NETWORKING FOR DIVERSITY

BG BM | Botanischer Garten & Botanisches Museum Berlin

BGBM Annual Report
2017 – 2019

Freie Universität Berlin

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Cover image: Research into global biodiversity and its significance for humanity is impossible without networks. The topic of networking can be understood in different ways: in the natural world, with the life processes within an organism – visible in the network of the veins of a leaf or in the genetic diversity in populations of plants – networking takes place by means of pollen, via pollinators or the wind. In the world of research, individual objects, such as a particular plant, are networked with the data obtained from them. Networking is also crucial if this data is to be effective as a knowledge base for solving global issues of the future: collaboration between scientific experts within and across disciplines and with stakeholders at regional, national and international level.

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Contents

Foreword

BGBM Annual Report 2017 – 2019

We are facing vital challenges. Climate change has been on everyone's lips for some time, but now – at least since the media debate on the report published in spring 2019 by the World Biodiversity Council (IPBES) – the biodiversity crisis and the global extinction of species have also been attracting the attention of society at large. Recently, a global pandemic has shown us the dramatic health, social and economic impact that emerging diseases can have in a short space of time. The ever deeper penetration of humans into previously untouched natural regions will increase these risks still further.

These societal challenges can only be overcome through a joint approach: collaboration and networking are crucial, not only on an international level, but also between politics, civil society and science as well as between the different scientific disciplines. To develop possible solutions, knowledge is required – and science is therefore paramount. A viable future for us all will depend on the decisions we make today. Fact- and science-based decisions require not only the broad availability of knowledge, but also a positive dialogue between science and society and the broad acceptance of science.

The title of this annual report – "Networking for Diversity" – underlines how important scientific networks and international knowledge exchange are for solving global problems. Here, at the Botanic Garden and Botanical Museum Berlin, one of our central objectives is to generate knowledge and to link received research data with relevant collection objects and other data worldwide so as to unlock new knowledge potential and make it usable. We develop standards and software tools and make biodiversity data available digitally – for the modelling of future scenarios, for example. Biodiversity data as a knowledge resource must be accessible worldwide and FAIR-compliant. Indeed, it is only as a globally networked knowledge community that we will be able to meet the challenges of the future.

Raising people's awareness of nature and getting them excited about plants is one of our key missions. As positive and relaxing places, botanical gardens themselves play their part in developing a new understanding of nature and thus also strengthening the desire to preserve its diversity. We see this in the growing responsiveness of our visitors.

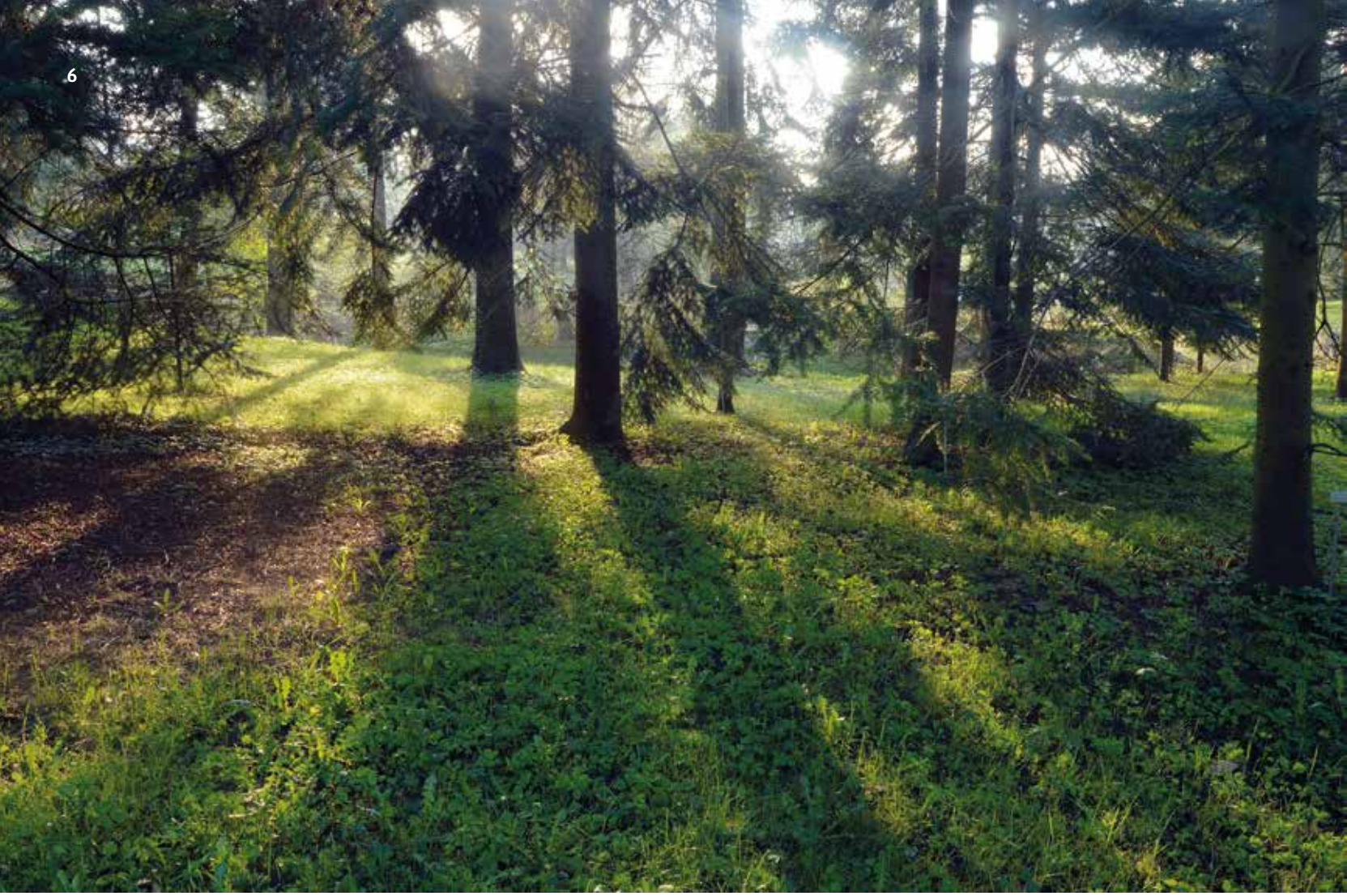
The Botanic Garden is due to be redeveloped in the coming years with new displays, garden areas and digital tools, while the Botanical Museum will be modernised in keeping with the times. And the new visitor centre will create a lively forum of urban openness for our visitors at the Königin-Luise-Platz entrance.

My heartfelt thanks go to our employees as well as to all donors and sponsors of the Botanic Garden and Botanical Museum Berlin. What we're able to show you in this report would not be possible without their commitment.

Happy reading! And happy looking!

Prof. Dr Thomas Borsch
Director of the Botanic Garden and Botanical Museum Berlin
November 2020

Image left: View of the Bromeliad House with *Tillandsia usneoides* in the foreground.



Atmospheric shot of the spruce (*Picea*) area of the arboretum.

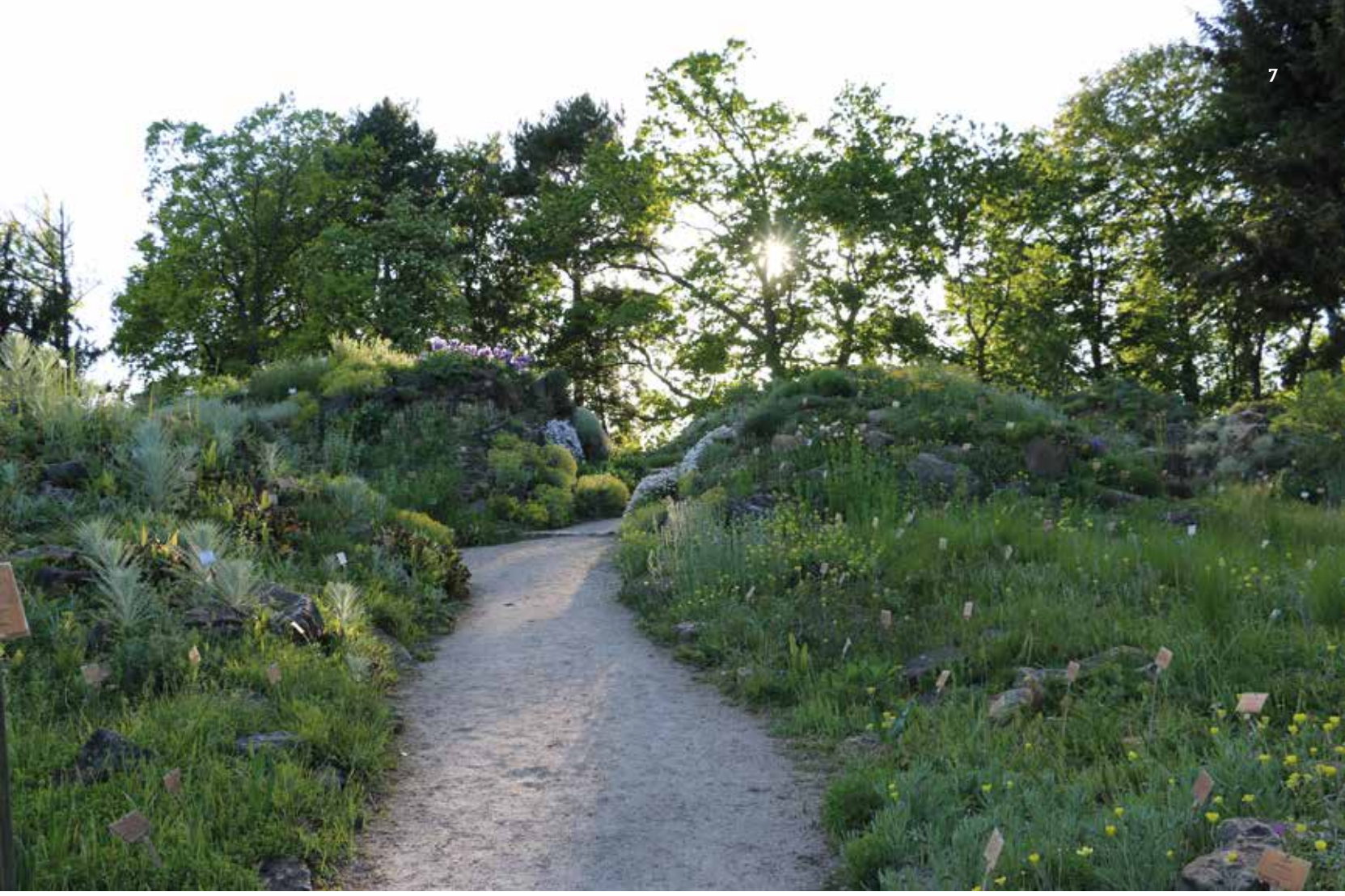
A network for plants

The BGBM connects people, institutions and information in Berlin and around the world

"Network!" This motto is a winning formula in many situations. Whether you want to get ahead professionally, achieve a political goal or start a new trend: exchanging knowledge, sharing resources and bringing together comrades-in-arms with different talents can only be advantageous.

