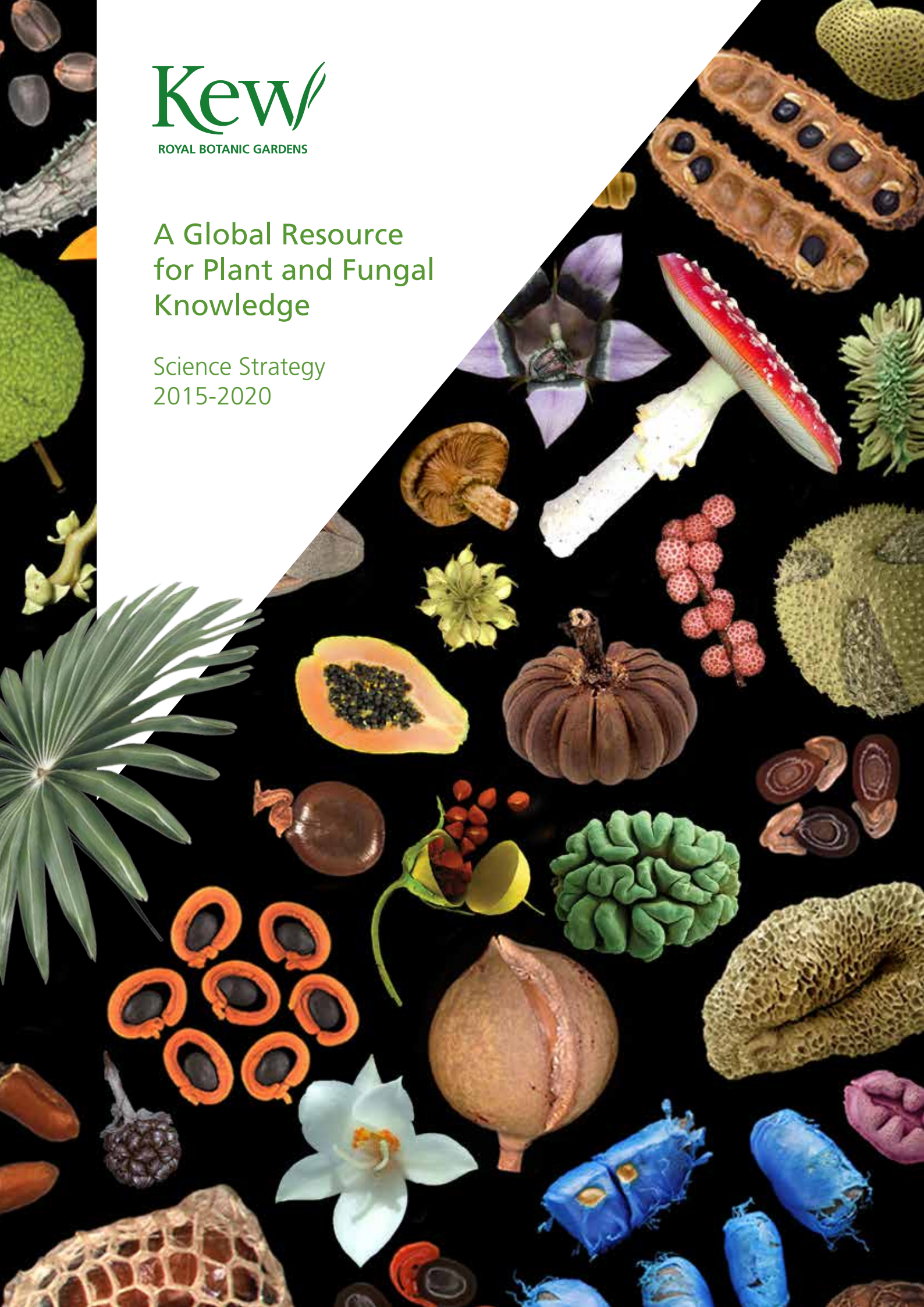
Kew
ROYAL BOTANIC GARDENS

A Global Resource for Plant and Fungal Knowledge

Science Strategy 2015-2020



The Royal Botanic Gardens, Kew, is a global resource for plant and fungal knowledge. Kew has one of the largest and most diverse collections of plant and fungal specimens (living and preserved) in the world. Our unique combination of extensive collections, databases, scientific expertise and global partnerships gives Kew a leading role in facilitating access to fundamental plant and fungal information. The core purpose of Kew's science stems from a simple but often overlooked truth: all our lives depend on plants.

Contents

Foreword

Science has always been the heart of Kew's purpose and it will continue to be so. Our collections, our people and our partnerships enable us to make an invaluable and highly relevant contribution to some of the biggest issues facing the global population. We do this through research, conservation, and educating and inspiring the public about the importance of plant and fungal science.

This document sets out how Kew intends to make a unique and valuable contribution to plant and fungal science and the specific outcomes we will deliver over the next five years. It has been developed in tandem with a major re-organisation of our scientific resources that, along with this strategy, will provide focus and clarity on Kew's scientific priorities. In delivering this strategy we also strive for transparency and accountability, both essential to any successful endeavour.

At each stage of the development of this document the ideas and proposals it contains have been rigorously challenged and shaped by Kew's Trustees, colleagues at Defra, and other stakeholders including academic institutions, non-governmental organisations and businesses. We are also grateful for the input of all Kew's scientists, and to a number of external experts whose insights and critical feedback were invaluable.

This strategy does not claim to have all the answers. The challenges facing humanity will evolve, and science will continue its forward progress. However, researching and conserving plant and fungal diversity has never been more urgent given the pressing challenges facing the planet and human populations. We believe this strategy, by describing Kew's science priorities, will make an important and unique contribution to addressing these challenges.

Professor Katherine Willis
Director of Science

Richard Deverell
Director

Cristalino State Park, Mato Grosso, Brazil

About this document

Kew's scientific vision is to document and understand global plant and fungal diversity and its uses, bringing authoritative expertise to bear on the critical challenges facing humanity today.

In this document we set out three strategic priorities to enable us to curate, use, enhance, explore and share Kew's global resource, providing robust data and a strong evidence base for our UK and global stakeholders as follows:

1. To document and conduct research into global plant and fungal diversity and its uses for humanity.
2. To curate and provide data-rich evidence from Kew's unrivalled collections as a global asset for scientific research.
3. To disseminate our scientific knowledge of plants and fungi, maximising its impact in science, education, conservation policy and management.

In addressing these priorities, we will achieve the following strategic outputs:

- Plants of the World Online Portal
- State of the World's Plants
- Tropical Important Plant Areas
- The Plant and Fungal Trees of Life
- Banking the World's Seeds
- Useful Plants and Fungi Portal
- Digitising the Collections
- Training the Next Generation of Plant and Fungal Scientists
- Science in the Gardens

These outputs will be led by multidisciplinary teams and will be facilitated by the newly formed structure of Kew's Science Directorate consisting of six research departments: Collections, Identification and Naming, Comparative Plant and Fungal Biology, Conservation Science, Natural Capital and Plant Health, and Biodiversity Informatics and Spatial Analysis.

With this new vision and strategy, we aim to make Kew's scientific resources a global asset, bringing benefits to science, conservation policy and education worldwide.

Mt Lidgbird, Lord Howe Island

Our 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.

The newest wing of Kew's Herbarium

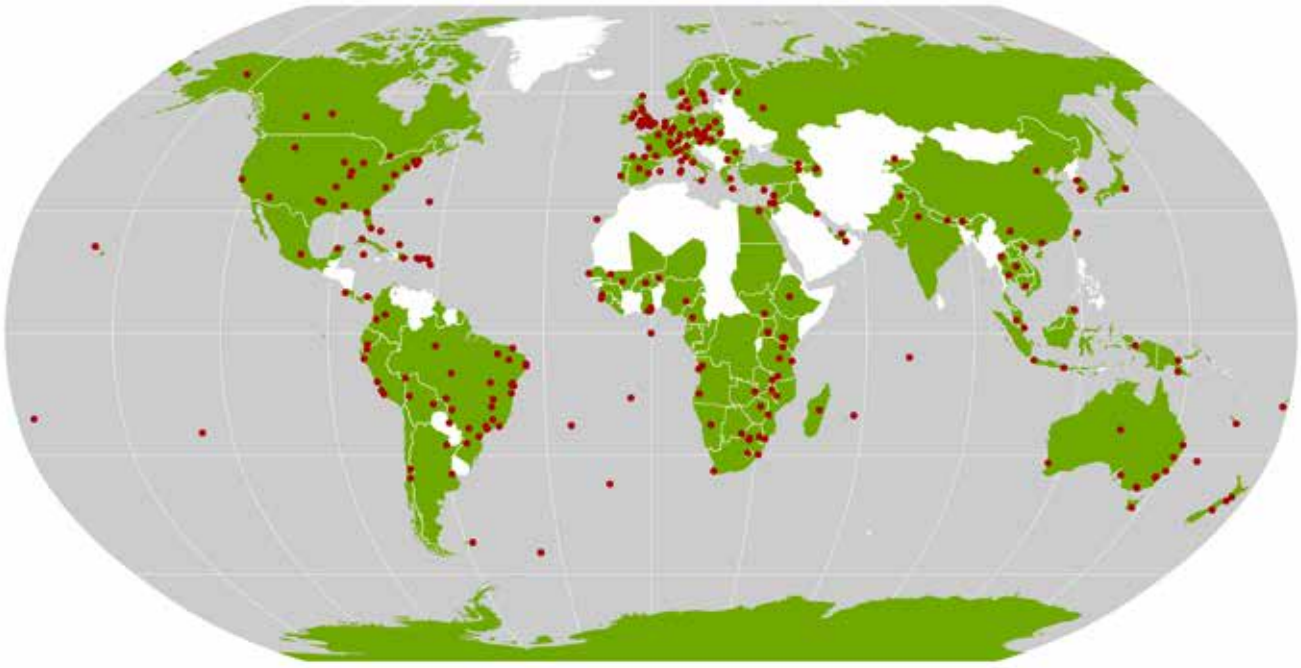
The Royal Botanic Gardens, Kew

A global resource for plant and fungal knowledge

The Royal Botanic Gardens, Kew, was founded in 1759 by Princess Augusta, the mother of King George III, and over the past 256 years has been at the centre of global discovery, collection, identification, naming and ordering of all things plant and fungus related. Spread over two sites (Kew Gardens in west London and Wakehurst Place in West Sussex), Kew's scientific collections contain over 8.5 million items, representing over 95% of known flowering plant genera and over 60% of known genera of fungi. They incorporate living and preserved material, seeds, spores and DNA, and between them cover an extraordinary breadth of plant and fungal diversity.

Many of Kew's collections are unique, and together they provide an unrivalled record of plant and fungal diversity in space and time. Kew also has over 250 highly skilled scientists, curators and technicians located in three purpose-built buildings: the Herbarium, the Jodrell Laboratory (both located at Kew) and the Wellcome Trust Millennium Building (located at Wakehurst Place). The combination of world-class expertise and our collections makes Kew a truly global resource in plant and fungal knowledge. The core purpose of Kew science stems from a simple but often overlooked truth: all our lives depend on plants.

Kew has an extensive international network of individual partners and consortia. Our scientific activities and collaborations span 110 countries worldwide. Much of the fieldwork and sharing of information that Kew undertakes in order to achieve its scientific objectives is dependent on working in partnership with key organisations, individuals and communities in these countries. We also deliver an extensive programme of training and capacity building. Our primary stakeholders are UK and global scientific institutions, governments, research councils, industry, international conservation and development agencies, and the public. Kew is also an Executive Non-Departmental Public Body part-funded by Defra. As part of the Defra Network, Kew plays an active role in delivering the Department's policy objectives.

