherine Willis
Director of Science

2015 marks the beginning of an exciting new phase for the Royal Botanic Gardens, Kew. The launch of the Science Strategy in February has set the organisation on a clearly defined pathway in pursuit of a re-invigorated scientific vision: **to document and understand global plant and fungal diversity and its uses, bringing authoritative expertise to bear on the critical challenges facing humanity today.**

This embodies a simple but often overlooked truth: all our lives depend on plants and fungi. Kew has a responsibility to take a leading role emphasising the importance and relevance of botany, mycology and taxonomy in the minds of the public and decision makers. This will ensure that we are able to do this. Our science will be accessible, inspirational and will demonstrate the value of plant and fungal science to all of our lives.

A GLOBAL RESOURCE IN PLANT AND FUNGAL KNOWLEDGE

Kew's position as a global resource in plant and fungal knowledge hinges on our world-class and unique collections and on the wealth of knowledge and



A seed collection of alder, *Alnus glutinosa*, ready to be put into the dry room at the Millennium Seed Bank. The seeds were collected as part of the UK National Tree Seed Project, which aims to establish a national tree seed collection to facilitate long term research into native trees and their conservation and management in the UK landscape. [Photo: Simon Kallow]

expertise of our scientists. Taxonomy, evolutionary biology, anatomy, biochemistry and conservation biology are just some of the disciplines represented. The vast collections, which include around 7 million herbarium specimens, 1.25 million fungus specimens in the fungarium,

45,000 samples in the world's largest wild plant DNA bank, and over 2 billion seeds in the Millennium Seed Bank, are at the heart of Kew's science and provide an unrivalled resource for scientific investigation.

The key to achieving the aims in the strategy is therefore recognising the potential of the collections to contribute to relevant research that provides a strong evidence-base for decision making. Kew's collections contain information covering huge spatial and temporal scales and over the next five years we will work at the forefront of new developments in technology to mine our data and use them in a predictive capacity. This articulates the role that collections-based research must play in addressing the complex questions and enormous challenges facing humanity: climate change, food and fuel security, disease, poverty and ecological scarcity. To ensure that we have maximum impact in key areas of science, education, conservation policy and natural resource management, we need to ensure effective dissemination of our knowledge and communication of our global science and conservation work. A further challenge is to enhance our education and training and to build capacity in the core skills of biodiversity science. We will achieve this through the development of a series of strategic outputs.

STRATEGIC OUTPUTS

Nine strategic outputs will ensure that the organisation disseminates its research more

widely than ever to conservation NGOs, researchers outside the world of plant science, governments, policy makers and business to influence responsible stewardship of important plant and fungal resources the world over.

Plants of the World Online Portal: All of the information that Kew holds about the world's known plant species will be accessible online by 2020, creating a multi-dimensional, digital catalogue of plant life, including information on identification, distribution, traits, threat status, molecular phylogenies and uses. It will utilise Kew's extensive resources alongside images from the collections. The portal will fulfil Kew's responsibility to share vital information and knowledge on the plant diversity with stakeholders across the world. We will also build an online resource for our vast fungal collections.



The 'gobstopper' fruits of *Salacia arenicola*, a recently discovered, threatened species of shrub from the Republic of the Congo. It was discovered by Kew scientists working with local botanists in 2013, and published in 2014. [Photo: Martin Cheek]

State of the World's Plants: The results from this annual horizon scan of the status of the Plant Kingdom will be revealed in December 2015. It is Kew's ambition that this study will become an essential document

for governments, policy makers and conservationists who will use the results to identify research and policy priorities for plants. It will tackle a range of topics beyond the threat levels to plants, for example: Which plant communities and species show resilience to environmental change? What is the status of plant genetic resources? Which crop's wild relatives are most promising for use in breeding programmes? Where are the emerging plant diseases?