However, as much as this strategy has grown in importance in the wake of digitisation, it has always been fundamental for plants: you only have to look into a forest to discover this green network. The trees there are connected to one another by an underground web of fungal threads, through which they are able to exchange nutrients and warn each other about pests. They are stronger together than they are alone.

So what could be more fitting than to use this winning formula for botanical research and the transfer of knowledge to society? This is exactly what the Botanic Garden and Botanical Museum Berlin (BGBM) has been practising for a long time. In the course of the BGBM's tradi-

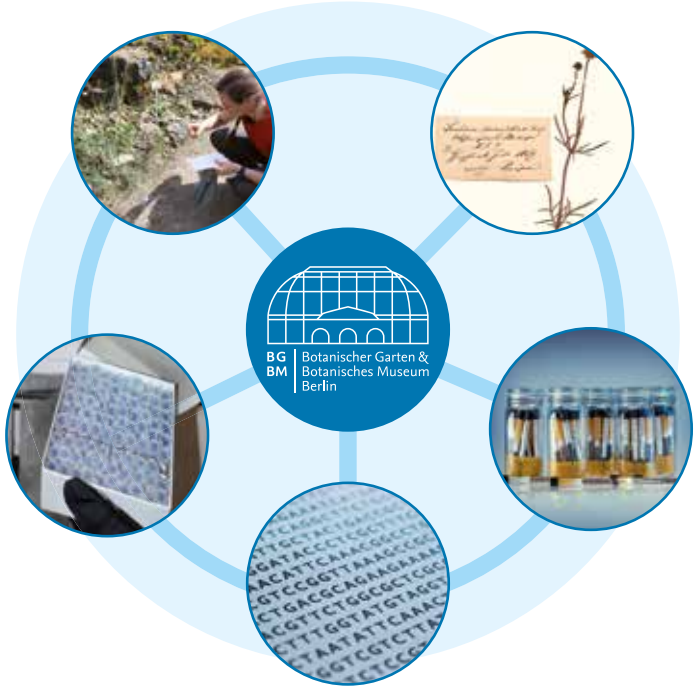


Plant geography section (Greece) in the afternoon sun.

tion-rich history, a robust network has emerged that connects collections and institutions, data and people. The 2017–2019 annual report presents this network of knowledge, growth and research.

Anyone who takes a walk through the garden or admires the green treasures in the greenhouses is already getting to see part of this green network: around 20,000 different species, subspecies and varieties of living plants have been assembled by the BGBM, together with partners at home and abroad. And there are also other botanical treasures behind the scenes, such as the nearly four million dried plants in the herbarium, the approximately 50,000 tissue and genetic material samples in the DNA bank or the frozen seeds of thousands of wild plants in the seed bank. The BGBM is thus part of a global memory bank of biodiversity that is preserved in herbaria and other natural history collections.

However, it is not enough to store the samples and data just the once and then let them slumber in drawers. The information from this memory bank should ultimately be available at any given moment to answer new research questions. That is why information scientists at the BGBM grapple with how best to make all this valuable data accessible. They have, for example, developed their own software to link together the various in-house collections, as well as the research data generated on the objects. This not only makes it possible to understand who brought a living plant from where into the greenhouse, where the associated material is in the herbarium and in the DNA bank, and whether seeds have also been stored. But also which DNA sequences or electron microscope images belong to an individual and what place this individual already occupies in one of the published family trees that reconstruct evolutionary history.



At the BGBM, all the different types of collection (living collection, herbarium, DNA bank, seed bank and data) are digitally networked with one another. This results in an ever-growing pool of knowledge that is made available globally.

Dr Robert Lücking (curator), in the fungus collection.

In addition, the data collected at the BGBM is made accessible via various online platforms. Anyone who might be interested can take a look, at any time and from anywhere in the world, at the BGBM's virtual herbarium or the Flora of Cuba, browse the Euro+Med PlantBase site for European and Mediterranean plants or retrieve information on global biodiversity on an internet platform called GBIF (Global Biodiversity Information Facility).

The BGBM network not only connects up the different sources of information within our own institution, its threads extend far beyond the institution itself and beyond Berlin. Indeed, the BGBM not only contributes to researching and protecting plant diversity in Germany, Europe and the world. It also offers the opportunity for exciting encounters between experts and laypeople. Whether through exhibitions, cultural events or special activities for school classes, there are many ways to foster dialogue. In citizen science projects, members of the public can even contribute to the research work of the BGBM themselves, for example by deciphering old handwriting on herbarium labels or helping with plant identification. We are stronger together than we are alone!

Berlin's Governing Mayor Michael Müller (centre), Regine Günther, Senator for the Environment, Transport and Climate Protection (2nd from right), Sarah Wiener (right), Dr Andrea Bör, Chancellor of the Freie Universität Berlin (left) and Prof. Thomas Borsch (2nd from left) at the ceremony for the reopening of the Victoriahaus.

Key events of 2017 – 2019

Audience with the Queen
The reopening of the Victoriahaus

Flowers and young leaf of the species *Victoria cruziana* (native to the Rio Paraná in Brazil) on display in June 2018 in the Botanic Garden's newly renovated Victoriahaus.

The South American giant waterlilies of the genus *Victoria* are considered the queens of all aquatic plants. After all, what other plant can boast two-metre floating leaves that can bear loads of up to 100 kilograms? Or magnificent flowers that, with a diameter of up to 35 centimetres, are among the largest in the world?

Visitors to Berlin have been able to admire this botanical attraction once again since 15 June 2018, the date on which the BGBM's Victoriahaus (Giant Waterlily House) was reopened with a celebration attended by more than 600 guests from the worlds of politics, business, science and culture. The greenhouse, which is more than 100 years old, was closed for twelve years and started getting into shape for its energy-saving operation in 2013 thanks to a thorough renovation in line with its status as a protected historic monument. This was made possible with funds from the regional government of Berlin, the European Regional Development Fund (ERDF) as part of the Environmental Relief Programme II and the Freie Universität Berlin's own funds.

Since then, one of the world's most important aquatic plant collections has been open to the public once more.

Editorial committee, from left to right and back to front: Fred R. Barrie, Anna M. Monro, Sandra Knapp, Michelle J. Price, Werner Greuter, John McNeill, Gideon F. Smith, David L. Hawksworth, Patrick S. Herendeen, Karol Marhold, Tom W. May, Jefferson Prado, Wolf-Henning Kusber, De-Zhu Li, John H. Wiersema (secretary) and Nicholas J. Turland (chair).

The naming book
The drafting of the *Shenzhen Code*

To avoid utter confusion breaking out in biodiversity research, scientists worldwide all have to agree on a correct name for each species. That sounds easier than it is, however. It becomes problematic if the same species is hidden behind several historical names. Or when research findings show that a species belongs to another genus. It is not only in the case of new discoveries, then, that plants often have to be renamed.

The rules to be followed are laid down in the *International Code of Nomenclature for algae, fungi, and plants*, which is updated every six years. The latest version was adopted on 29 July 2017 at the 19th International Botanical Congress in the Chinese city of Shenzhen. Nicholas Turland from the BGBM headed up the 16-strong editorial committee.

The editorial committee at work.

When it comes to plant names, **Nicholas J. Turland** is an expert. He first started to develop an interest in the subject in 1994 when he was working at the Natural History Museum in London on names of plant species that Carl Linnaeus described in the 18th century. But he knows from personal experience the challenges involved in producing floristic treatments, having worked at the Missouri Botanical Garden from 1997 to 2012 on the *Flora of China*, from 2006 onwards as project co-director. By the time the Flora was completed in 2013, over 31,000 vascular plant species were included. At the BGBM, he has been head, since 2013, of the publishing and graphics section, which publishes the two scientific journals *Willdenowia* and *Englera*. He is also *rapporteur-général* for the Nomenclature Section of the International Botanical Congress (2017 and 2023) and chairs the editorial committee of the *International Code of Nomenclature for algae, fungi, and plants*, which lays down the internationally applicable rules for the scientific naming of these organisms.

The participants of the "Protection of Threatened Plant Species in Central Europe" symposium in front of the entrance to the Botanical Museum.

A botanical parachute
Specialist symposium on the protection of Central European plant species

The common goal is clear: it's about doing everything possible to preserve the dwindling plant diversity in Central Europe. But how can this best be achieved? What contribution can science make, and what contribution can practical nature conservation make? And how can both be combined so that the right research questions are asked and the research results can actually be used? Such issues were debated by around 80 participants from all over Germany, Austria and Switzerland at the conference "Schutz bedrohter Pflanzenarten in Mitteleuropa" (Protection of Threatened Plant Species in Central Europe), which took place from 23 to 25 February 2017 at the BGBM. The genetic diversity of plant populations was just as much a topic of discussion as the measures and concepts for species protection. Ultimately, the event turned into a nature conservation forum in which academics and practitioners could exchange ideas and formulate their needs. The specialist symposium was part of a project funded by the Federal Agency for Nature Conservation in order to support the implementation of Germany's nature conservation goals.

Design for the visitor centre by heneghan peng architects.

Modern infrastructure for a Botanic Garden with history
The building of a new visitor centre begins

The Botanic Garden Berlin looks back proudly on its 300-year history. But even a garden with history needs a modern infrastructure to make its architectural calling card as appealing as possible. And when it comes to infrastructure, change is on its way thanks to funding from the GRW, a government scheme set up to improve regional economic structures. The construction of a new visitor centre is the most visible change for visitors in a whole series of planned building work, which includes a new visitor signage and information system, the repair of a large number of the garden paths and the redesign of the Botanical Museum.