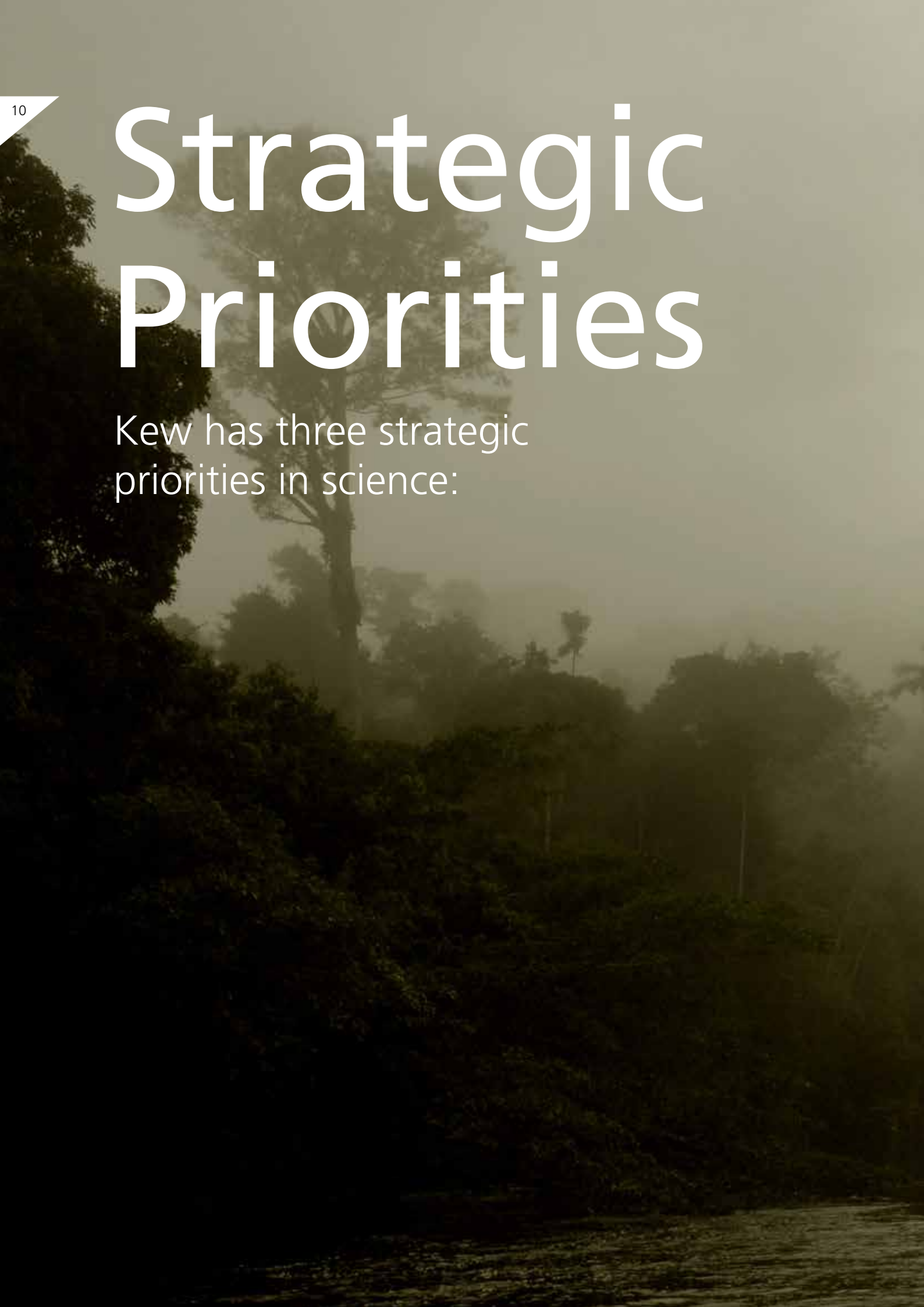


Kew's scientific work spans 110 countries (shaded green) and involves over 400 collaborating institutions worldwide (red dots).

Kew works with international partners across the globe to discover and document plant and fungal diversity, especially in the tropics of Asia, Africa and the Americas. The image shows a Kew and Papua New Guinea Forest Research Institute joint expedition camp in the Cromwell Range, Huon Peninsula, Papua New Guinea.

Strategic Priorities

Kew has three strategic priorities in science:



1 To document and conduct research into global plant and fungal diversity and its uses for humanity

2 To curate and provide data-rich evidence from Kew's unrivalled collections as a global asset for scientific research

3 To disseminate our scientific knowledge of plants and fungi, maximising its impact in science, education, conservation policy and management

Rio Cristalino, Brazil

STRATEGIC PRIORITY 1

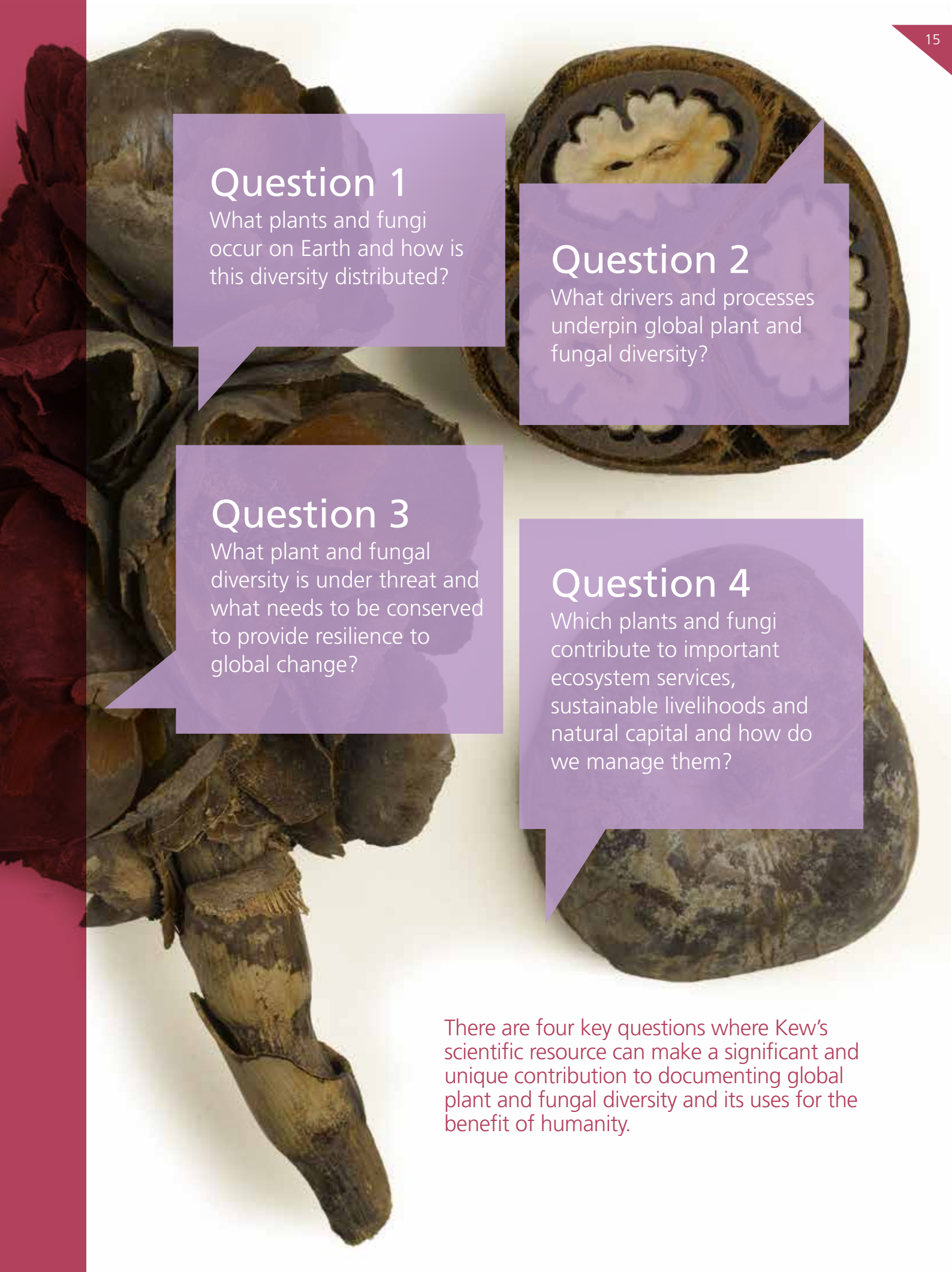
Mycena chlorophos, Ecuador

Strategic Priority 1

To document and conduct research into global plant and fungal diversity and its uses for humanity.

We are currently facing the greatest global challenges ever experienced by humankind. Climate change, habitat destruction, disease, population growth, and the associated need to ensure food and fuel security, are all taking an unprecedented toll on Earth's natural resources.

It is now widely acknowledged that plants and fungi are critical in finding many of the solutions to these global challenges, but only if we know what they are, where they are, what they do, how they function and their role in providing humankind's life support systems. Which are the important species for food, fuel, medicine and other vital resources? Where are their centres of genetic diversity? What are their closest wild relatives? And how will they respond to current and future environmental perturbations? These challenges are also relevant at a local scale. Closer to home in the UK, for example, there are frameworks for managing important plant communities and a need to consider them through the lenses of the ecosystem services and natural capital that they provide.



Question 1

What plants and fungi occur on Earth and how is this diversity distributed?

Question 2

What drivers and processes underpin global plant and fungal diversity?

Question 3

What plant and fungal diversity is under threat and what needs to be conserved to provide resilience to global change?

Question 4

Which plants and fungi contribute to important ecosystem services, sustainable livelihoods and natural capital and how do we manage them?

There are four key questions where Kew's scientific resource can make a significant and unique contribution to documenting global plant and fungal diversity and its uses for the benefit of humanity.

Question 1

What plants and fungi occur on Earth and how is this diversity distributed?

Inventory work in Cameroon has resulted in a surge of species discovery, and analysis of species distributions has allowed hotspots of diversity in need of protection to be identified. Kew's work in the region has led to the designation of five new protected areas. The image shows the 'moon rocket' tree, *Desbordesia glaucescens,* in lowland rainforest in Cameroon.

Biodiversity is intrinsically important; it is also critical to our survival, providing vital resources such as food, fuel, shelter and medicine, and helping to regulate global and local environments.

However, despite centuries of study, the huge diversity of life on Earth remains poorly understood, and we can only estimate the total number of species in existence. Even in better-known groups, such as vascular plants, large numbers of new species are still being discovered, and around 2,000 new species names are published each year. Some of these are known from only a single record, particularly in the species-rich tropics.

A lack of understanding of the taxonomy, distribution, ecology and properties of many species and their associated gene pools represents a significant knowledge gap, which undermines global biodiversity conservation efforts. Collecting baseline knowledge of the world's plants and fungi, naming and identifying species and analysing patterns and distributions in time and space therefore form a fundamental part of our scientific mission.

Kew's expertise in naming and identification is global in its reach with a particularly strong emphasis on the extremely species-rich, yet highly threatened, tropical regions of the globe, including the large remaining blocks of rainforest in Africa, Asia and the Americas. We also focus on locating and identifying those plants and fungi that benefit human livelihoods and well-being, including food crops (e.g. coffee, yams, legumes, palms, grasses), crop wild relatives, fuel crops and timbers.

Brownea jaramilloi was discovered in the Yasuni National Park in the Ecuadorian Amazon and was named by Kew taxonomists and collaborators in 2013. It had previously been overlooked but is uniquely defined by its yellow flowers (among other traits); the genus *Brownea* is usually characterised by red hummingbird-pollinated flowers.

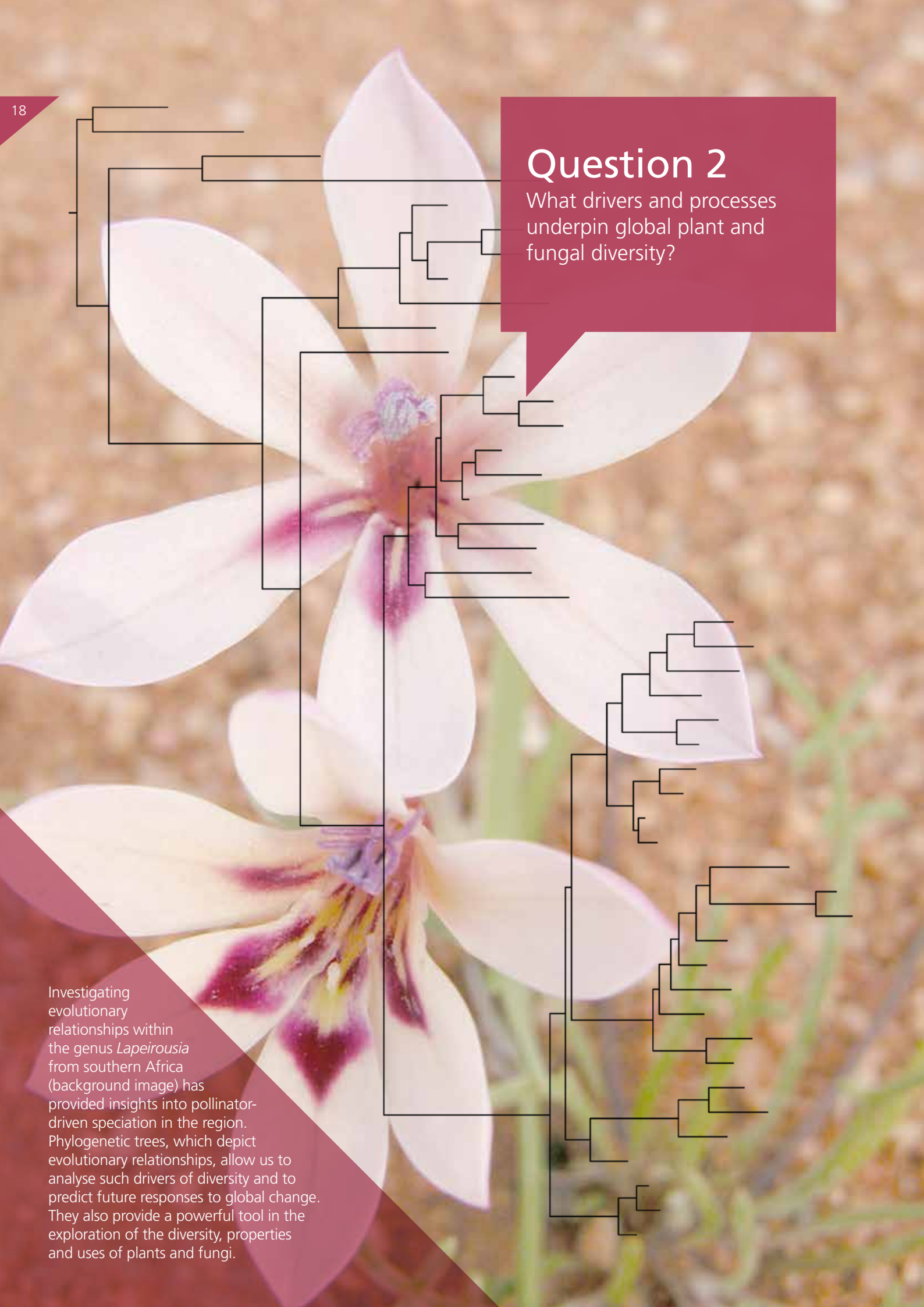
The long-term collection of plant and fungal material, with records for some individual species spanning more than 250 years, means that Kew is also critically placed to determine the ecological tolerances of many of these species and ascertain how they have changed over time, including their flowering times, distribution and traits such as leaf-shape.