Boletus edulis, an edible porcini mushroom, growing near beech trees (*Fagus sylvatica*) at Wakehurst Place. Kew scientists recently highlighted how little is known about the diversity of fungi when DNA sequencing revealed three new species of porcini in a single packet of commercial porcini purchased from a London grocer. [Photo: Bryn Dentinger]

Tropical Important Plant

Areas (TIPAs): Kew's expertise in the naming and identification of plants is strong in the species-rich, highly threatened, tropical regions. In a project that represents a first for plants in the tropics, we will focus this expertise on identifying the most diverse and highly threatened pockets of tropical plant diversity and designate them as TIPAs. It will focus on seven areas: Bolivia, Guinea, Uganda, Cameroon, Mozambique, Tanah Papua and the Caribbean UK Overseas Territories.

The Plant and Fungal Trees

of Life: Since the 1990s, Kew has pioneered the classification of flowering plants based on genetic (DNA) information. Whilst evolutionary relationships of flowering plants are now well understood, the next step is to flesh out this framework by

producing DNA data for a representation of all genera of plants and fungi and, ultimately, all known species. Evolutionary trees provide a powerful tool for prediction, for example, opening the way to identifying new plants for foods or medicines and enabling scientists to determine which plants will be resilient to environmental change.

Banking the World's Seeds:

In 2010, Kew's Millennium Seed Bank Partnership celebrated collecting, banking and conserving 10% of the world's wild plants. A programme to conserve a further 15% of the world's plants by 2020 is well under way. By 2020, some 75,000 species will be stored in the Millennium Seed Bank and in partner seed banks, representing 25% of known and bankable seed plant species. These collections capture the genetic diversity of wild plants, and hold the key to conserving threatened species and investigating useful traits such as pest and disease resistance in the wild relatives of our crop species.

Useful Plants and Fungi

Portal: Kew has a long history of research into useful plants and fungi. Current projects include helping the Ethiopian Government to develop a climate resilient coffee industry, investigating the chemistry of plants to search for naturally occurring pesticides and using plants to benefit some of the world's poorest communities. A newly created Natural Capital and Plant Health department consolidates this expertise and gives this important area of research a new impetus. One of the channels through which the team will communicate its work will be in the development of an on-line web interface – the Useful Plants and Fungi Portal.

Digitising the Collections: To increase access to our collections, we will use modern technologies, including high-throughput scanning of herbarium sheets and microscope slides, to digitise Kew's collections. We aim to achieve 80% digitisation by 2020, creating the foundation for a virtual herbarium and other online resources, and feeding into the Plants of the World Online Portal (POWOP). In addition we will also target parts of the collections for more in-depth data capture to address particular science questions. Such data can be used to support conservation assessments or to model future species distributions under different climate scenarios. We will also continue to develop the UK Overseas Territories virtual herbarium, which has already proven itself to be an indispensable planning tool for plant conservation. Capturing and making available data from our substantial UK and UKOTs fungal collections will be a priority, to provide fundamental support for conservation. We will also undertake crowd-sourcing as a mechanism for capturing data from imaged specimens and to connect our science with a broader audience.

Training the Next Generation of Scientists:

As one of the foremost research institutes in the world, Kew has a responsibility to pass on its knowledge, skills and expertise to the next generation, both in the UK and globally, and to encourage and inspire questioning minds to delve further into pure and applied biodiversity science. This will be achieved through updating our portfolio of short courses, continuing to host PhD students, and delivering our new MSc course in *Plant and Fungal Taxonomy, Diversity and*