"We are pleased that the new visitor centre can start to take root in the ground that has now been prepared", comments Prof. Thomas Borsch, director of the Botanic Garden and Botanical Museum, in December 2019. Designed by heneghan peng architects, this light timber-roofed building will ultimately provide space for a shop, information centre, lockers and checkout area and will be connected to the Botanical Museum via a courtyard garden. Together with a café and a more spacious lobby, this new, informative forum will be ready to welcome nature lovers, recreation seekers and botany enthusiasts at the Königin-Luise-Platz entrance by the end of 2021.

The Garden's administration building houses the offices of the biodiversity informatics team.

When diversity goes online

The digitisation and networking of collections offers new research opportunities

When James Francis Macbride of the Field Museum in Chicago travelled across Europe in 1929, camera in hand, he laid the foundations for a priceless resource. The botanist visited various herbaria and photographed the "type specimens" – in other words, those pressed plants that had been used as the basis for describing the respective species for the first time.

Scientists look at these historical blueprints, for example, when they want to distinguish new species from those that are already known. But do you really have to drive halfway around the world? With his photos of type specimens collected in the New World, Macbride wanted as much as possible to save his colleagues that expense. So, within the space of ten years, he put together a huge picture archive with 40,000 negatives. He also took thousands of photographs in the Berlin herbarium – little realising that most of his subjects would go up in flames during the Second World War. It is only in these photos, which are still kept in the Field Museum to this day, that many of the burned Berlin type specimens are preserved.

Even the leaves of the giant waterlily *Victoria* rely on a network. Thanks to the rib-like supporting tissue on the underside of the leaf, it can support weights up to 100 kilograms.

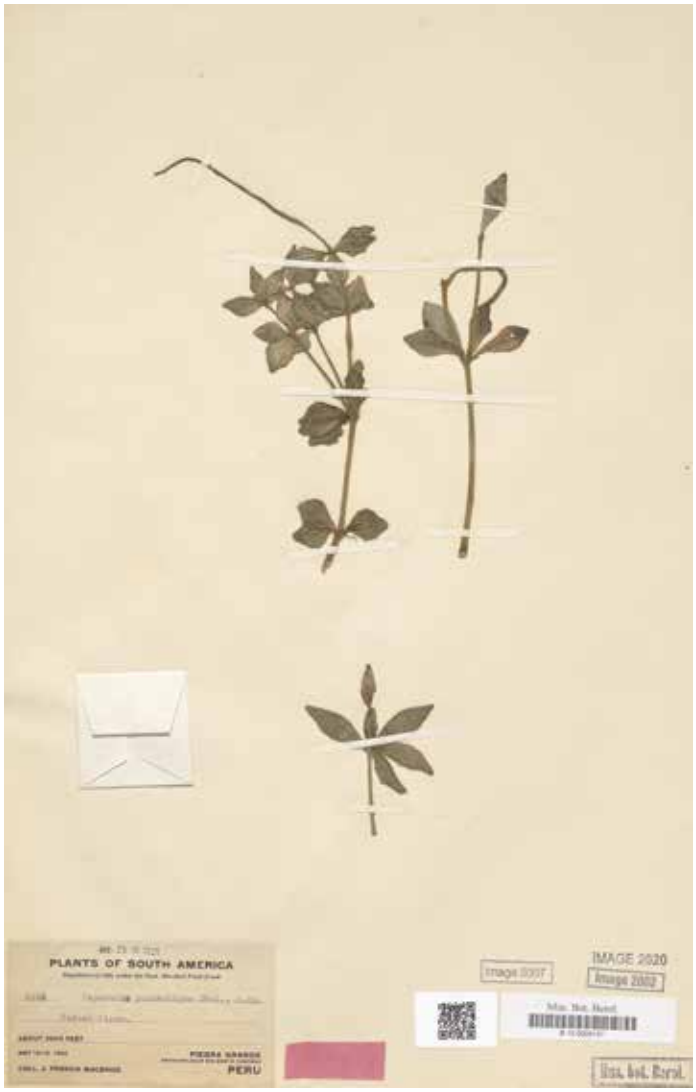
"In the meantime, our colleagues from the Field Museum have digitised Macbride's photo collection, and so these valuable samples have at least now returned to us virtually", Dr Walter Berendsohn, head of the Department of Research and Biodiversity Informatics at the BGBM, is pleased to report. He sees this as a good example of how long botanical research institutions have already been networked with one another – and how valuable that connection is. Macbride's photo initiative is thus something of an exemplar when it comes to making collection material visually available.

"In the age of digitisation, far better opportunities are of course open to us than in Macbride's day", says the botanist. He and his team are therefore working on a complex digital infrastructure that connects people and data across institutions. Information about the living and pressed plants, seed material and DNA samples in the BGBM's collections is fed into databases that the Berlin team has either largely developed itself or in conjunction with its partners.

What's important here is puzzling out how to best record and structure all this data. Because it's only when this is done according to uniform standards that the information can be networked and made accessible internationally. And that is precisely the aim: anyone interested in certain species (or a certain region) should be able to access collections all over the world via a central access point on the internet.

These efforts are already well advanced thanks to an international network called the Global Biodiversity Information Facility (GBIF), which was founded in 2001 and in which more than 50 countries are now members. Each of these must set up at least one national hub or "node" via which museums, botanical gardens and other institutions can share their biodiversity data with the rest of the world.

There are eight such nodes in Germany, each of which is responsible for a different group of organisms. In addition to overall coordination, the BGBM has also taken on botany. The participating research institutions can communicate directly with the GBIF platform via the re-



Herbarium specimen collected by James Francis Macbride in 1923 in Peru. It was on the basis of this material (type) that the species *Peperomia puberulipes* Trel. was described by William Trelease.

Herbarium specimen collected by James Francis Macbride in 1923 in Peru. This material (type) was the basis for Ellsworth Paine Killip's description of the species *Bomarea campylophylla* Killip.

spective nodes. With the help of special software, their local database is integrated into the GBIF standard and can then be accessed centrally. The result is a huge virtual library that contains more than a billion entries on the Earth's biological diversity. They reveal, for example, when a particular invasive plant species was first collected in Germany or when a particular bird species was observed where. The information from the GBIF was incorporated into almost 800 scientific studies in 2019 alone. Indeed, there are numerous ways of using the GBIF's treasure trove of data. It can be used to create distribution maps for individual species and see whether the occurrences have changed over the years. And sometimes future trends also become tangible. "If you find out that a leaf-mining moth is destroying the agaves in Argentina, you can link the occurrences of the insect with climate data", explains Walter Berendsohn. This makes it possible to estimate where the pest might next be introduced. And that can also be worth knowing from an economic standpoint: if the moth appears to be advancing towards Mexico and threatening to destroy the agaves there – and with them tequila production.

The data also plays a major role in assessing the threat to biodiversity. Thus, depending on the species group, today between 20 and over 50

per cent of all plant species are threatened with extinction – but for many species there is no reliable data. The digitisation and linking of the data collected with the herbarium specimens therefore constitute an important basis for the results published by the World Biodiversity Council IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services).

"The software components that we have developed have not only been integrated into the GBIF", says Anton Güntsch, head of biodiversity informatics at the BGBM. There are a whole host of other platforms that are organised in a very similar way. One of these is the Global Genome Biodiversity Network (GGBN), founded in 2011, in which 96 research institutions are now members. The platform provides an overview of which DNA and tissue samples are stored where.

Almost three million such samples are already recorded in the database. But that is only a fraction of the estimated ten to twelve million specimens stored overall at the participating institutions. It will be another few years before they can all be searched and requested online. "In the course of our work, we take in material from all possible organisms except modern humans", explains BGBM employee Gabriele Dröge, who is the GGBN's technical manager. "The spectrum ranges from bacteria to great apes."

By contrast, another portal that uses the software developed in Berlin deals exclusively with plants. Evo-BoGa is conceived as a kind of online catalogue for the living collections of around 90 botanical gardens in Germany. Anyone who needs living examples of certain species for their research work should, in future, be able to look up where they are cultivated. For the large orchid and bromeliad plant families, there are already numerous data sets in the portal.

But efforts are also being made at European level to make the treasures of natural history collections more accessible to scientists. Botanical gardens, natural history museums and other collecting institutions have therefore banded together to form a network called CETAF (Consortium of European Taxonomic Facilities). One of the projects run by the consortium is the Distributed System of Scientific Collections (DiSSCo), in which 120 institutions in 21 European countries are currently participants. The BGBM is one of seven German research institutions that are involved. DiSSCo will coordinate access to collections across Europe using the most modern methods, meaning that the search systems for collection items will be even more efficient. It will then be possible to look for herbarium specimens of certain plants and borrow them if necessary or study them on a high-resolution image.

Anton Güntsch is a graduate in computer science and has been head of the biodiversity informatics research group at the BGBM since 2005. He specialises in databases and expert systems and is particularly interested in how to prepare biological data for a wide variety of research questions and how to interlink it. In numerous projects and collaborations he adapts advanced methods of biological information processing. Working at such a research-oriented botanical institution as the BGBM can only be an advantage – especially when it comes to testing and introducing the software products developed by your own team.

"Image data has become ever more important in the digitisation of collection objects in recent times", says biodiversity informatics specialist Anton Güntsch. Because James Francis Macbride's hundred-year-old idea is more relevant today than ever: if photos are available on the internet, expensive trips to collections around the world become superfluous. And today, as then, the pictures sometimes end up being the last reminder of lost treasures. It was only in September 2018 that a devastating fire destroyed countless treasures in the Natural History Museum in Rio de Janeiro. "Digitisation is admittedly no substitute for a physical collection like that", emphasises Walter Berendsohn. "But at least it offers some kind of safeguard in case of emergency."

Collecting seeds from wild plants at their natural growth site requires very good knowledge of plant species and the morphology of fruits and seeds.

On the quest for diversity

In order to protect species and evaluate the condition of habitats, good observation programmes are needed

It's real detective work. If you want to know more about the dwindling biodiversity of our planet, there's no getting away from meticulous stocktaking. Which species occur where? How big are their populations, are they growing or shrinking? How great is their genetic diversity? And what conclusions can be drawn from this? There are various reasons why it is important for researchers at the BGBM to answer such questions. On the one hand, monitoring biological diversity in this way can tell us which species are endangered, and how severely, and how we can help the most threatened candidates. On the other hand, certain organisms are living indicators that reveal more about the condition of their habitat.