Armed with this knowledge, Kew can provide the data-rich evidence needed to evaluate the potential impact of current and future global change on the diversity, physiology, distribution and abundance of some of the most important plant groups. Spanning all aspects of biodiversity (from genes, species and populations through to whole ecosystems) such evidence is critical for the development and delivery of policies to manage current environments and also safeguard future environmental resources, both in the UK and around the world.

Kew plant and fungal taxonomists name up to 250 species new to science every year

Question 2

What drivers and processes underpin global plant and fungal diversity?



Investigating evolutionary relationships within the genus *Lapeirousia* from southern Africa (background image) has provided insights into pollinator-driven speciation in the region. Phylogenetic trees, which depict evolutionary relationships, allow us to analyse such drivers of diversity and to predict future responses to global change. They also provide a powerful tool in the exploration of the diversity, properties and uses of plants and fungi.

Knowledge of evolutionary relationships is fundamental to all scientific research, both pure and applied.

It is critical, for example, that we fully understand the nearest evolutionary relatives to some of our most important food sources. Currently, 80% of human calorie intake comes from just 12 dominant crops, and 50% of our calories come from just three grasses: wheat, maize and rice. What are their nearest wild relatives? Where do they occur? What traits do they have that may be useful? Answers to these questions are essential, in order to insure against ecological scarcity and to provide alternatives if and when our current crops are affected by disease, climate change or other environmental perturbations. We also need to know their ideal environmental niche, which is often one that relates to their evolutionary origin.

Broad-scale analyses of molecular genetic sequence data at Kew have transformed our understanding of evolutionary relationships across the tree of life for both plants and fungi. These improved frameworks provide logical structures for classifying and understanding biodiversity. Both plants and fungi follow sets of developmental 'rules' that are at least partly dictated by their genomes. Exploring genome structure and comparing character traits – especially in species that break the rules – help us to understand the underlying evolutionary patterns and processes and how organisms become adapted to their environments.

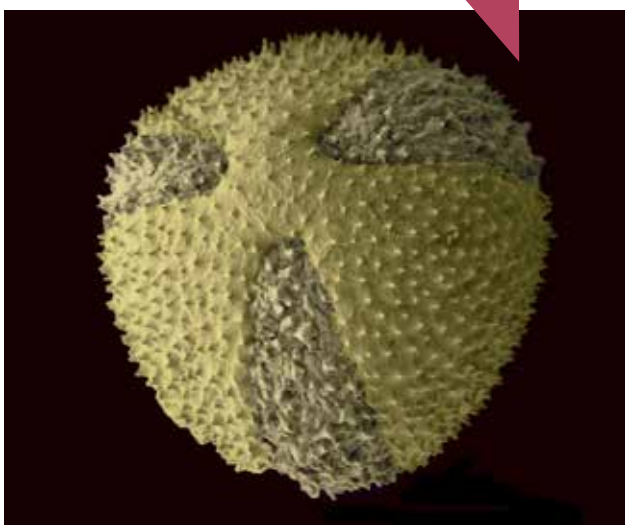
Kew aims to enhance this work to provide authoritative and wide-ranging knowledge of the structure, development, evolution, classification and genomics of all the major plant and fungal groups. The majority of current studies in plant science relate to a few crops and other model species, so that biological information is lacking for most of the world's species. Kew's unparalleled collections of living and preserved plants and fungi make it extremely well-placed to address this imbalance by pursuing detailed comparative studies on carefully targeted groups.

At Kew, we also focus on plants that are currently under-utilised but are likely to have great potential for humankind, especially in regions undergoing climatic change. Kew takes a leading role in the identification and conservation of crop wild relatives and research to identify the genes underlying key traits that enable resistance and resilience.

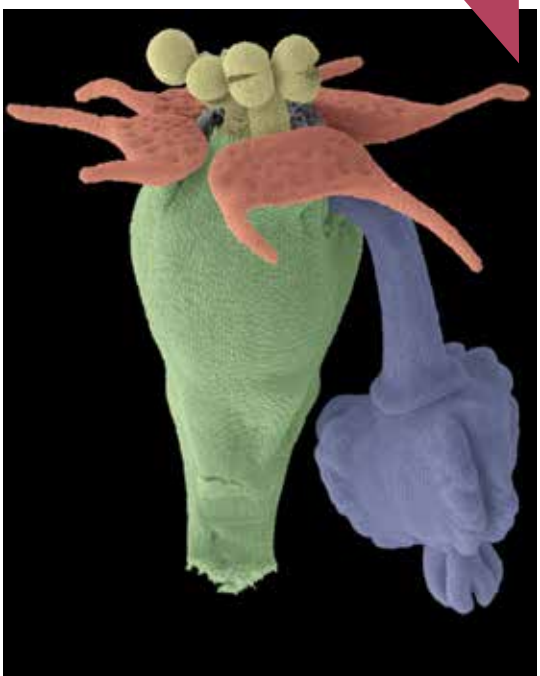
By applying a range of approaches, our aim is therefore to greatly elevate scientific understanding of evolutionary relationships, drivers and processes across the tree of life and in particular for those species of highest economic potential for humankind.

Kew is a leading international authority on plant and fungal systematics and diversity

Our comparative pollen studies contribute not only to understanding of plant evolution, but also to studies of pollination biology and palaeoecology. The image shows a coloured scanning electron micrograph (SEM) of a single pollen grain of *Papaver rhoeas* (Flanders poppy).

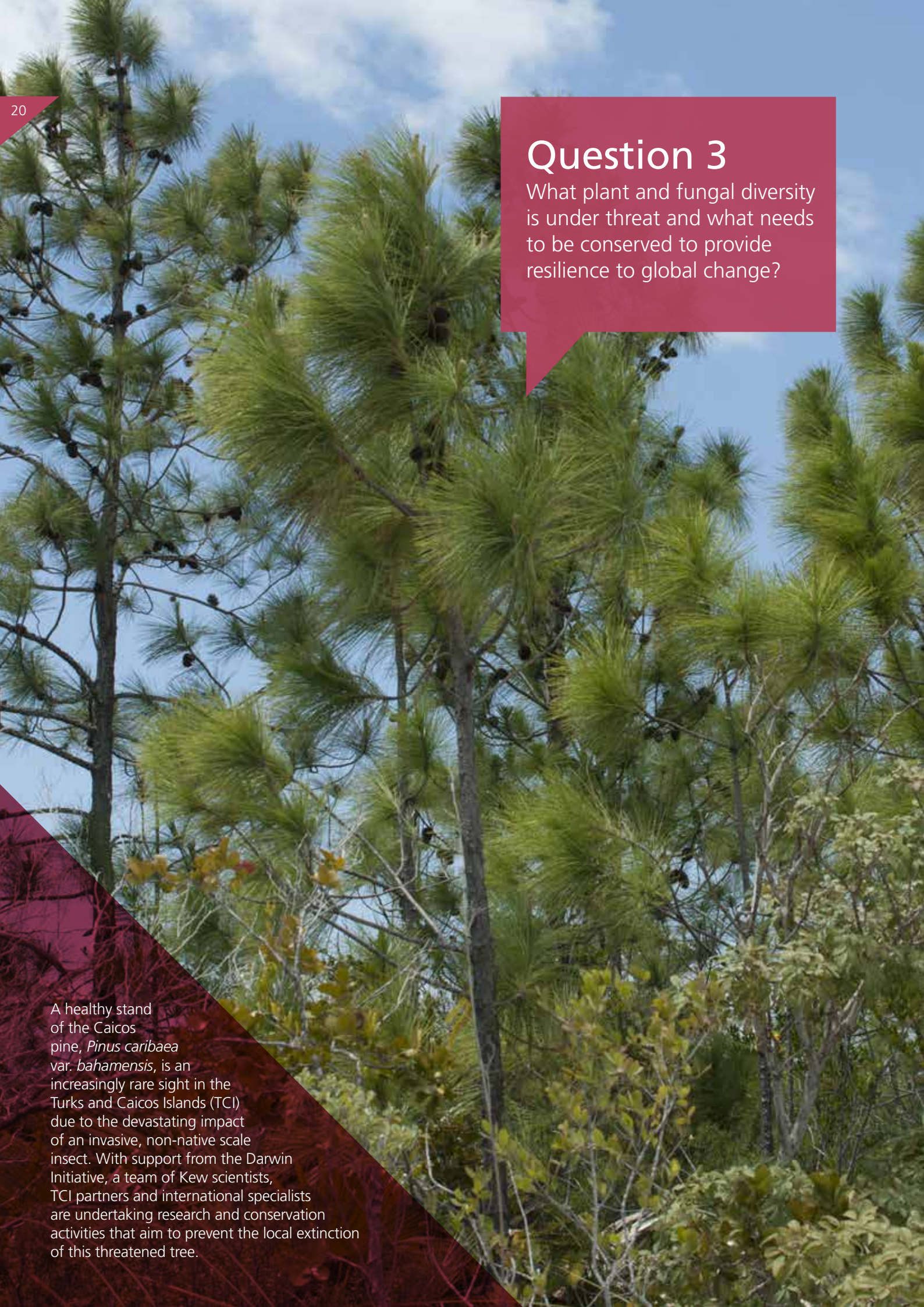


Coloured scanning electron micrograph (SEM) of a condensed flower cluster (cyathium) of *Euphorbia peplus*.



Question 3

What plant and fungal diversity is under threat and what needs to be conserved to provide resilience to global change?



A healthy stand of the Caicos pine, *Pinus caribaea* var. *bahamensis*, is an increasingly rare sight in the Turks and Caicos Islands (TCI) due to the devastating impact of an invasive, non-native scale insect. With support from the Darwin Initiative, a team of Kew scientists, TCI partners and international specialists are undertaking research and conservation activities that aim to prevent the local extinction of this threatened tree.

Climate change, land-use change, disease and global transportation (including trade) of plants and fungi are radically changing plant communities, their composition and distribution.

A lack of understanding about how plants and fungi are responding to these pressures represents a significant gap in our knowledge – what is happening to their abundance and distribution and how does this impact the critical ecosystem services that these plants and fungi provide?

In addition, there are still large knowledge gaps in understanding the impact of invasive species, particularly on islands where they pose a high level of threat to native species and communities. Changing plant-herbivore, plant-insect and plant-fungal interactions in response to anthropogenic pressures and climate change are also now having a visible impact on populations, species and communities.

Kew's conservation scientists, in conjunction with our extensive network of stakeholders, are in an exceptional position to provide assessments, monitoring and evaluation of the world's plants and fungi. In particular, Kew's collections, supplemented by remote-sensing expertise, vegetation data contained in online databases (e.g. Global Biodiversity Information Facility) and online mapping tools (e.g. Kew's GeoCAT mapping tool) provide an unrivalled resource to map and determine risks and threats at local, regional and global scales. This information is useful to a wide range of stakeholders from individual landowners to conservation managers, non-governmental organisations and governments.