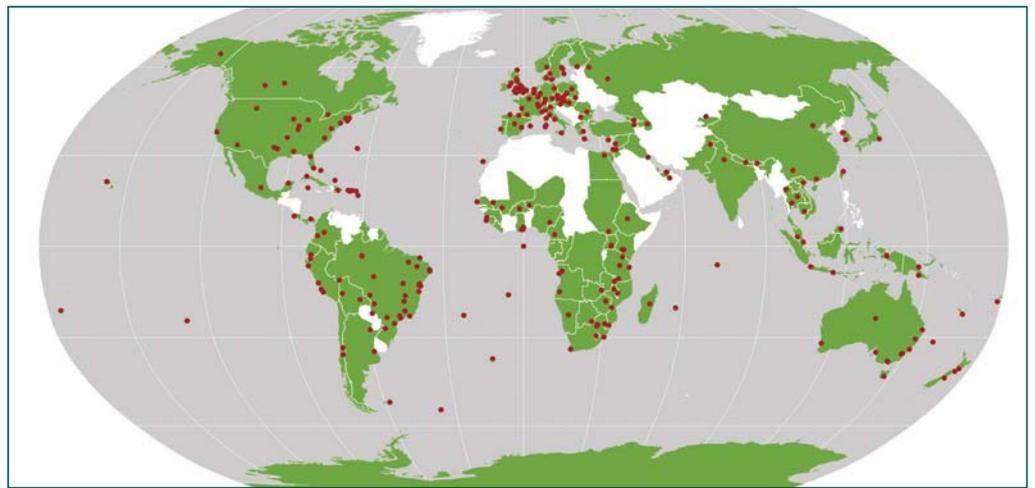
Conservation in conjunction with Queen Mary University of London. The new MSc will begin in 2015, and will address the skills gap in taxonomy and systematics identified by the Natural Environmental Research Council and Living with Environmental Change in their 2012 report *Most Wanted II. Postgraduate and Professional Skills Needs in the Environment Sector*. It will equip students with the knowledge and skills to undertake research in the fields of taxonomy, molecular systematics, ecology and evolution, or to engage in more applied conservation work. We will train a new generation of taxonomists in cross-disciplinary skills with applications in academia, government, industry, consultancy and non-governmental organisations.



Wild Arabica coffee, *Coffea arabica*, flowering in the highlands of south-western Ethiopia. Kew is leading a project that aims to improve the capacity of Ethiopia's coffee sector to deal with climate change. Our work demonstrates how our specialist knowledge of crop species biology and computer modelling can be combined to generate science-based policy resources and intervention strategies.

Science in the Gardens: The gardens at Kew and Wakehurst Place provide the perfect setting for disseminating the importance of plants and fungi and the work of Kew's scientists. We aim to make Kew a world leader amongst botanic gardens in engaging visitors in new ways. By exploiting modern technologies, such as mobile apps and location-specific sensor technology, we will deliver information tailored to

different audiences and also allow self-guided themed walks. Emerging technologies are providing the opportunity to transform the way science is communicated to the public, both on-site and through digital channels, and full use will be made of these to encourage our audience to seek out information on plants and fungi and the science behind the scenes. Our vision is for the development of a 'Virtual Kew' allowing people to 'e-walk' round the Gardens at different times of year, with plants linked to an online portal giving instant access to names and interesting information. In addition a plant science festival for children will be a new addition to the 2016 visitor programme. The festival will play a role in reinvigorating the way in which plants feature



Kew's scientific work spans 110 countries (shaded green) and involves over 400 collaborating institutions worldwide (red dots).

on the science education curriculum.

We will make Kew's scientific resources a global asset, bringing benefits to science, conservation policy and education. Understanding and

conserving plant and fungal diversity has never been more relevant for society at large. I am excited by the opportunities for Kew's scientists to continue world-class research and make an important and unique

contribution to addressing major challenges of our time.

To download the strategy and find out more, visit: www.kew.org/science-strategy

Contact: kewscience@kew.org

DEVELOPING A CIRCULAR ECONOMY – the critical role of the waste and resources industry



Jacob Hayler
Executive Director,
Environmental Services Association

The unprecedented pace and scale of Chinese development in the past decade has transformed the world order and placed unforeseen pressures on global resources. The expansion of the Chinese middle class has been perhaps the most spectacular story in the history of economic development and drove a worldwide commodity boom which reversed a long term trend of falling prices.

This focused the minds of the world's leaders on a new era of competition for resources. Despite recent falls in commodity prices (and oil in particular), increases in demand for goods and services are expected to occur as more of the developing world reaches income levels previously only enjoyed by Western consumers. The scale of this likely increase

in demand has driven calls for a new approach to economic systems which could provide the ultimate win-win scenario.

A circular economy, where we recover the materials and energy from our discarded materials and use them as inputs into production, provides a potential solution to future development. Economic drivers can be aligned

with reducing environmental pressures, thereby solving the critical problem of our age: how to raise living standards for all without despoiling the environment.

The recent highs in commodity prices drove change at all levels of the "waste hierarchy" (reduce waste, re-use, recycle, recover energy, with landfill used only as