"Diatoms, for example, which we study here, have very varied requirements", says Dr Jonas Zimmermann, who has been head of the BGBM's diatoms research group since 2019. Some are dependent on higher temperatures, pH values or salinity levels, others need lower ones. On the basis of fossil diatom shells, palaeontologists are also able to draw conclusions about the climate of times long past. And

Mountain arnica (*Arnica montana*) has died out almost everywhere in the North German Plain. Employees of the BGBM, and the local authorities, have been supporting the last occurrence in Western Pomerania with cultivated seedlings. This population, richly blooming once again, is now attracting many flower-visiting insects.

The broad-leaved marsh orchid (*Dactylorhiza majalis*) was once a widespread wetland species in Germany. Thanks to appropriate care, the now rare native orchid can still grow in populations rich in individuals. The Dahlem Seed Bank stores seeds from numerous occurrences in eastern and central Germany, which can then be used to establish new stocks.

sometimes the tiny witnesses prove useful in criminal cases too. "A corpse found in water with freshwater species in its lungs cannot have drowned in the sea", explains the researcher. The experts in the diatoms research group, however, have set out on the trail of the tiny telltales for different reasons. According to the EU's Water Framework Directive, diatoms are among the organisms that should be used as indicators for the condition of water bodies. Because the presence or absence of certain species – or indeed their frequency – allows you to determine how heavily the water is polluted with nutrients.

The range of diatoms that occur must of course be analysed as precisely as possible. The traditional way of doing this is to examine the shells of these unicellular organisms under the microscope. But since this is very time-consuming and does not always provide unequivocal results, the diatoms research group also relies on a special method of genetic analysis: DNA barcoding, or, in the case of environmental samples with many organisms in them, environmental DNA metabarcoding.

The concept is modelled on the barcodes that are scanned at supermarket checkouts and then, in no time at all, spit out the item details including the price. For several years now, biologists have also been looking for a similarly simple identification code for living beings: a tiny piece of the genetic material of a plant or animal that might quickly reveal which species it is. Supported by the German Barcode of Life (GBOL) project, research institutions nationwide are working on developing these kinds of DNA barcodes for the species that live in Germany. Linked to this, a sub-project based at the BGBM focuses on diatoms.

Germination experiments are used to research the conditions that a seed requires for germination. If the germination conditions are known, germination tests provide information about the vitality of the collected seeds.

In fact, the new approach has already proven itself. Once the researchers have collected a water sample from a river or lake, they can automatically scour it for diatom barcodes using modern DNA sequencing devices. By doing this, they often get a much more precise – or at least complementary – picture of the diatom community in comparison with that seen through the microscope. However, this only works if you can compare the DNA sequences you have discovered with as many others as possible.

"We feel like the police when they're trying to match traces of DNA from a crime scene to a suspect", explains Jonas Zimmermann. The larger the comparison database, the better in both cases the chances of a successful investigation. Which is why the BGBM team has compiled an extensive reference library for diatom barcodes, which is constantly being expanded.

However, there are also yet other tiny algae that can reveal something about the ecological state of water bodies. The European Water Framework Directive alone lists more than 350 such bioindicators. A team led by Wolf-Henning Kusber, who is a member of the diatoms research group, has created "wanted posters" for the 50 most important of them. Detailing what each species looks like, where it occurs and what ecological requirements it has make the work of algae investigators easier. The latter often also reveal something about their future prospects. "For species that rely on nutrient-poor water, the outlook is pretty bleak today", says the scientist. This trend can be seen very clearly in the new "Red List" of ferns and flowering plants, mosses and algae published by the German Federal Agency for Nature Conservation in December 2018. Wolf-Henning Kusber was responsible for the chapter on desmids. These pretty, single-celled algae grow in nutrient-poor lakes and bogs and die if they're over-fertilised by nutrient inputs. Accordingly, in the total species list, half of the 968 analysed species are classified as a Red List species with an endangered status.

The news is similarly grim when it comes to the higher plants; here, about a third of the wild species are in trouble. "We have a real biodiversity crisis right here on our doorstep", warns Dr Elke Zippel, who coordinates the "Wildpflanzenschutz Deutschland" (WIPs-De) project – a scheme aimed at protecting wild plant species – at the BGBM. Five botanical gardens have joined forces to collect the seed material of threatened wild plants. They store most of it as a kind of preserve for later. From what is left over they grow new plants in order to strengthen or rebuild stocks in their natural habitats.

Originally, they concentrated on 15 species that have a centre of distribution in Germany. In 2018, however, the second phase of the project was approved, expanding this list to 92 species. So that this larger group of candidates is also able to benefit from seed-collecting and reintroduction programmes, the Federal Agency for Nature Conserva-

There are only a few plants left in north-eastern Germany of the slender cottongrass (*Eriophorum gracile*) – in a single Uckermark bog. With the help of progeny and the development of a propagation programme at the BGBM, the natural population is expected to increase in the future.

The protection of threatened plant species is of particular concern to **Dr Elke Zippel**. The biologist came to the BGBM in 2003 and has been working at the Dahlem Seed Bank since 2009. As its curator she is responsible for the exchange, collection and long-term storage of seeds from all over the world. Native plant species, however, are one of the focal points of the collection. Alongside endangered species from Central Europe, the aim is to store seeds from all plant species in north-eastern and eastern Germany on a long-term basis and so represent the genetic diversity of different original populations. Dr Zippel has a great deal of experience in stabilising stocks of endangered native plants *in situ* or indeed reintroducing them.

tion has provided the BGBM with a total of almost one million euros for five years.

"However, if you actually want to save a species, you have to know it very well", stresses Prof. Albert-Dieter Stevens, head of the BGBM's Department of Biological Collections. You have to know not only when its seeds are ready to be harvested, but, most importantly, where it still occurs at all. Good monitoring is therefore also crucial for this type of botanical work.

It is true that, in many cases, Elke Zippel and her team can fall back on inventories compiled by the authorities and nature conservation associations. But when these are already a few years old, the scientist sometimes notices dramatic changes: there might only now be woeful remnants of what were once plentiful stocks, or indeed nothing at all. "This development also affects species such as the broad-leaved marsh orchid (*Dactylorhiza majalis*) or the immortelle (*Helichrysum arenarium*), which used to be widespread and very common", reports Elke Zippel. And it's not just the species themselves that are running into danger: the genetic diversity within a species is also declining – and that is often a prerequisite for the survival of a species.

However, she also knows that, at least in a few individual cases, the decline can be halted. When they check on the progress of their reintroductions year after year, the researchers see positive developments. "The arnica population in Mecklenburg-Vorpommern (Western Pomerania), for example, is unlikely to die out completely", says Elke Zippel. In order for such successes to be achieved, however, numerous details have to be taken into account at every step: the collecting, cultivating and the very laborious reintroduction stage. The WIPs-De team has produced a guide summarising what these are.

The team has done this because its members are convinced that the effort that goes into such protection projects is worthwhile – and not only for the affected plants, but also for people. "We're smack in the middle of nature's web", says Albert-Dieter Stevens. "Right now we're tearing it apart in lots of different places and hoping that we don't fall through it regardless. But it is becoming obvious that at some point we will sever crucial threads."

The biology of the zombie weevil fungus (*Ophiocordyceps curculionum*) is fascinating: it attacks weevils and, before killing them off, influences their behaviour so as to ensure the spread of its spores. The underlying biochemical processes are of great interest to the pharmaceutical industry, and there are still a large number of unrecognised species in this group of fungi.

Invisible diversity

In the world of algae, fungi and lichens, many exciting things are yet to be discovered

The lungwort (*Lobaria pulmonaria*) is a bioindicator of semi-natural habitats with high air quality.

At first glance, they are not necessarily among the most spectacular inhabitants of seas, rivers, lakes and soils. But they are among the most common and most important. The single-celled algae known as diatoms are not only an irreplaceable component of the global food web of which humans are also part; they are also heavily involved in absorbing carbon dioxide, and therefore help to mitigate the greenhouse effect. As a secondary benefit, they also contribute at least a quarter of global oxygen production. But what kind of organisms make every fourth breath possible for mankind? A research group at the BGBM has set itself the task of getting to know these influential unicellular organisms better.

This means venturing into a world that is packed full of surprises, even for experts – since the tiny, single-celled algae live in elaborate-looking, glass-like silica shells and often only reveal their secrets at second glance. They cannot even be seen with the naked eye. But under a light microscope or an electron microscope they present an astonishing variety. “There is barely any other region in the world where diatoms have been as thoroughly studied as in Berlin waters”, says Dr Regine Jahn, long-time head of the diatoms research group at the BGBM. “Even so, we always find new species even here.”

One of the most important and effective wood decomposers is the fairy inkcap (*Coprinellus disseminatus*), which has a worldwide distribution.

Identifying them can, however, become a real challenge. During cell division the newly formed silica shells always end up slightly smaller than those of the mother cell. After a few generations, the cells no longer look like their ancestors. Of course, this shrinking cannot go on indefinitely. At a certain point the algae would no longer be viable. That is why they have found ways to suddenly grow back to maximum size, for example when two cells fuse together and form large reproductive cells. In other respects, too, members of the same species can outwardly look very different from one another.

"If you want to get an overview of the biodiversity of the diatoms, you have to pay attention to the tiny external features as well as take a look at the genome", explains Dr Jonas Zimmermann, who has been head of the diatoms research group since 2019. He is supported in this endeavour by Dr Nélida Abarca, who has been the curator of the diatom herbarium at the BGBM since 2019. So far, scientists have identified around 2,000 species for Germany. There are currently around 20,000 species of diatoms described worldwide, and new species are discovered every year. "We suspect that we only currently know at most ten per cent of all diatom species on Earth", says Regine Jahn. According to some estimates, there are at least 200,000 and possibly up to two million species of these remarkable unicellular organisms worldwide.