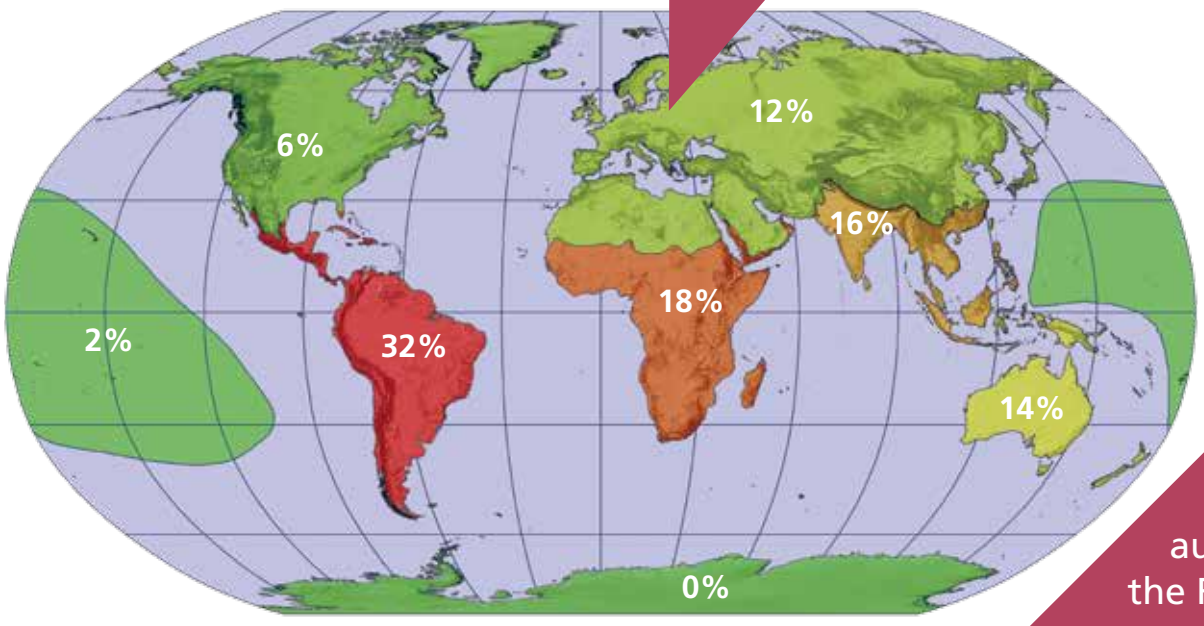
Building on previous successes (e.g. development of the first Sampled Red List Index for Plants), Kew aims to enhance its conservation science further, in order to contribute to the achievement of national and international conservation goals such as the Global Strategy for Plant Conservation and the Aichi Biodiversity Targets.

Kew's extensive records of species distributions also enable it to be one of the few places where there is adequate data to address the question of whether biodiverse environments are more resilient to environmental perturbations. Understanding what makes ecosystems resilient is critical, to ensure that global conservation efforts are well-targeted, accurate, effective, and sustainable in the long term. This knowledge includes research into functional traits that might make plants more resilient to environmental stress at a wide range of scales, from the molecular and genomic scale to whole plants and their ecological interactions (e.g. with fungi).

Translating knowledge into practice is another critical aspect of effective conservation. We will therefore continue to ensure the survival of plant species through *ex situ* banking of viable seeds in the Millennium Seed Bank. In addition, Kew's extensive plant DNA bank, which is an invaluable resource for understanding plant and fungal genetic diversity and genetic bottlenecks, will be used in conjunction with analytical techniques to improve prediction and management of genetic risk in conservation actions.

The Sampled Red List Index for Plants project estimated that one in five vascular plant species is at risk of extinction. This was the first assessment of the conservation status of the world's plants and illustrates the value of Kew's Herbarium collections for conservation science. The results provide an important overview of the global distribution of threatened plants and a baseline for further research.

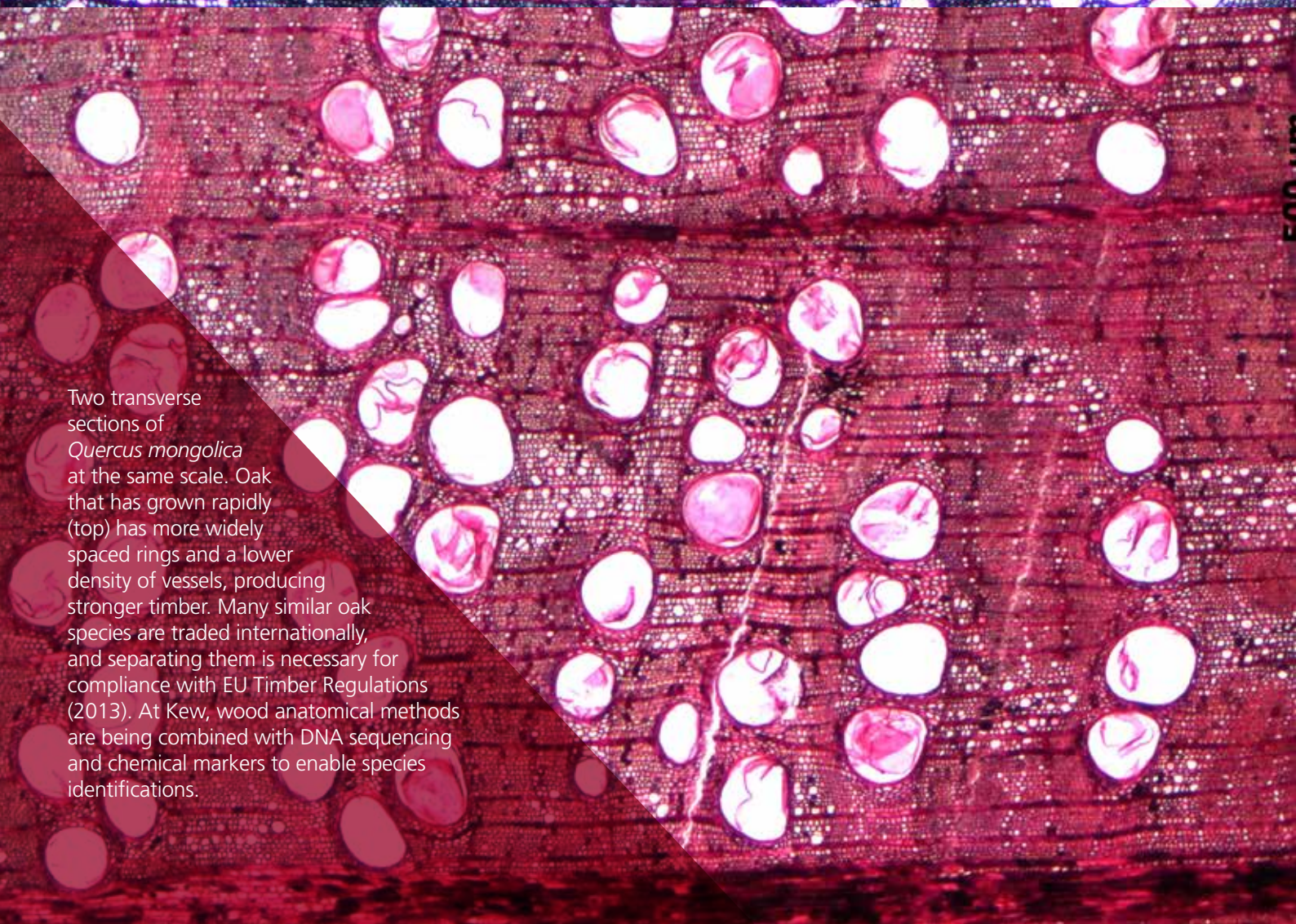
Percentage of the world's threatened species occurring in each of the major plant regions



Kew is a global authority on the Red Listing of plants

Question 4

Which plants and fungi contribute to important ecosystem services, sustainable livelihoods and natural capital and how do we manage them?



Two transverse sections of *Quercus mongolica* at the same scale. Oak that has grown rapidly (top) has more widely spaced rings and a lower density of vessels, producing stronger timber. Many similar oak species are traded internationally, and separating them is necessary for compliance with EU Timber Regulations (2013). At Kew, wood anatomical methods are being combined with DNA sequencing and chemical markers to enable species identifications.

Ecosystems, along with their component species and intrinsic genetic diversity, provide vital services to humankind.

These services include regulating and supporting the fundamental processes that maintain our environment in a habitable state and the provision of resources and services essential for human well-being and livelihoods. Plants and fungi play crucial roles in the delivery of ecosystem services. Their sustainable management and use will allow their rich diversity to be conserved and harnessed for the benefit of future generations.

From fundamental exploration of the properties and uses of species, their traits, resilience and population genetics through to monitoring the impacts of climate change and land use on biodiversity and ecosystem services, Kew's scientists are establishing the scientific building blocks for conservation and sustainable management of natural capital. We are also uniquely placed to undertake research into the interface between plant and fungal diversity and human livelihoods, including in areas of the highest development need.

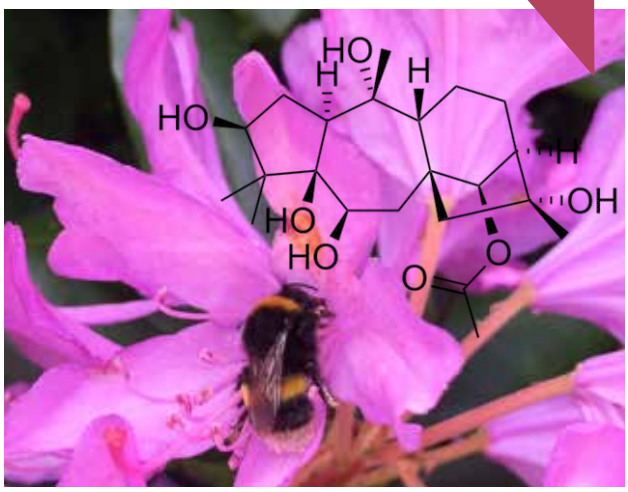
Kew's strengths in this area of research include investigations into fundamental processes such as pollination, seed biology, and plant-fungal interactions. These provide essential insights into ecosystem function and the management of biodiversity. We also have research strengths in plant and fungal chemistry and in the development of systems for authenticating medicinal plants, supporting the use of plant and fungal resources for human health.

Research into the diversity of crops (especially those that are poorly understood or under-utilised) and conservation of their wild relatives form an important part of our research agenda. The information that results from this work is essential in identifying plants that can ameliorate the effects of environmental change and ecological scarcity.

Across all these themes, the integration of scientific knowledge from different collections allows us to identify useful species efficiently, to fully explore their potential, and to inform the development of robust and effective conservation and management strategies.

In addition, through our global partnerships we have the unrivalled ability to apply our science in support of sustainable agriculture, food security, health, sustainable livelihoods and the maintenance and restoration of essential ecosystem services.

Grayanotoxin 1 is a diterpenoid compound that occurs in *Rhododendron* nectar. We have shown that while most bees suffer poisoning or death from this compound, bumble bees are unaffected. The compound may benefit *Rhododendron*, by making pollination more efficient, but may also result in this invasive species presenting a threat not only to native plants but also insect diversity.



Kew leads the world's most extensive partnership for conserving the seeds of wild plants – the Millennium Seed Bank Partnership

STRATEGIC PRIORITY 2

Jars of seeds stored in the Millennium Seed Bank

Strategic Priority 2

To curate and provide data-rich evidence from Kew's unrivalled collections as a global asset for scientific research.

Kew has an unrivalled wealth of scientific collections of plants and fungi, greatly enhanced by the living collections in the gardens and glasshouses and by the extensive library, art collections and archives.

Our collections, combined with the expertise of our scientists, provide data-rich evidence for addressing the key scientific questions in plant and fungal science. Well managed, well curated and widely accessible collections are therefore crucial to the success of our science programme and are a global resource for science, policy and conservation.

A gourd surrounded by a woven net, used as a water bottle by the Dayak people of Borneo. This item is from Kew's Economic Botany Collection and is made from the fruit of the bottle gourd *Lagenaria siceraria*.

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.