The situation is likely to be similar in the case of fungi. "There are countless species of fungi and not nearly enough experts in a position to document this diversity", explains fungi and lichen expert Dr Robert Lücking from the BGBM. In many regions of the tropics, the

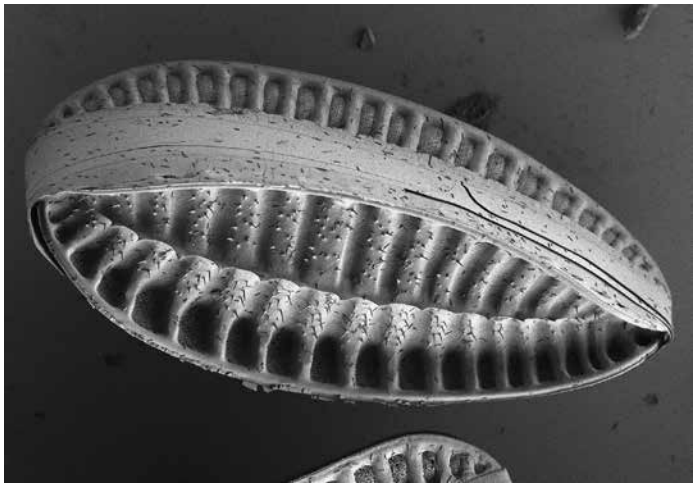
Dr Regine Jahn has been enthusiastic about the microscopically small world of diatoms for decades. She was already engaging with the ecological significance and diverse forms of these single-celled organisms during her doctoral studies at the Freie Universität Berlin – and she has pursued the topic ever since. She came to the BGBM in 1991 as curator of algae, and in 1999 also took over the running of the laboratories here. Through externally funded projects, she set up the diatoms research group, which she led until March 2019. The group explores how to identify these tiny creatures, clarify their interrelationships and use them for the purposes of environmental monitoring.

Dr Nélida Abarca has been algae curator in the BGBM diatoms research group since 2019. She studied biology and natural sciences at the Universidad Michoacana de San Nicolás de Hidalgo, Morelia, Mexico. After receiving her doctorate in 2010 from the Freie Universität Berlin on the biodiversity of diatoms in Mexico's Lerma region, she then worked as a postdoc on various diatom projects at the BGBM. Her main research interests are the phylogeny and taxonomy of diatoms, with a particular focus on the light- and electron-microscopic analysis of micromorphological features.

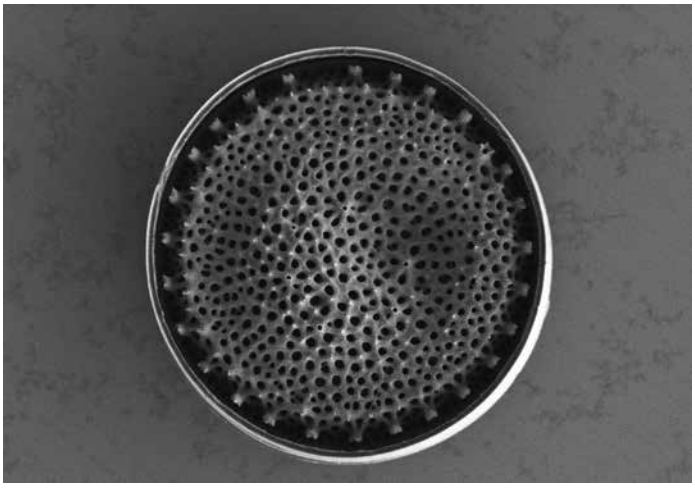
Four cells of the freshwater diatom *Cymbella* sp. in the scanning electron microscope. After mitotic division, these large diatoms often remain attached to the substrate by a common gelatinous stalk that in each case is excreted at one end of the shell. The siliceous cell wall forms boxes made up of upper and lower shells, which are held together by so-called girdle bands. In this species, the boxes are wedge-shaped, and the wide girdle bands are clearly visible here in the cells on the left as well as centre right and right.

The globally widespread split-gill (*Schizophyllum commune*), a wood decomposer that is being experimentally investigated to improve oil production, is considered biologically unique.

occurrences are still largely unexplored. And with these organisms, just as with algae, several species are often concealed behind a single name. Genetic studies have shown that there is by no means just one fly agaric, but ten to twelve different ones. Fungi often have important functions. In the natural environment they contribute – in a symbiotic relationship with trees – to the nutrition of the latter. People also use fungi in a variety of ways, whether in bread-making or in the preparation of life-saving medicines. And lichen fungi are important indicator organisms for the quality of our environment. It is therefore important to know the species exactly, which is why there is a huge guessing game over the total number of fungi species on Earth. Estimates usually vary between half a million and ten million. Robert Lücking and his colleague Prof. David Hawksworth from London's Natural History Museum published a new projection in 2017 that is based on various sources. "It has been established that an average of ten new species are hidden behind a known fungus species", explains the BGBM researcher. Other empirical data indicates that on average around nine different fungal species coexist with each higher plant species. And, finally, there is a suspiciously high level of fungal DNA found in water and soil samples that nobody noticed because they do not produce fruiting bodies. When they factor all of that in, the two researchers get to a figure of 2.2 to 3.8 million species of fungi worldwide. "Over 90% of them are unknown to us.", says Robert Lücking. "And many of these unknowns are disappearing before we can find out anything about them."



The diatom *Iconella* sp. in the scanning electron microscope. This large diatom is typical of freshwater littoral zones. View of a whole cell. The siliceous cell wall is roughly sculpted with various outgrowths and spines. Among this group, the raphe – the locomotion structure of the diatoms – is located on a keel along the margin of the shell and runs once around the entire shell. Details of this structure can be seen on page 41.



The diatom *Thalassiosira* sp. in the scanning electron microscope. This medium-sized diatom is a typical representative of the brackish-marine plankton. View of a whole cell in valve view. The ring-like structure belongs to the valve mantle. The siliceous cell wall can be seen in the section on page 41.

Dr Jonas Zimmermann took over from Regine Jahn as head of the diatoms research group. He studied biology at the Freie Universität Berlin, wrote his thesis at the BGBM in the diatoms research group and earned his doctorate from the Justus-Liebig-Universität in Giessen in 2015 on the establishment of DNA barcoding and metabarcoding for diatoms. His main research interests are the integrative taxonomy of diatoms and the development and application of eDNA metabarcoding to the assessment of water quality using diatoms in the context of the EU Water Framework Directive.

The páramo habitat in the Andes in the hinterland of Bogotá: the yellow-flowering giant-rosette shrubs (*Espeletia* species from the daisy family) are a typical sight here and are known as "frailejones".

Humboldt 2.0

The Colombian-German project ColBioDiv examines the biological diversity of the South American country from many different viewpoints

Alexander von Humboldt might perhaps have managed it all on his own. After all, he is considered to be one of the last universal scholars in the history of science: a man who collected plants and examined volcanic rocks, took meteorological measurements and described the social conditions in other countries. "For him, it was quite normal to combine botany, geography and politics", says Prof. Marianne Braig from the Institute for Latin American Studies at the Freie Universität Berlin. "If we want to cover this same spectrum today, we need to call on at least six or seven different disciplines."

That doesn't make the research work any easier, but it does make it particularly exciting. Because every discipline has its own view of the world. And the more of these perspectives you include, the more mul-

ColBioDiv workshop in Bogotá, Colombia, in November 2017.

tifaceted a picture you get of a region. If you want to know more about the strongholds of biological diversity on Earth, you shouldn't just look at these areas through botanical glasses. And certainly not just through German ones.

The BGBM has therefore launched a number of international and interdisciplinary projects to explore these treasuries of biodiversity. "Understanding a natural region, however, takes a huge amount of time", stresses BGBM director Prof. Thomas Borsch. Which is why long-term collaborations with universities, botanical gardens and other institutions in the respective countries are very important.

Collaboration with Cuba, for example, has a tradition that goes back decades. But there are always new regional focuses. In 2012, a partnership was initiated between the BGBM and the botanical garden in the Colombian capital Bogotá, which has since spawned a large German-Colombian research network.

Scientists from both countries are now working together in the ColBioDiv (Integrated Biodiversity Management in Exemplar Regions of Colombia) project, which functions as something of a nucleus and which has also already started to facilitate other complementary projects. On the German side, there is central funding from the Federal Ministry of Education and Research (BMBF). In Colombia, various institutions with resources contribute to these activities, including the national research funder Colciencias, but also universities such as the Universidad del Norte in Baranquilla and the Jardín Botánico de

Group photo of the Colombian-German ColBioDiv research network at the Cátedra Europa event in Barranquilla, Colombia.

Bogotá. From Germany, the BGBM, the Institute for Latin American Studies and the Institute of Geographical Sciences of the Freie Universität Berlin are involved, from Colombia the Jardín Botánico de Bogotá, universities such as the Universidad del Norte and the Universidad del Rosario, and the Instituto Alexander von Humboldt, Colombia's biodiversity institute. Together, the participants are keen to find out how nature and humans influence the biological diversity of this South American country.

"This is particularly valuable because Colombia's biodiversity is still far from being fully recorded", says project coordinator Dr Grischa Brokamp from the BGBM. Anyone who stumbles across an unknown plant in Germany usually has a good chance of identifying it with the help of a standard field guide. For Colombia, however, such literature only currently exists in rudimentary form; no one has a complete overview of what species there are and where they grow. "Fifty years of civil war haven't of course improved this situation", says Prof. Marcela Celis from the Universidad del Norte, who heads the research programme on the Colombian side. "But the peace process now offers us an opportunity to get to know the flora of the country better."

This is particularly important now because, with the end of the fighting, the pressure on many landscapes has grown. Agriculture and other land uses are expanding into new areas, increasing the risk that species will disappear before science has even taken note of them. That is why the ColBioDiv team is working to better understand the biodiversity of Colombia and to identify the reasons and factors that, on the one hand, lead to biodiversity loss and, on the other, enable sustainable management of ecosystems.

The first job, however, is to gather the requisite basic knowledge. To achieve this, the researchers are concentrating on two sample regions. One includes the area around Bogotá and the remaining Andean for-

Biodiversity research requires close international cooperation. Colombian and German researchers during a workshop on land use and land-use change in the Atlántico department (Colombian Caribbean) during the Cátedra Europa meeting at the Universidad del Norte in Barranquilla (from left to right: M.C. Martínez-Habibe, B. Salgado-Negret, O. Rojas, T. Borsch, B. Moncada).

ests. The other is in the north of the country on the Caribbean coast and centres on the tropical dry forest around the city of Barranquilla.

"The botanists in our project first have to determine which plants and fungi are found where", say Dr Robert Lücking from the BGBM and Dr Bibiana Moncada from the Universidad Distrital in Colombia, who have already discovered several new species of lichen in the sampling plots. In order to get a better understanding of species boundaries, selected groups of plants are also examined using molecular methods, for example the willow relatives of the genus *Casearia* or the tropical relatives of the caper in the genus *Capparidastrum*. In the hinterland of Bogotá, they also recorded all trees with a trunk diameter of more than five centimetres on more than 30 sampling plots measuring 20 by 20 metres, but also identified lianas and herbs. The doctoral student Mariasole Calbi from the BGBM and the early-stage researcher Francisco Fajardo from the Jardín Botánico de Bogotá worked here on large datasets over a period of several months and were able to show that there are six different types of Andean mountain forest in the region around Bogotá, which are distinct from one another in their species spectrum and in their ecology. "In the long term, we want to find out what impact human activity has on the structure of such ecosystems", explains Thomas Borsch.

The geographers in the project are also interested in how humans leave their mark on the landscape and what consequences this has. To help them in this quest, the team led by Prof. Brigitta Schütt from the Institute of Geographical Sciences at the Freie Universität Berlin relies, among other things, on the view from space. Because satellite images can tell you a lot about how the landscape has changed through use and how sensitive it is. Remote sensing data from 1987 to 2017 reveals many changes in vegetation cover in the hinterland of Barranquilla during this period. Forests have disappeared, grown up again,

Lino Olivares is one of the most knowledgeable and passionate experts on the flora of the Colombian Caribbean's dry forests and has played an active role in the EcoSecos initiative and other conservation efforts in the region for about 20 years.

and perhaps been reshaped by cattle grazing. "Since 2001 the forested areas in the region have increased in size again", says Marcela Celis. "But we should be asking ourselves about the quality of the forest." Will a once deforested area be as rich in species as before? And does it provide the same ecological benefits? Oscar Rojas, doctoral student at the Universidad del Norte, is looking into the question of whether there is regeneration potential from seeds that are still present in the soil. The answers to such questions are not only valuable for nature conservation, but above all for the local people. "If the vegetation is damaged, the risk of landslides increases", explains Thomas Borsch. "We are keen to find out how land use can be improved."

Marianne Braig and her team from the Latin America Institute are particularly interested in the political and social aspects of biological diversity. "We look at the people in the particular region and examine how urban and rural life is changing", explains the political scientist. Many wealthy families from Barranquilla have built their houses 50 to 80 kilometres outside the city – in the very region where farmers also graze their cattle. "We witness the meeting of a wide variety of lifestyles, which have to do on the one hand with the gentrification of peri-urban rural areas and on the other with new forms of production that are in tension with one another and always come into conflict with nature conservation", says Marianne Braig. "We want to know what is changing as a result of these diverse urbanisation processes and what consequences this has for land use."

In this way, each of the participating disciplines contributes its own mosaic pieces to the colourful picture of Colombia's biological diversity. For Grischa Brokamp, who coordinates the activities of three disciplines and two nationalities, this involves a huge amount of organisational work. As he knows from experience, "The idea that you might achieve something together doesn't just happen." But it's worth the effort. And in his opinion there's no alternative to it anyway: "Today we are facing global problems that can only be solved through collaboration."

Dr Grischa Brokamp relies heavily on his extensive experience of South America. Indeed, the biologist has been coordinating the joint biodiversity research projects with Colombia since 2015. It is particularly important, in such an endeavour, to bring the various institutes and specialist disciplines together under a single umbrella and to support close contact between the different partners in Germany and Colombia. The central project is currently "Integrated Biodiversity Management in Exemplar Regions of Colombia" (ColBioDiv), which is funded by the German Federal Ministry of Education and Research. Grischa Brokamp is also the relevant contact person for visiting scientists from Colombia at the BGBM. His own research interests include the human impact on tropical forests and the question of how plant resources can be conserved and used sustainably.

Prof. Marcela Celis is a professor of biology at the Universidad del Norte (UNO) in Barranquilla, the largest city in the Colombian Caribbean. Her principal research interests include the systematics and taxonomy of flowering plants and the biodiversity of Colombia. She has worked on the checklist of Colombia's vascular plants and been involved in setting up and cataloguing herbaria, for example at the Instituto Humboldt, the Jardín Botánico de Bogotá and the Universidad del Norte. She is currently curator of the Herbario UNO, which is being rebuilt at the Universidad del Norte, and coordinates the research activities of the Colombian partners in the bi-national research project ColBioDiv.

View of the Gumbashi Pass in the North Caucasus.

Between East and West
Recording and understanding the plant diversity of the Caucasus

The Caucasus boasts spectacular landscapes and an unusually rich flora and fauna. This is partly because the mountainous region between the Black and Caspian Seas offers a huge range of habitats catering to the widest variety of needs. The Greater Caucasus, its peaks more than 5,000 metres high, rises up in the north with its glaciers, mountain meadows and forests. By contrast, forests and meadows on gentle hills are typical of the Lesser Caucasus in the south. On the Black Sea lies the rainy Colchis region, where numerous plants survived the last ice age thanks to its favourable climate and where dense forests thrive. And a similar history is shared by the Hyrcanian Forests on the southern shore of the Caspian Sea – both forest regions are home to a large number of different trees and shrubs, some of them with ancestors from subtropical climates. Open steppes characterise the drier, continental landscapes in the east, which then continue on the other side of the Caspian Sea across huge swathes of Southwest and Central Asia. So it's no wonder, then, that the Caucasus ecoregion is considered to be one of the great treasuries of global biodiversity. In an area covering 580,000 square kilometres – approximately one and a half times the size of Germany – there are an estimated 6,300 vascular plant spe-

The wild pear species *Pyrus demetrii* in Georgia.

cies. And the flora of the Caucasus doesn't by any means consist solely of common-or-garden plants: around a quarter of the vascular plants there, such as the Caucasian rhododendron (*Rhododendron caucasicum*) or the Caucasian scabious (*Lomelosia caucasica*), are endemics – species that do not occur anywhere else on Earth.

This fascinating region has long been an exciting field of activity for botanists. Good relationships had already been forged there in the days of Adolf Engler, who, as director of the Berlin Botanic Garden at the end of the nineteenth century, significantly advanced research into global plant diversity. And these relationships were revived after the fall of the Iron Curtain.

"If we want to understand the flora of the Caucasus, we must if possible investigate the entire region", stresses BGBM director Prof. Thomas Borsch. The Berlin team therefore works with research institutions from the Russian Federation as well as from Armenia, Azerbaijan and Georgia. "In 2009, together with partners in the region, we launched the Caucasus Plant Biodiversity Initiative", says the BGBM director. This provides the framework for projects that aim to research the plant diversity of the Caucasus, promoting scientific exchange and capacities in the countries there and making knowledge available for the protection and sustainable use of Caucasian biodiversity.

With the support of the Volkswagen Foundation (VolkswagenStiftung), we were able, starting in 2012, to implement the two-phase project "Developing Tools for Conserving the Plant Diversity of the South Caucasus". Participating in the project were: the Takhtajan Institute of Botany and the Orbeli Institute of Physiology of the National Academy of Sciences of the Republic of Armenia, Yerevan; the Institute of Botany of the Azerbaijan National Academy of Sciences and the Central Botanical Garden, Baku, Azerbaijan; the Botanical Institute of the Ilia State University and the National Botanical Garden, Tbilisi, Georgia; the Botanical Garden, Batumi, Georgia; and the Georgian National Museum, Tbilisi. The final workshop took place in Berlin in November 2019.

This project initially focused on investigating – as models – selected multi-species Caucasian plant groups. The choice fell on the lichens and bellflowers, as well as the daisy, mint and carnation families and the wild pear (rose family). Wild pears also play an important role as relatives of cultivated plants – particularly since many of the wild species are adapted to dry and warm environmental conditions. Preserving

them could therefore be of very practical importance for the future cultivation of common pears in these times of climate change.

"For the wild pears of the genus *Pyrus*, the Caucasus is seen as an absolute hotspot worldwide", says Dr Nadja Korotkova, who researched this model group as part of the Caucasus project at the BGBM. Depending on the source, 30 to 50 different types of pear have been described for the region. However, it is unclear exactly where the species boundaries lie. Because in the last 150 years botanists have classified the pear family according to different criteria: at times the focus has been mainly on the appearance of the leaves, while at others attention has been drawn instead to the characteristics of the fruits. "Today, on the other hand, we can take a detailed look at the genome of species from the Caucasus and then compare it with that of relatives in other regions of Europe and Asia", explains Thomas Borsch. This enables us to find out which species exist in the first place, how they are related to one another, and when their evolutionary lines separated.

The problem, however, is that wild pear diversification only began to gather momentum from the Pliocene (about 5 million years ago). In the grand scheme of evolution, that's the blink of an eye. But this means that the individual species are still very similar genetically. "It is therefore very hard to reconstruct their evolutionary history using the usual genetic markers", says Nadja Korotkova. So, in addition to various genes from the cell nucleus, the project team members also went on to analyse the complete DNA sequences of the chloroplasts.

These tiny, green cell organs are responsible for photosynthesis in the leaves and have their own genetic material. This can be used to explore in great detail the genetic similarities and differences of various pear trees and thus construct well-resolved family trees, in which the splitting of the species over time can be precisely calculated using a molecular clock. The latest methods for sequencing and bioinformatic analysis of complete plastid genomes are used here – work that is the domain of project member Dr Michael Grünstäudl, an early-stage researcher and post-doctoral candidate in the Department of Biology, Chemistry and Pharmacy at the Freie Universität Berlin. Candidates on biology courses in both the Caucasus countries and Germany benefit from this in their academic training. Of course, it's not just about looking into the history of pears. The plants studied are as diverse as the nature of the Caucasus itself. In the meantime, project member Dr Rashad Salimov from the Institute of Botany at the Azerbaijan National Academy of Sciences is on the trail of the secrets of the skullcap genus (*Scutellaria*, members of the mint family), many endemic species of which are found in the Caucasus. As part of her doctoral thesis, Nana Silakadze from Georgia is doing research into a species group of bellflowers (*Campanula*) that occur above the tree line in the higher altitudes of the Caucasus, and Dr Anush Nersesyan from the National Academy of Sciences of the Republic of Armenia works on the carnation genus (*Dianthus*). By comparing gene sequences with the other bellflower and carnation species from Europe and Asia, decisive new insights could be gained into the origin and evolution of the Caucasian endemics. The phylogenetic analysis of the genus *Jurinea* (members of the daisy family), which in addition to the Caucasus has a particular centre of diversity in Central Asia, showed that the Caucasian species belong to four different evolutionary lines, one of them with many endemics in the North Caucasus. The analysis was carried out by Dr Eckhard von Raab-Straube from the BGBM, together with Dr Alexander Sennikov from the Komarov Botanical Institute in St Petersburg, Prof. Svetlana Livinskaya from the Kuban State University in Krasnodar and Prof. Georgy Lazkov from the Kyrgyz Academy of Sciences, Bishkek. From this analysis, a basic pattern emerges: plant migrations between East and West for several million years and subsequent speciation in the particular habitats of the mountains had a major influence on the emergence of biodiversity in the Caucasus. Elmira Maharramova from Azerbaijan wrote her doctoral thesis on the biogeography and genetic diversity of typically Caucasian tree species such as the Caucasian walnut (*Pterocarya fraxinifolia*) and the Caucasian elm (*Zelkova carpinifolia*). The results are also of great practical importance for the management and conservation of these silvicultural genetic resources.