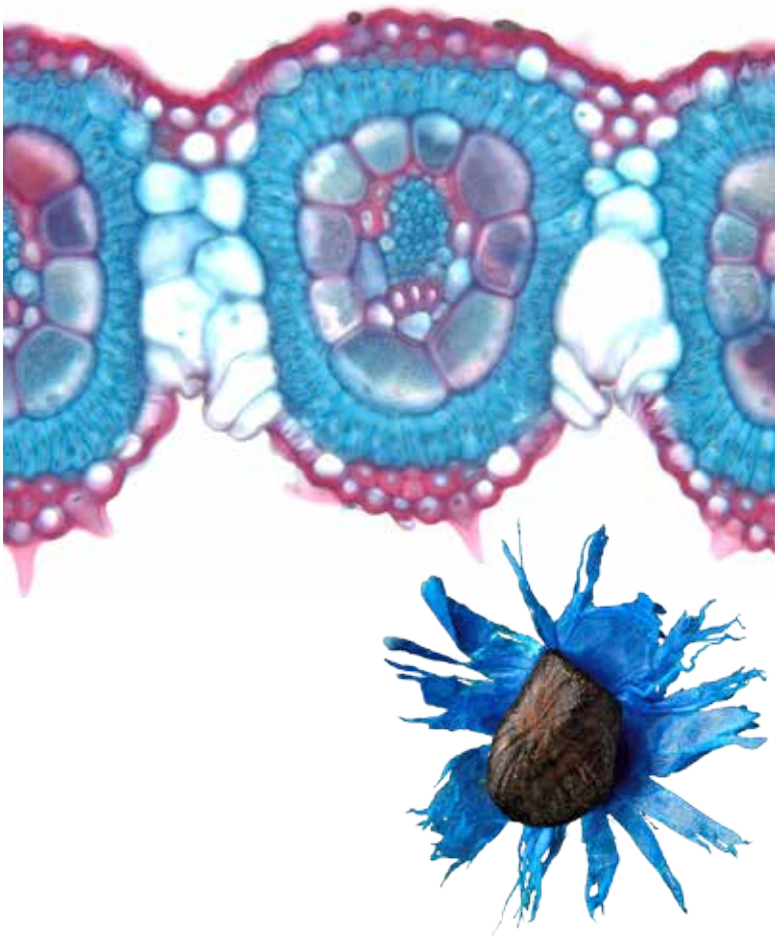
Kew's collections include around 7 million dried plant specimens in the Herbarium; a living collection of over 19,000 plant species spanning two sites (Kew Gardens and Wakehurst Place); the Fungarium containing 1.25 million dried fungal specimens; over 150,000 glass slides detailing plant micro-traits; 95,000 economic botany specimens; the world's largest wild plant DNA and tissue bank (including 45,000 DNA samples representing 35,000 species); and over 2 billion seeds (from around 35,000 species) in the Millennium Seed Bank, in addition to many other smaller collections and databases.

Alongside the physical collections, Kew holds a vast and growing collection of plant and fungal-related data and databases storing information on collections, names, taxonomy, traits, distributions, phylogenies, phenology and conservation. These include the International Plant Names Index, World Checklist of Selected Plant Families, The Plant List, eMonocot, Legumes of the World Online, Plant DNA C-values Database, Seed Information Database and online collection catalogues.

Together, these collections and associated data represent a priceless resource, feeding into all branches of pure and applied research at Kew and at scientific institutions across the world. Our strategic priority is to use and share Kew's outstanding collections and through biodiversity informatics and spatial analysis to provide data-rich evidence that will underpin and enhance our ability to address key scientific questions. In turn, this will enable us to work with our partners, other institutions and governments worldwide to address the critical challenges facing humanity.

We maintain the highest standards of specimen and data curation, and we will continue to grow our collections, guided by a new collections development plan with a clear vision for targeting geographical areas and taxa to fill current gaps in spatial coverage and knowledge. We aim to have 98% of vascular plant genera and 95% of UK non-lichenised fungal species represented in our collections by 2020. We will also enhance the genetic diversity of our collections, providing new and exciting opportunities to explore patterns and responses within species and to identify patterns of resistance and resilience to global change, disease and pathogens.

We will explore, extract and better link the extensive information held in all our collections and databases to provide a data-rich resource for scientific investigation into our priority questions and for the use of the global scientific community. This will lead to robust and reliable scientific evidence to inform UK and global policy and management.



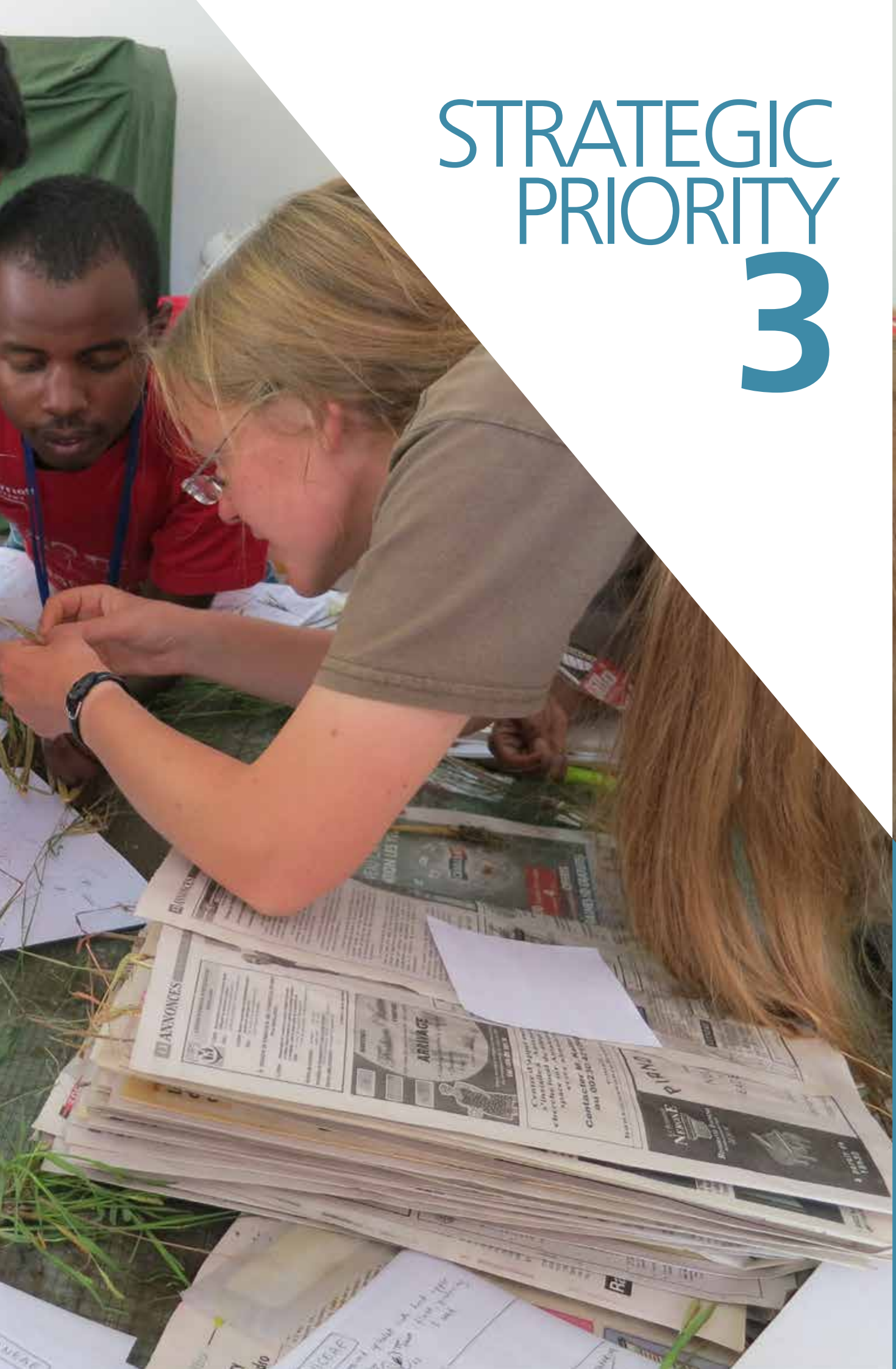
Global biodiversity science relies on information, images and samples of living organisms being readily available to researchers. To maximise their reach and impact, these resources and data need to be digitally available and thus discoverable, accessible and citable. Kew is committed to sharing its collections and knowledge for the benefit of scientific research, government policy and public understanding of plant and fungal diversity.

Approximately 20% of the collections are currently digitally available. Accelerating digital access is therefore a significant component of our development plan for the collections and will improve the efficiency and effectiveness of internal scientific research and increase opportunities for collaboration and income generation.

We aim to make 80% of our collections digitally available by 2020. The capture of data from the physical collections is an important first step in making this data available for study and analysis; in addition to the digitisation of the remaining analogue collections, we will engage in data improvement and mobilisation to support research into our priority research questions. We will seek new ways of making our data accessible to multiple audiences, primarily scientists, policy-makers and the UK and global public, using all the opportunities afforded by current communication technologies.

Kew's collections currently span 95% of vascular plant genera; by 2020 we aim to achieve 98% coverage and to make 80% of our collections digitally available

STRATEGIC PRIORITY 3

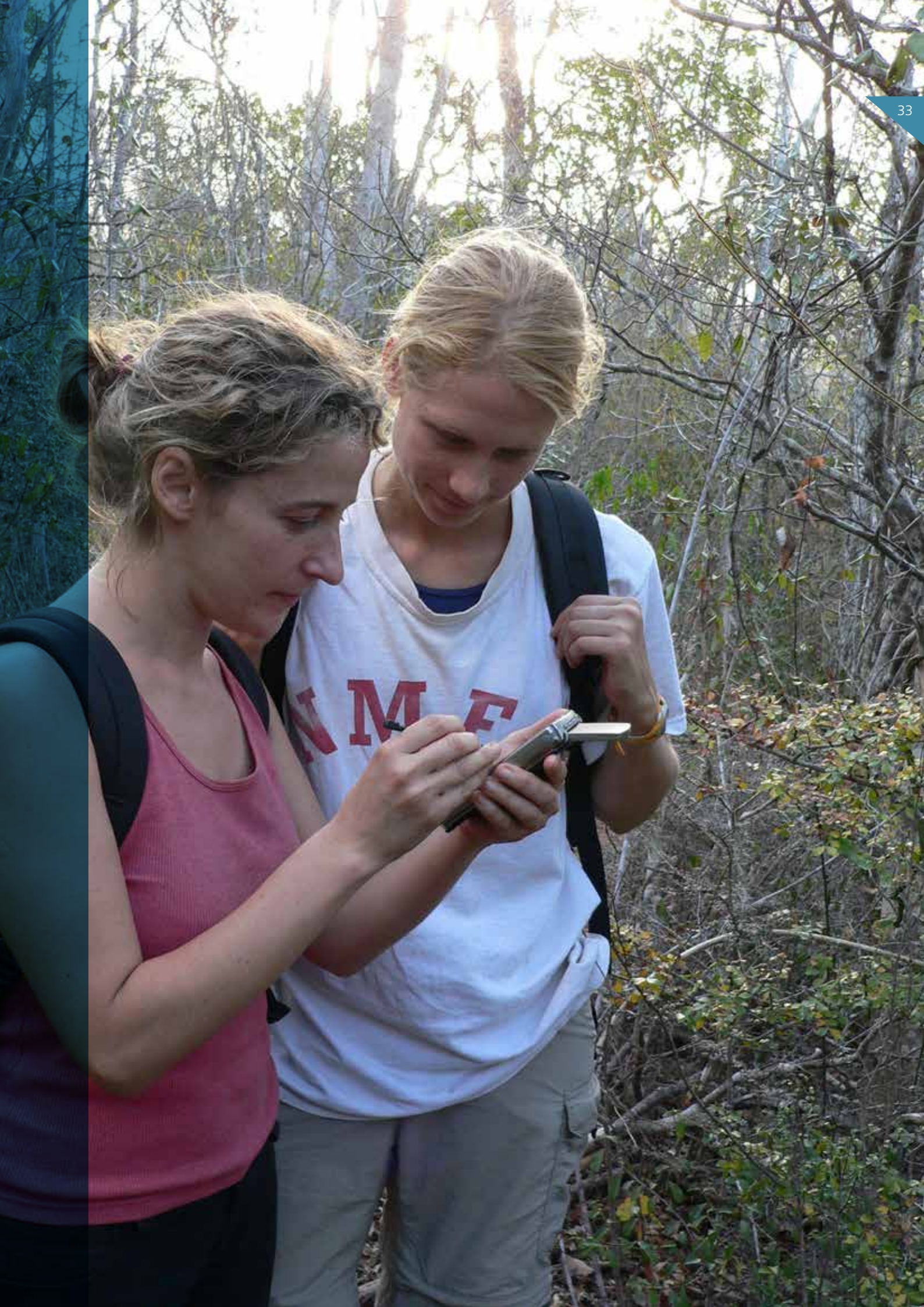


Strategic Priority 3

To disseminate our scientific knowledge of plants and fungi, maximising its impact in science, education, conservation policy and management.