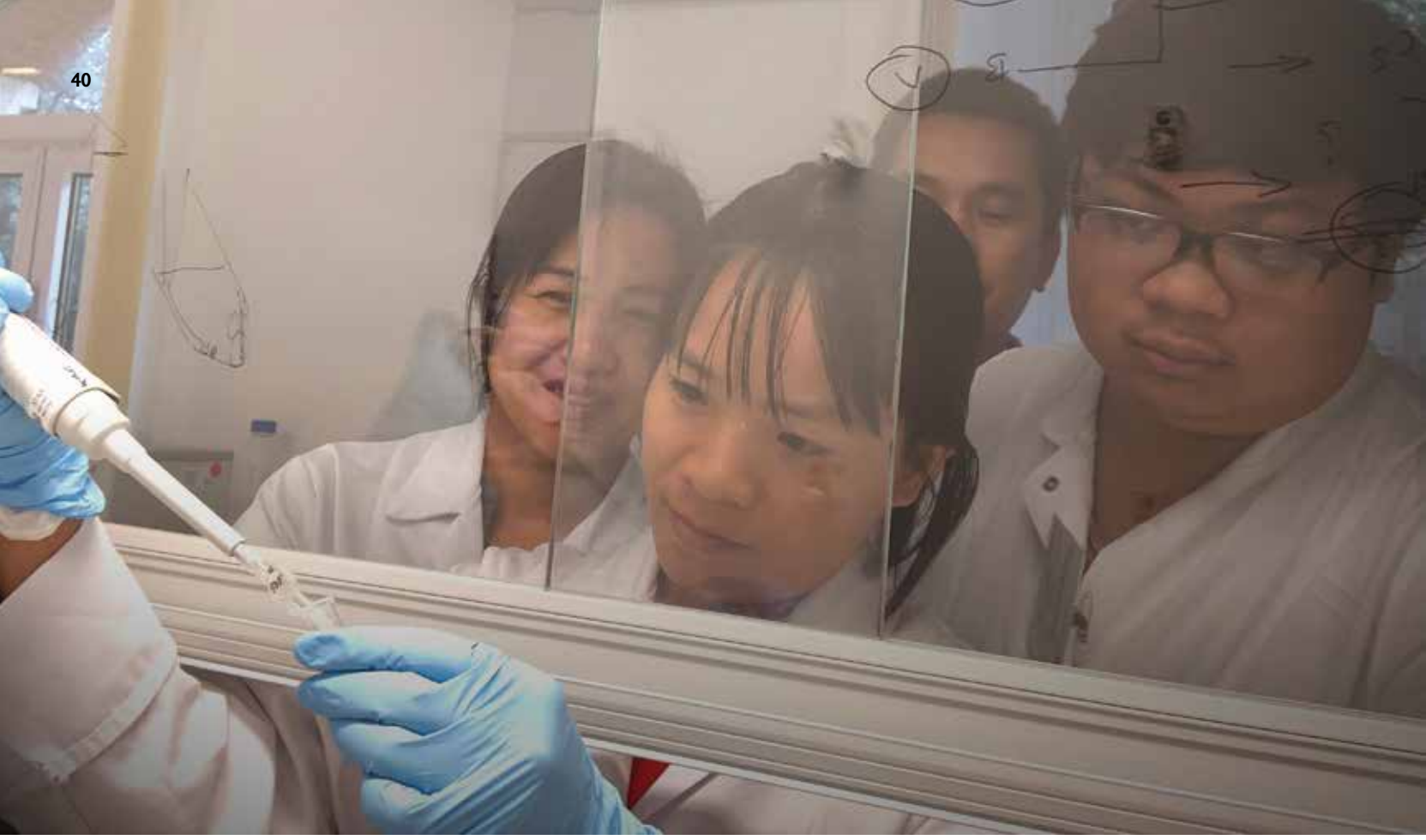
It is often the case that the smaller the organisms, the more new discoveries there are to be made. As part of his doctoral thesis, Arsen Gasparyan identified, in a first for the country, 196 species of lichens for Armenia alone – including four species that, with assistance from the BGBM's lichen specialists, Dr Robert Lücking and Dr Harrie Sipman, were described as new to science.

The explicit goals of the Caucasus partnership include not only the communication and establishment of modern research methods, but also the development of molecular laboratory capacities and the setting-up of collections such as herbaria or documented living plants in botanical gardens. On countless joint excursions throughout the Caucasus region over the past ten years, thousands of samples have been collected and deposited in the collections of the Caucasus countries as well as at the BGBM. The support of the Volkswagen Foundation has also made it possible to improve technical capacities in Armenia, Azerbaijan and Georgia and to make a start on the digitisation of herbarium specimens, especially in the model groups examined. In addition, a database infrastructure was established that simplifies the exchange of data between the herbaria and facilitates the backflow of information – such as new identification results – into the collections. As a further achievement, this biodiversity data is fed directly from the herbaria into the Global Biodiversity Information Facility (GBIF), enabling the participating institutions in Armenia, Azerbaijan and Georgia

Scientists from Armenia, Azerbaijan and Georgia, as well as the BGBM, at the final status seminar of the project "Developing tools for conserving the plant diversity of the South Caucasus", which took place from 11 to 15 November 2019 at the BGBM.

to take part directly in global biodiversity programmes. Herbaria are of great importance as sources of information for the occurrence of a plant in a certain place and at a certain time – and they are sources of high-quality biodiversity information, since the species-identification of objects can be checked at any time. The team therefore aims in future to drive forward the digitisation of the herbaria at the institutions in the Caucasus and to network with the databases of other important collections such as those in the Russian Federation. In the same way, the Caucasian collections in the Botanic Garden and Botanical Museum Berlin – the most comprehensive from the region in Germany – will also be digitised and made available. On the basis of this, it should be possible to create, among other things, detailed distribution maps for the species.

Such insights are particularly important for nature conservation. Because if you want to preserve and use the unique plant diversity of the Caucasus, you first have to get an overview: Which species are there to begin with? And where do they occur? Which of them are threatened and in what way? And what can be done about it? There is still insufficient data to be able to make informed statements. The commitment of the BGBM and its partner organisations within the framework of the joint Caucasus initiative will therefore be continuing in the coming years. Specifically, a constantly updated, generally available online catalogue of the entire plant diversity of the Caucasus is due to be created, which is also synchronised with international infrastructures for biodiversity information such as the Euro+Med PlantBase and the World Flora Online. A treasure trove of biodiversity in digital form.



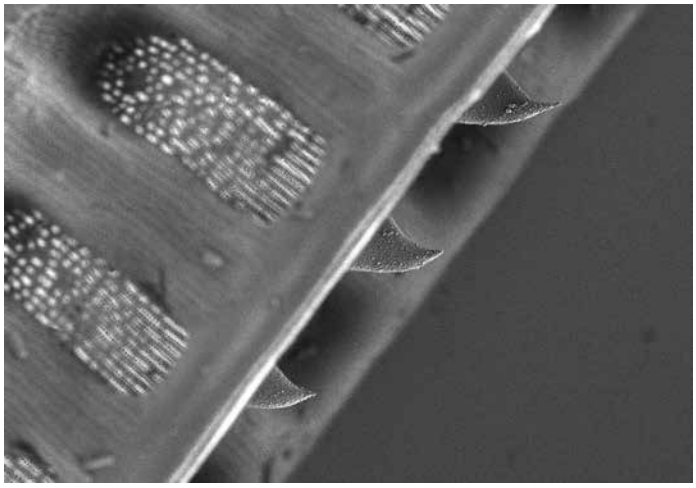
Visiting Vietnamese scientists carry out investigations in the BGBM laboratory during the VIETBIO fungal sampling training session in September 2019 (Lücking R. et al.: Caveats of fungal barcoding: a case study in *Trametes* s.lat. (*Basidiomycota*: *Polyporales*) in Vietnam reveals multiple issues with mislabelled reference sequences and calls for third-party annotations. – Willdenowia 50: 383–403. doi: https://doi.org/10.3372/wi.50.50302).

At the service of science

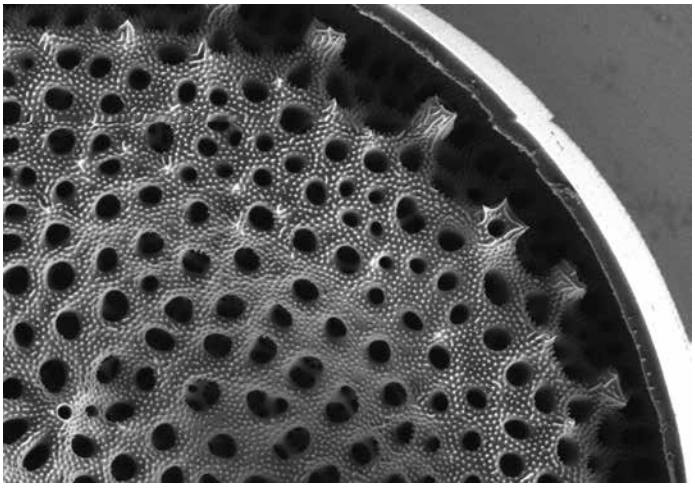
The Department of Administration and Scientific Services creates the conditions for successful research

Sometimes they look like tiny biscuit barrels, or microscopic boats, stars or jewels. Juliane Bettig's work very often gives her aesthetic pleasure too. When she examines the glassy shells of diatoms under the electron microscope, she sees an amazing variety of miniature works of art. "The shells themselves are tiny, but the details on them are smaller still", says the BGBM laboratory technician. "And here we can reveal even those tiny details. It's completely fascinating, a bit like magic."