Kew's science has global reach and relevance. 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 aim to provide a consistent, informative, progressive and engaging message about Kew's scientific research and collections and their relevance to policy, management of natural capital and, most importantly, to people's lives. We will achieve this through the development of the following strategic outputs:

- Plants of the World Online Portal
- State of the World's Plants
- Tropical Important Plant Areas
- The Plant and Fungal Trees of Life
- Banking the World's Seeds
- Useful Plants and Fungi Portal
- Digitising the Collections
- Training the Next Generation of Plant and Fungal Scientists
- Science in the Gardens

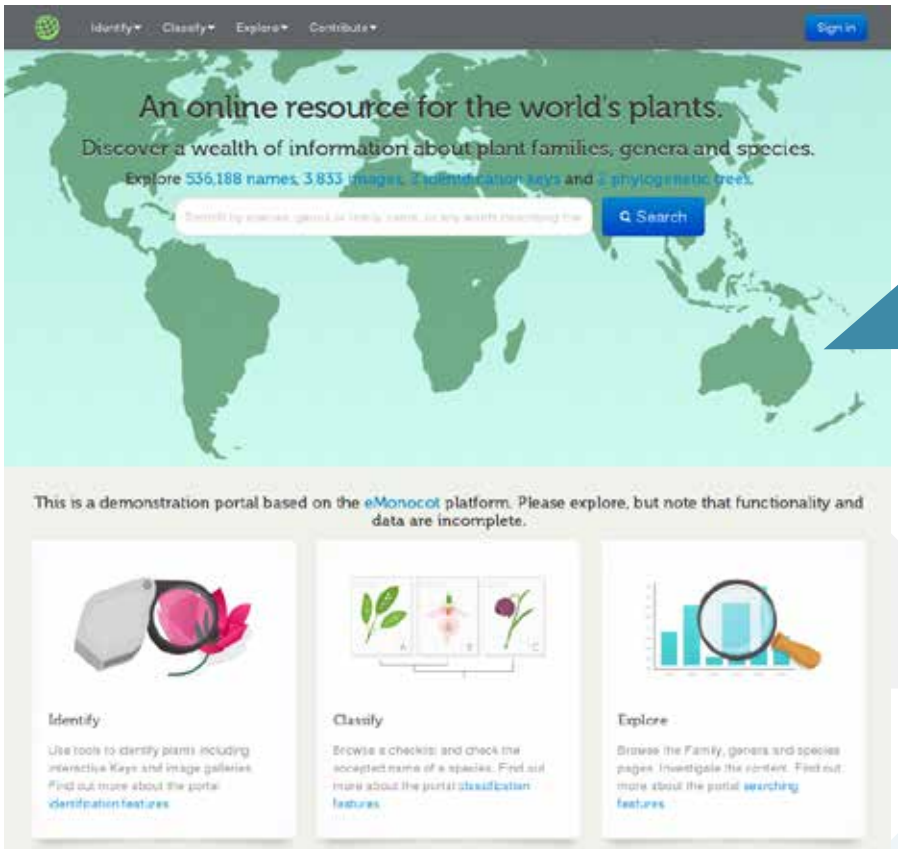


Plants of the World Online Portal (POWOP)

Information on all the world's known seed-bearing plants accessible online through Plants of the World Online Portal by 2020

Our vision for digital dissemination of information is to lead the delivery of an online global resource for plants: the Plants of the World Online Portal (POWOP). This e-resource will be a single point of access for authoritative information on plant species, from anywhere in the world. It will provide a multi-dimensional catalogue of plant life, including information on identification, distribution, traits, threat status, molecular phylogenies and uses. It will utilise Kew's extensive data resources alongside images from the digitisation of the collections. This one-stop portal will enable dissemination of plant information at levels accessible to all.

The UK flora is extremely well known, and POWOP will consolidate the wealth of information on UK species in a dedicated UK portal, making it an invaluable resource for taxonomy, policy, conservation, management, sustainable agriculture and teaching. In addition, we will start to build a similar online repository for UK fungal collections and will provide the knowledge and support for partners in other countries to set up their own portals, which can be linked through to Kew. This will ultimately lead to a resource that has global coverage, linking directly through to the taxonomic framework provided by the World Flora Online (www.worldfloraonline.org), which aims to provide an online taxonomic resource for all known plants.



The Plants of the World Online Portal will provide a single access point for all plant species information.

State of the World's Plants

Annual cutting-edge horizon scan of the status of the plant kingdom from 2015

Associated international science and policy symposium, evaluating trends and influencing global policy and opinion

To be launched in December 2015, Kew's *State of the World's Plants* report and symposium will be an annual overview of the global status of the plant kingdom. In this important new initiative, Kew scientists will combine their extensive knowledge and expertise in a definitive, hard-hitting evaluation of the status of plants – the foundation of the world's ecosystems. Which species are threatened and is their conservation status changing? Which invasive species are most problematic? Where is native vegetation threatened and what are the major drivers of change? What policies and management interventions are proving effective? Which plant communities and species show resilience to environmental change? What is the status of plant genetic resources? What crop wild relatives are most promising for use in breeding programmes? Where are the emerging threats to plant health? In addition to providing new evidence and perspectives on a range of key issues, the report will act as an important horizon-scanning exercise to identify strategic research and policy priorities to be pursued both in the UK and overseas.

Remote sensing of vegetation in vulnerable areas and detailed spatial analysis of species distributions will play a major part in assessing the state of the world's plants.

Deforestation in the highly fragmented Atlantic Forest of Bahia, Brazil, where Kew has been working to identify key species for reforestation.

Tropical Important Plant Areas (TIPAs)

TIPAs assessed and mapped in seven tropical countries by 2020

One in five of the world's plant species is threatened with extinction; many of these occur in the tropics, where species extinction continues due to destruction of natural habitats for agriculture, industry, energy and other development. We will identify concentrations of threatened species in the tropics, designating them as Tropical Important Plant Areas (TIPAs) and enabling national authorities to prioritise their protection. Many tropical countries lack the data and resources to demarcate their TIPAs, and Kew seeks to remedy this on a global basis, initially in selected countries where we have strong partnerships and robust data sets. The Important Plant Areas initiative, established by Plantlife International, provides an effective model using simple but scientifically sound and verifiable criteria. By 2020, Kew and our local partners will have completed the first phase of TIPA analysis: delimitation and mapping in seven countries throughout the tropics with information on the component species available through the Plants of the World Online Portal. Information from this output will feed directly into conservation prioritisation for delivery of on-the-ground conservation actions by our partners.

Montane forest in the Huon Peninsula, Papua New Guinea, domimated by the tree genus *Quintinia*. Tropical montane forests such as this are threatened by habitat loss and shifts in elevational zonation due to climate change. Understanding the threats to such species and ecosystems will be a vital element in identifying Tropical Important Plant Areas (TIPAs) in focal regions including Guinea, Cameroon, Mozambique and Uganda in Africa, Bolivia in the Americas, and New Guinea in Asia.

The Plant and Fungal Trees of Life

The Plant and Fungal Trees of Life completed for all genera by 2020

Evolutionary trees provide a powerful tool for prediction, species discovery, monitoring and conservation. To better understand how the world's plants and fungi are related to each other and how they have evolved, we aim to complete the Plant and Fungal Trees of Life. Through comparative analysis of DNA sequence data, the backbones of these Trees of Life are already relatively well understood, and many components have been studied in great detail. However, DNA data are still lacking for many genera and the vast majority of species of plants and fungi, preventing their accurate placement within this evolutionary framework.

To complete the Plant and Fungal Trees of Life for all genera, we will utilise our collections to produce genome-scale DNA data for a representative of each genus of plant and fungus using high-throughput sequencing technologies. We will also continue to investigate species-level relationships for groups of economic, ecological and evolutionary importance in which Kew holds particular expertise. This comprehensive investigation of evolutionary relationships will provide a unifying framework for comparative plant and fungal research, greatly accelerating the discovery of new taxa, particularly in less well-known groups, as well as facilitating the exploration of properties and uses. The project is an essential step towards the compilation of genomic data for all known species using Kew's collections.

Amborella trichopoda, in the Amborellales
Tree redrawn from Figure 1, APG III (2009), *Bot. J. Linn*. Soc. 161: 105–121

Kew scientists have been instrumental in improving understanding of patterns of evolution in the flowering plants and fungi. As we fill the gaps in the plant and fungal trees of life we will enhance scientific understanding of biodiversity and open up new avenues of research.

Banking the World's Seeds

Seed of 25% of the world's plant species banked by 2020

Kew's Millennium Seed Bank, housed in the Wellcome Trust Millennium Building at Wakehurst Place, is a vast vault for the long-term storage of seeds for research and conservation. Its associated global network, the Millennium Seed Bank Partnership (MSBP), is the largest *ex situ* plant conservation programme in the world and is active in over 80 countries. The MSBP will continue to collect and conserve high-quality seed in order to achieve its target of banking 25% of the world's plant species by 2020. By then the number of partners and countries in the MSBP will have grown by up to 20%, with common seed conservation standards used across the network. There will also be increased focus on collection quality and genetic diversity of collections.

We will also continue to build the seed collections of the UK flora, with a focus on multi-provenance collections of woody species via the UK National Tree Seed Project. In parallel to this, we will continue our research into the different strategies needed to conserve seeds that cannot withstand desiccation and freezing.

The Wellcome Trust Millennium Building is home to the Millennium Seed Bank, a vast underground vault of over 2 billion seeds from around 35,000 different plant species. By 2020, 25% of the world's plant species will be banked, enabling research into seed biology and useful traits and providing a global resource for conservation science.

Useful Plants and Fungi Portal

Data on 80% of priority useful plants (including crops, crop wild relatives and those important for food security, livelihoods and human health) available through the Useful Plants and Fungi Portal by 2020

The Useful Plants and Fungi Portal will be an authoritative, expert-driven, online resource providing information on the economic and traditional uses of plants and fungi. It will meet the needs of user communities ranging from scientists to policy-makers and the general public.

Data from the portal will be drawn from existing Kew databases, such as SEPASAL (Survey of Economic Plants for Arid and Semi-Arid Lands) and the Kew Economic Botany Collection, and from research into species important for food security, livelihoods and human health. The portal will be designed to bring together content to help guide, for example, the enhancement of the provisioning services of plants and fungi (food, fibre, fuel and water). It will be a useful resource for researchers studying the uses of plants and fungi, their relationships with human well-being, and the ecosystem services they provide. The portal will also be relevant to policy-makers, development agencies and other stakeholders working on food security and other global challenges.

Yams are vital sources of starch; cultivated races of yams feed over 100 million people in Africa alone. Yams have a wide range of wild relatives, some of which are already exploited as food sources. The yam family (Dioscoreaceae) therefore contains a large amount of diversity with economic potential. The Useful Plants and Fungi Portal will provide a comprehensive information resource for these and other useful plants by 2020.

Digitising the Collections

- 80% of specimens digitised by 2020
- All UK and UK Overseas Territories specimens digitised by 2020
- 3 million visits per year to Kew's digital resources by 2020

To increase access to the data held in our collections, we will use modern digitisation technologies, including high-throughput scanning of herbarium sheets and microscope slides, to digitise Kew's extensive 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 to digitising 80% of specimens by 2020, 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.

Digitising the UK and UK Overseas Territories (UKOTs) collections will support the UK aspect of POWOP, making the information available to the public and a broad science and conservation audience. We will continue to develop the UKOTs virtual herbarium, which has already proven itself to be an indispensable planning tool for plant conservation. Capturing and making available collection data from our substantial UK and UKOTs fungal collections will be a priority, to provide fundamental support for conservation initiatives. We will also undertake crowd-sourcing as a mechanism for capturing data from imaged specimens and to help connect our science with a broader audience.

To date, Kew has digitised in excess of 320,000 type specimens from its herbarium collections as part of the Global Plants Initiative, an international project focused primarily on the digital capture of label data and high resolution (600ppi) images of type specimens deposited in participating herbaria (currently over 300 institutions from over 70 countries). Kew's material is made widely accessible for scholarly research purposes through the JSTOR Global Plants online resource (plants.jstor.org) and Kew's herbarium catalogue (www.kew.org/herbcat), which holds over 770,000 records.

Training the Next Generation of Plant and Fungal Scientists

New MSc course from 2015: *Plant and Fungal Taxonomy, Diversity and Conservation*

Over 100 MSc students trained at Kew by 2020

As one of the foremost plant and fungal research institutes in the world, Kew has a responsibility to pass on its knowledge, skills and expertise to the next generation of plant and fungal scientists, 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 developing and 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 directly 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*. The programme 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 many applications in academia, government, industry, consultancy and non-governmental organisations.

Kew's new MSc course in *Plant and Fungal Taxonomy, Diversity and Conservation* will combine specimen work with lab- and field-based techniques to teach plant and fungal identification skills in the context of evolutionary biology, and conservation theory and practice.

Science in the Gardens

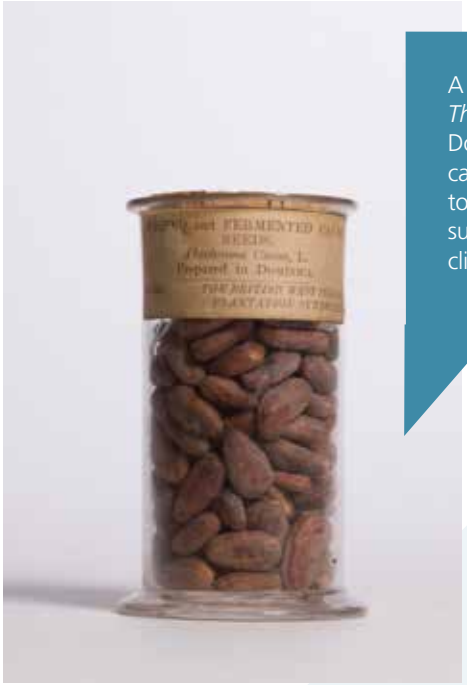
- Annual Children's Science Festival from 2016
- Over 100 Kew scientists interacting directly with our visitors each year by 2020
- Location-specific scientific information delivered to visitors using the latest technology from 2015

The gardens at Kew and Wakehurst Place provide the perfect setting for sharing the wonders 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 and innovative ways. By communicating through both new and existing channels we will make Kew's science accessible to a broad and diverse audience.

Exploiting modern technologies, such as mobile apps and location-specific sensor technology, we will deliver information about our work that can be 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 Kew's audience to engage with and 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, the visibility of Kew's science and scientists in the Gardens will be greatly increased through initiatives including pop-up science sessions, science open days, behind-the-scenes tours, collaborative science street-theatre events, pop-up micro-interpretation with roaming scientists, and practical sessions for children and adults alike. We will also launch an annual Children's Science Festival from 2016, bringing science to life through fun and informative children's games and activities.

The new Kew app delivers location-specific science content to visitors through their phone.



A 19th century jar of fermented *Theobroma cacao* from the Dominican Republic. Chocolate can be used as a starting point to engage families in subjects such as plant chemistry and climate change.

The 'Science in the Gardens' output will bring science to life by allowing hands-on learning as part of the annual Children's Science Festival.

Conservation policy and management

Through the delivery of key outputs, we aim to provide scientific evidence to underpin and inform global policy decisions. Kew already has significant scientific expertise in supporting the implementation of major international conventions such as the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) and the Convention on Biological Diversity (CBD). Kew is also the UK CITES Scientific Authority for plants, providing independent scientific advice, undertaking research into plant groups affected (or potentially affected) by international trade and CITES legislation, and working with enforcement authorities on the inspection, holding and disposal of detained or seized CITES material at Kew's purpose-built quarantine facility.

Kew's policy advisors will also continue to coordinate the implementation of the Convention on Biological Diversity at Kew, particularly in relation to the Nagoya Protocol on Access to Genetic Resources and Benefit Sharing. Access and benefit sharing agreements, negotiated with partners, ensure that plant material is acquired and used in accordance with national and international laws and policies (including the newly formed Intergovernmental Platform on Biodiversity and Ecosystem Services). Through this way of working, the scientific benefit gained from the cooperation and collaboration of local partners in our international programme is acknowledged, shared and fed back into the country through infrastructure, resources, capacity building and training.

Kew is also a critical part of the UK's national scientific infrastructure. Kew's science and policy work aligns closely with UK priorities such as those set out in Defra's Network Evidence Strategy:

- Enhanced competitiveness and environmental performance in the environmental, food and rural sectors.
- Natural resources managed sustainably and equitably to promote economic growth, public health and healthy ecosystems.
- Greater resilience through well managed risk and better contingency planning and mitigation of risks associated with the natural environment.

Kew has a role in delivering robust evidence for all three strategic evidence priorities, and also in applied areas such as improving the environment and safeguarding plant health. Kew will input into these national priorities through its assets, such as the collections, quarantine facilities and international taxonomic and policy experts, and also through specific areas of research such as modelling species distributions and ecosystem change, and investigating the evolution and biology of plant pathogens.

Through these contributions to conservation policy and management, Kew will be in a position to provide a powerful resource in the translation of pure and applied scientific research to tangible outcomes in biodiversity and ecosystem services conservation and monitoring.

Kew provides expert advice on international trade in plants, for example supporting Georgian partners in developing quotas for sustainable *Galanthus* (snowdrop) harvesting (right). We are also active in global plant policy, providing expertise on policies and procedures for plant collecting, use and supply. A key example of this is Kew's role in advising on the implementation of the Nagoya Protocol, a new legally binding regime governing access to genetic resources and the fair and equitable sharing of benefits arising from them.

Kew's Quarantine House, purpose-built in 2011, aids UK biosecurity and plant health, supporting the implementation of international conventions including the CBD and CITES.

FULFILLING KEW'S SCIENTIFIC VISION

The bioluminescent fungus *Filoboletus manipularis*, Sarawak (Malaysian Borneo)

Fulfilling our scientific vision

The new science departments

To deliver our strategic priorities, our science programme has been structured into six interconnecting research departments listed below. In addition, we have created an Office of the Science Directorate, which includes the policy, education and communication teams, to support these research departments and ensure that we have the right scientific infrastructure to deliver our strategic priorities and outputs.

- Collections
- Identification and Naming
- Comparative Plant and Fungal Biology
- Conservation Science
- Natural Capital and Plant Health
- Biodiversity Informatics and Spatial Analysis

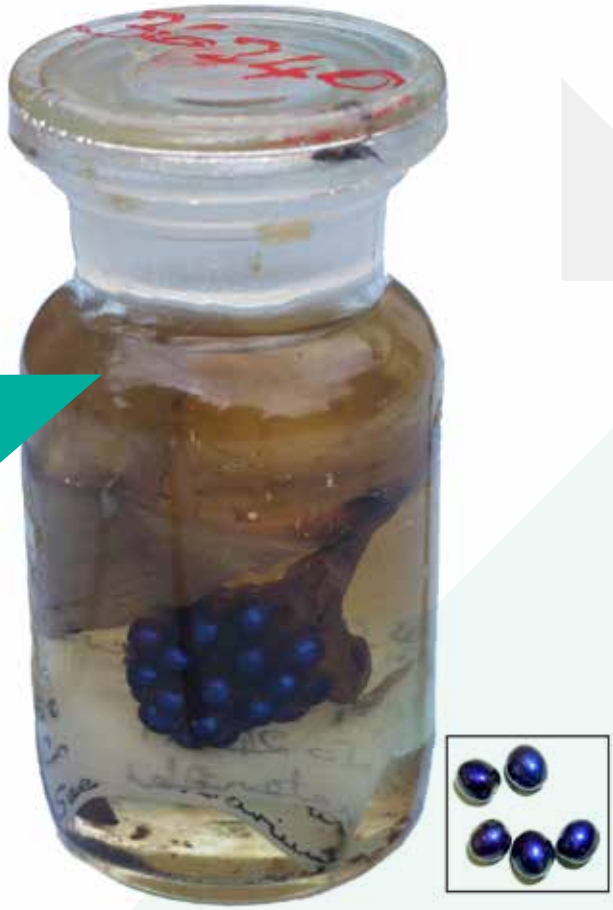
Collections

The strength and breadth of Kew's collections provide an unparalleled opportunity to understand plant and fungal diversity and to carry out research to support our scientific vision. Kew's collections and expertise are at the heart of the science carried out both here and in institutions across the globe. Thus, we are developing the collections to support the science foci of this strategy, while also maintaining the global representation of plant and fungal diversity necessary to document large-scale patterns of diversity and change, and to respond to future challenges.

The work of the Collections department is focused in the following areas:

- Ensuring representation of the global breadth of vascular plant and fungal diversity.
- Enhancing those parts of the collections deemed to represent priority taxa, areas and/or themes; in particular, focusing on those that can be defined as agenda-setting and globally relevant in the framework of the Science Strategy.
- Further development of best practice in collection management.
- Digitisation to increase access to, and use of, the collections. This will include both large-scale digitisation and dissemination of in-depth data derived from collections to answer specific science questions.
- Integration of data and information about, and derived from, individual collections, both within Kew and with complementary external information resources (e.g. the Global Biodiversity Information Facility).

The collections underpin Kew's science, and work in this department is therefore essential to all strategic outputs: Plants of the World Online Portal, State of the World's Plants, Tropical Important Plant Areas, Plant and Fungal Trees of Life, Banking the World's Seeds, Useful Plants and Fungi Portal, Digitising the Collections, Training the Next Generation of Plant and Fungal Scientists, and Science in the Gardens.



Specimen of *Pollia condensata* collected in 1974 in Ghana and preserved in Kew's spirit collection. Despite its age, the fruits (shown inset) have retained their remarkably intense blue coloration that makes them attractive to birds. Kew's collaborative optical and ultrastructural studies have shown that the strong reflected colour of this fruit results from the layered properties of the cell wall rather than from chemical pigments.

Identification and Naming

The Identification and Naming department comprises four teams (Africa & Madagascar, Americas, Asia, and Mycology). Each undertakes fundamental taxonomic research and inventories, developing innovative projects to address Kew's research questions whilst supporting and enhancing the collections.

Priorities for the Identification and Naming department are:

- Enhancing species discovery and accelerating the speed at which new species descriptions are made accessible to the global scientific community.
- Continuing the global inventory of species and the production of Floras and eFloras in collaboration with international partners, with maximum coverage for Kew's focal regions in the tropics.
- Working to complete a full account of known fungal species, and to significantly increase the number of fungal taxa reported (for example, carrying out full fungal inventories in key regions such as the UK Overseas Territories).
- Driving forward e-taxonomy and new technologies for the discovery, description and identification of biodiversity.
- Improving the value of the collections – Kew's primary naming and identification resource – through optimising accurate naming and curation, and improving the linkages between basic taxonomic knowledge and its applications, particularly in the areas of conservation and plant health.
- Providing assistance to non-specialists, citizen science communities etc, through development of user-friendly identification guides in printed and electronic form.

Accurate taxonomy forms the bedrock on which all of Kew's pure and applied science is based. Work in this department will therefore contribute to all strategic outputs: Plants of the World Online Portal, State of the World's Plants, Tropical Important Plant Areas, Plant and Fungal Trees of Life, Banking the World's Seeds, Useful Plants and Fungi Portal, Digitising the Collections, Training the Next Generation of Plant and Fungal Scientists, and Science in the Gardens.

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 led by Teva Kami in 2013, and published in 2014.

Comparative Plant and Fungal Biology

The Comparative Plant and Fungal Biology department provides authoritative and wide-ranging expertise on the structure, development, evolution, classification and genomics of major plant and fungal groups. Comparative research draws heavily on Kew's wide-ranging collections of both living and preserved plants and fungi. By studying all levels of organisation, from whole organisms through morphological traits to molecular pathways, we construct fundamental predictive frameworks that explain how plants interact with their environment.

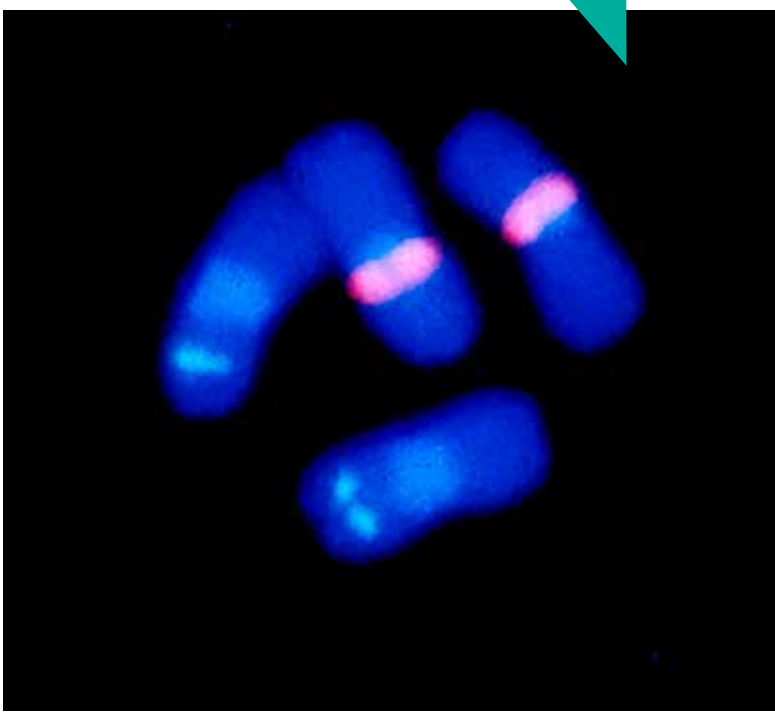
Research foci of the Comparative Plant and Fungal Biology department include:

- Plant and fungal evolution, covering trait evolution, plant rarity, uniqueness, and extinction risk, with an emphasis on the consequences of global environmental change.
- Comparative seed biology, encompassing biochemical, physiological, molecular and morphological studies focused on identification of the different mechanisms and traits important for longevity, optimal growth and restoration of seeds.
- Specialist systematics of selected vascular plants, with particular focus on groups of economic, ecological and/or phylogenetic significance, such as legumes and grasses.
- Specialist systematics of selected groups of fungi, especially those of economic importance, such as rust fungi, mycorrhizas and mushrooms.

This research represents a vital evidence base for numerous external stakeholders, including scientific institutions, governments, agri-tech companies, and food, timber, and pharmaceutical industries.

Work in this department will directly contribute to the following strategic outputs: Plants of the World Online Portal, Plant and Fungal Trees of Life, Training the Next Generation of Plant and Fungal Scientists, and Science in the Gardens.

Kew's scientists are seeking to understand the origin and immense diversity of genome size and how it influences where, when and how a plant grows and responds to environmental change. The image shows *Zingeria biebersteiniana*, one of only five plants with just four chromosomes per cell.



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.

Conservation Science

The Conservation Science department undertakes rigorous, evidence-based research and conservation activities to improve the global outlook for biodiversity. Working with partners in the UK and overseas, we provide evidence to enable monitoring, conservation and evaluation of the status of the world's plants, fungi and protected areas.

The Conservation Science department has four interlinked conservation research foci:

- Islands – prioritising UK, UK Overseas Territories and Madagascar. Provision of baseline science to underpin conservation policies for plants and fungi. Key activities comprise baseline inventories, conservation assessments, collections and recommendations for *in situ* and *ex situ* conservation management.
- Seed conservation. Working with our international partners to undertake geographically-focused seed collecting to bank 25% of the world's bankable plant species at the Millennium Seed Bank and partner seed banks worldwide by 2020.
- Conservation genetics. Undertaking studies in population genetics, phylogenetics and genome size, using high-throughput sequencing technology and other relevant techniques to ensure that conservation actions are based on sound genetic evidence.
- Conservation assessment and analysis. Initially focusing at the species level, utilising Kew's collections (particularly herbarium specimens) and employing novel techniques to scale-up the production of plant Red List assessments to better understand extinction risks in plants. Along with data on habitats, protected area networks and future climate scenarios, we will employ relevant analytical methods to enable more effective conservation prioritisation of plants and ultimately a better understanding of the status of the world's plants.

Work in this department will directly contribute to the following strategic outputs: Plants of the World Online Portal, State of the World's Plants, Tropical Important Plant Areas, Banking the World's Seeds, Useful Plants and Fungi Portal, Digitising the Collections, Training the Next Generation of Plant and Fungal Scientists, and Science in the Gardens.

The wild relatives of our crops are a valuable source of useful traits for crop improvement for food security. Kew's Millennium Seed Bank is supporting national partners to collect and conserve the wild relatives of 29 of the world's most important food crops. These will be made available to plant breeders, who can use these to produce crop varieties adapted to future climates.

The palm species *Dypsis decipiens* in the Itremo Massif Protected Area, which is managed by Kew's local team in Madagascar in collaboration with communities. We have published IUCN conservation assessments for Madagascar's 200 palm species and found that 83% are threatened with extinction. Characterising the population genetics of threatened species, baseline biodiversity inventories, and research on fire ecology is helping inform effective conservation management of these savanna habitats across the Central Highlands.

Natural Capital and Plant Health

The Natural Capital and Plant Health department uses collections-based science to identify and evaluate the roles plants and fungi play in providing services to humankind. It seeks to address overarching issues that include ecosystem service provision, the effects of climate change, resilience and resource security.

Research in the Natural Capital and Plant Health department is driven by four interrelated foci as follows:

- Agro-biodiversity research, ranging from global plant resources such as coffee to smaller scale products such as woody crops, legumes, cereals and tubers. This includes identifying key traits and useful diversity in crop wild relatives. Plant resource work will also investigate wood and timber identification and use, and generate and utilise understanding of the fungal communities that live within plants.
- Natural product chemistry approaches to studying plant-insect and plant-fungal interactions, focusing in particular on pollinator behaviour and health. These approaches will also identify natural chemical defence mechanisms against herbivores and pathogens, authenticate medicinal plants and evaluate their bioactivity.
- Research into the beneficial impacts on human livelihoods of plant and fungal diversity, from medicinal herbs to forest trees. We work with communities in locations and economies where nutritional, income, health and biodiversity issues are of paramount importance, in many cases in partnership with external organisations.
- Plant disease research, especially on fungal pathogens in native UK plants. This will be principally undertaken in agricultural, forestry and horticultural contexts through, for example, molecular tools and citizen-science web platforms for survey and monitoring purposes.

Work in this department will directly contribute to the following strategic outputs: Plants of the World Online Portal, State of the World's Plants, Tropical Important Plant Areas, Useful Plants and Fungi Portal, Training the Next Generation of Plant and Fungal Scientists, and Science in the Gardens.

Erysiphe alphitoides, a common mildew fungus, covering oak leaves with white powdery colonies, appears to be increasing in abundance. Fungal pathogens of UK trees, crops and garden plants will be a key study area for Kew's new Plant Health Team.

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.

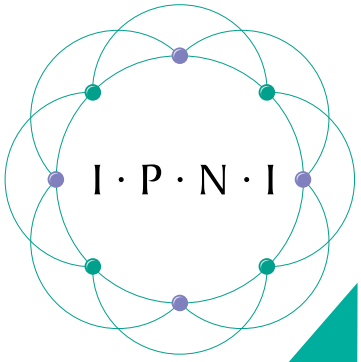
Biodiversity Informatics and Spatial Analysis

Vast amounts of data are held in our collections and in our nomenclatural and taxonomic databases, covering significant spatial and temporal ranges. They represent a huge, often untapped resource, providing evidence of changes in plant distribution and diversity over time and space.

Over the next five years, the Biodiversity Informatics and Spatial Analysis department will utilise the power of newly emerging computational techniques to edit, curate, organise and mine these data and to evaluate trends and patterns through time and space (geographical, meteorological and ecological) to enable a new level of utilisation of the collections. Key research and departmental priorities include:

- Plants of the World Online Portal – an online global resource for disseminating Kew's plant and fungal data to a wide range of audiences, maximising its impact.
- Developing a plant and fungal names backbone to link databases and improve access to the vault of information held in Kew's collections and nomenclatural and taxonomic databases, and providing critical evidence to meet policy and operational needs – both for the UK and international agenda.
- Curating key global plant and fungal nomenclatural and taxonomic resources, including the International Plant Names Index, the World Checklist of Selected Plant Families, The Plant List and Index Fungorum.
- Applying sophisticated spatial and analytical tools, and providing associated services, to greatly enhance our ability to address the critical research knowledge gaps set out in Strategic Priority 1.
- Expanding the capacity for powerful spatial analyses, ecological modelling and the analysis of genomic data in order to develop the tools and web-based platforms for the display of plant data alongside satellite imagery and climatic data.
- Mapping and analysing plant populations and communities at greatest environmental risk and identifying those that display remarkable resilience and persistence to environmental perturbations – information that is critical to identify and understand potential opportunities and threats to the vast natural capital provided by plants.

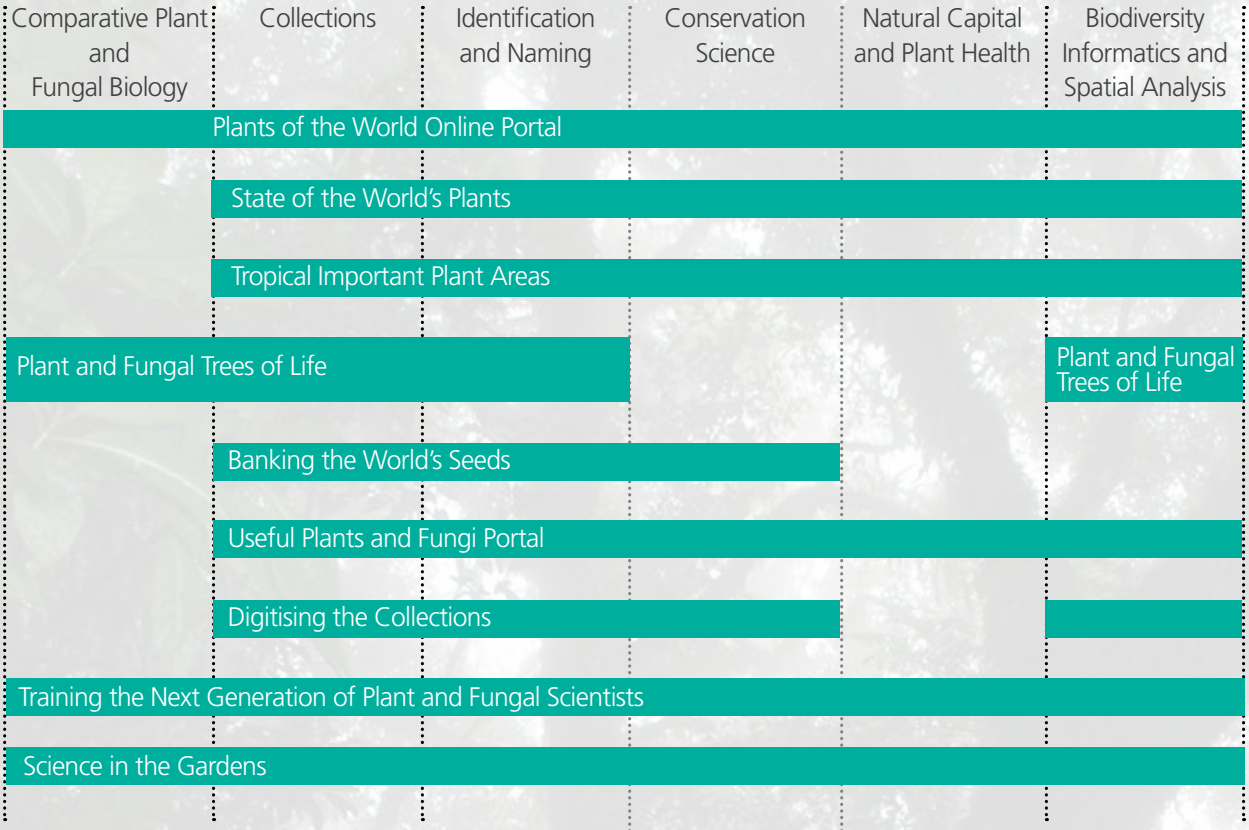
Work in this department will directly contribute to the following strategic outputs: Plants of the World Online Portal, State of the World's Plants, Tropical Important Plant Areas, Plant and Fungal Trees of Life, Useful Plants and Fungi Portal, Digitising the Collections, Training the Next Generation of Plant and Fungal Scientists, and Science in the Gardens.



The International Plant Names Index (IPNI) will be a key building block of the plant and fungal names index that will underpin the Plants of the World Online Portal and Useful Plants and Fungi Portal.

GeoCAT (Geospatial Conservation Assessment Tool) developed by Kew spatial scientists. The image shows a screenshot of GeoCAT being used to analyse the distribution of a palm species, *Dypsis decipiens*, in Madagascar.

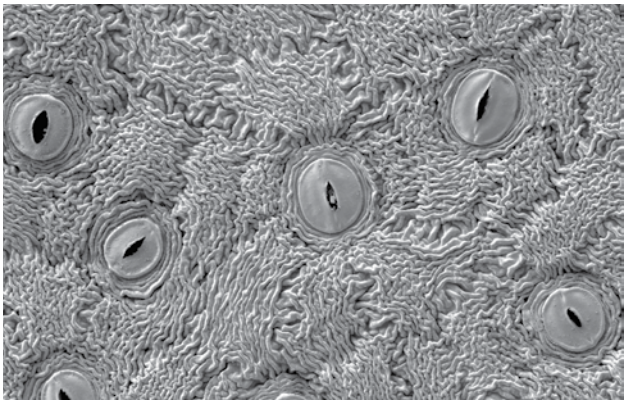
Delivering the Outputs



What success will look like in 2020

- Kew recognised globally for world-class plant and fungal science and conservation – demonstrably making a relevant contribution to the big issues of our time
- Information on all the world's known seed-bearing plants accessible online through Plants of the World Online Portal
- 150,000 newly available taxonomic treatments (including monographs, Flora entries and e-taxonomy treatments), building plant and fungal knowledge and addressing critical knowledge gaps
- 500 new species of plant and fungi described between 2015 and 2020
- Annual *State of the World's Plants* report and international science and policy symposium, evaluating trends and influencing global policy and opinion, in its sixth year
- Tropical Important Plant Areas assessed and mapped in seven tropical countries
- The Plant and Fungal Trees of Life completed for all genera
- 98% of vascular plant genera and 95% of UK non-lichenised fungal species represented in collections
- Digital access to 80% of collections, including all type specimens and all UK and UK Overseas Territories species
- 3 million visits per year to Kew's digital resources
- Seed of 25% of the world's plant species banked by the Millennium Seed Bank Partnership
- Seed collections from over 350 crop wild relative species from 29 major crop gene pools conserved in the Millennium Seed Bank
- Population-level representation of all threatened English vascular plants (25% of UK flora) in the DNA Bank
- Data on 80% of priority useful plants (including crops, crop wild relatives and those important for food security, livelihoods and human health) available through the Useful Plants and Fungi Portal
- MSc in *Plant and Fungal Taxonomy, Diversity and Conservation* in its sixth year
- Over 100 MSc students trained in the skills of taxonomy and biodiversity science
- Over 100 Kew scientists interacting directly with the public in the Gardens and through media and social media channels each year
- Annual Children's Science Festival in its fifth year
- Scientific information delivered to visitors in the Gardens using the latest technology
- Over 1800 new scientific books and articles published between 2015 and 2020, including at least 40% in high impact journals

Scanning Electron Micrograph (SEM) of the leaf surface of *Austrobaileya scandens*



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