Regardless of this, the Department of Administration and Scientific Services sees itself as "a team of service providers with a strong focus on service", says the head of department, Sylke Gottwald. As well as the laboratory services, the department includes the general administration, IT and project support units. All these people are working to keep the research work going, day by day. They look after the infrastructure and create the necessary environment without which scientific activity would be impossible.



The diatom *Iconella* sp., magnified 5,000 times by the scanning electron microscope. Section from a part of the silica shell with a spiny edge and a raphe (seam) on a keel with window-like openings. The whole cell can be seen on page 29.



The diatom *Thalassiosira* sp., magnified 11,000 times by the scanning electron microscope. Details of the cell wall, sculpted by wart-like surface structures, strutted processes and areoles (openings). The lightweight construction prevents its sinking in the water column and allows material exchange with the surrounding water. The whole cell can be seen on page 29.

The diatoms research group is totally reliant on electron microscope images. A typical diatom might be one hundredth of a millimetre in size, or even smaller. Yet the scientists are not just looking at its external shape. They even examine all the pores on its surface, the notches and ribs, points and barbs which often indicate the difference between two species.

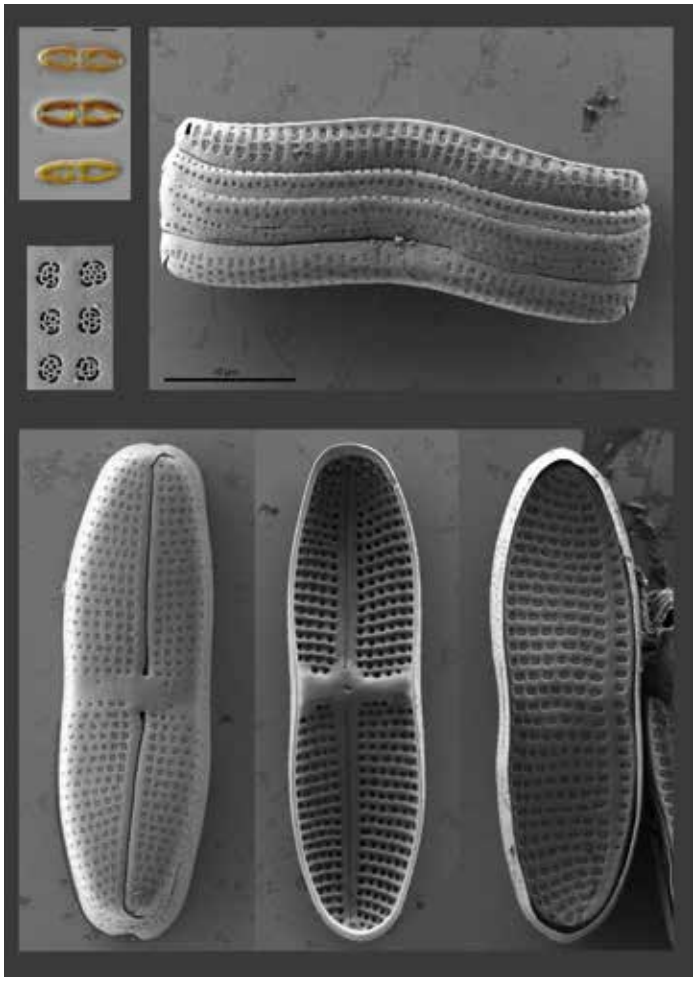
This work is made possible by a high-definition field emission scanning electron microscope, an instrument that is not yet widely used in research. "This is the only one of its kind in Berlin available for botanic research", according to Kim Govers, head of laboratories at the BGBM. The most frequently viewed objects, in addition to diatoms, include pollen and the surfaces of leaves.

If, for example, the diatom team brings back a sample from a water source, Juliane Bettig must first prepare that sample. "We dissolve the cell content, leaving just the shells", explains the laboratory technician. These shells are then set out on a plate and placed in the microscope's high vacuum chamber. A closely bundled beam of electrons scans the individual objects. They bounce off the irregularities on the surface, knocking off further electrons with a range of energies, which are recorded by detectors and transformed into a 3D-like black-and-white image. After about an hour's work, Juliane Bettig can finally see on her screen all the fine raised areas and holes, every curve and shadow of the silica shells. The 150,000-180,000x magnification reveals works of art with details smaller than a thousandth of a millimetre.

"Our equipment needs only 1,000 volts to produce such impressive results", says head of laboratories Kim Govers. Earlier models needed 30,000 volts, which radically speeded up the electrons. The surplus energy had to be conducted away so that the image quality did not suffer. "That meant we had to spray the objects with gold or platinum, to make them conductive", explains Kim Govers. This practice, still usual for other electron microscopes, is now no longer necessary in the BGBM laboratory. One wonderful side effect of this is that the tiny structures of the shells are now visible, and no longer covered over.

This modern equipment, however, is still vulnerable to external disturbances. For this reason, the scanning electron microscope is on the ground floor of the Botanical Museum, in a room built like a Faraday cage: it screens out magnetic fields which could otherwise influence the measurements.

The BGBM laboratory work is carried out in close coordination with the Systematic Botany and Geography of Plants working group, part of the Department of Biology, Chemistry and Pharmacy, and based in the Altensteinstraße, very close to the Botanical Museum. The labs are organised accordingly: instead of individual rooms and equipment for each team, there are joint facilities that can be used by both parts of the

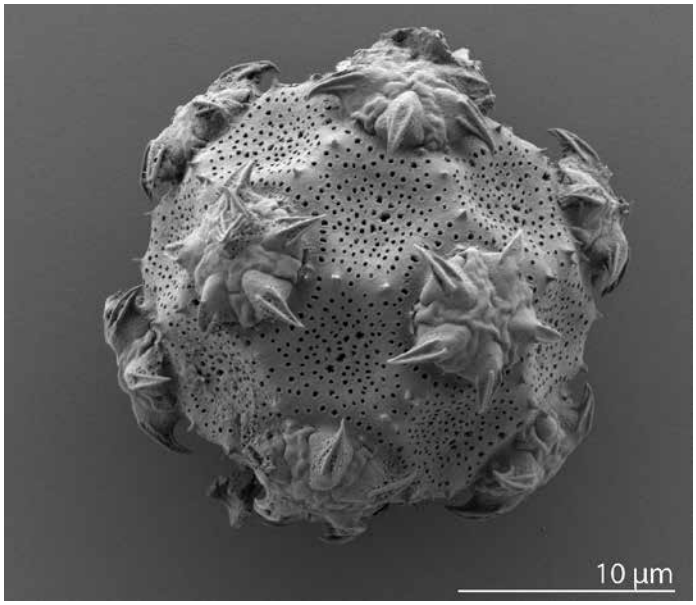


Various views of the diatom *Achnanthes* sp. This medium-sized diatom is typical of brackish water. Top left: three living cells with chloroplasts seen through the light microscope. Seen through the scanning electron microscope: top right: side view of the diatom with girdle bands that hold the valves (shells) together. Bottom left: external view of the raphe valve, with magnified section above. Centre: internal view of the raphe valve. Right: internal view of the rapheless valve. Scale 10 µm.

University. Eight colleagues from laboratory services keep everything running and make sure that all the investigations meet set standards. They are responsible for occupational safety, ordering laboratory supplies, instructing visiting scientists from Germany and abroad in the use of the equipment, and for the entire organisation of the laboratories. In this 450-square-metre area, they operate not only the electron microscope, but also modern equipment for DNA analysis.

Since 2009, the Freie Universität Berlin (the Department of Biology, Chemistry and Pharmacy and the Department of Mathematics and Computer Science) and the BGBM have been part of a consortium, the Berlin Center for Genomics in Biodiversity Research (BeGenDiv). This consortium also includes three Leibniz institutes (the Institute for Zoo and Wildlife Research, the Institute of Freshwater Ecology and Inland Fisheries and the Museum für Naturkunde [Museum of Natural History] Berlin), as well as some departments of the University of Potsdam. The consortium is based at the BGBM and pools expertise in the field of genomics, i.e. investigation into an organism's DNA, in the context of biodiversity and evolution research. High-throughput sequencing is used in the laboratories for this purpose, taking mostly short, overlapping DNA snippets, which are sequenced to reconstruct a species' genetic material. "In principle it's as if you had ten copies of the same book, but all had disintegrated into sections of just a few pages each", explains Kim Govers. "And our job is to reconstruct the whole text from these fragments". The BGBM labs also offer exceptional facilities and equipment for this molecular-biological puzzle work.

However, a well-equipped workplace is not the only key factor in successful research work. Nine people working in the general administration unit therefore provide a wide range of background services. They are responsible for human resources and internal organisation, the budget and procurement, official trips and contracts. "We provide services for 29 different groups of people", explains Carola Andersen, deputy head of administration at the BGBM. All sorts of details and



Pollen grain from an amaranth of the genus *Centemopsis*. When magnified 3,000 times by the scanning electron microscope, the grain can be analysed precisely for pollen characteristics.

Kim Govers is a laboratory engineer. Born in the Netherlands, he worked in various laboratories, in research and development and quality control, before arriving at the BGBM in 2008. Here he manages the laboratories. He is supported by a team of technical assistants, specialising in a whole range of procedures and methods, from electron microscopy to next-generation sequencing: a comprehensive environment for the production of scientific data. Around 65 people are currently working in the laboratories on their own research projects.

particularities need to be borne in mind. Scientists, for example, need a different type of contract from postgraduate students and, again, from volunteers.

In 2017 and 2018, the administrative team was faced with a particularly complex task. In April 2007, following cuts, an individual operating company took over some activities at the BGBM. It provided support with infrastructure-related, technical and gardening tasks. Now, however, the BGBM is one of the few cases where this controversial outsourcing is being reversed. The operating company stopped its work at the end of 2017, after which all its staff were taken on by the Freie Universität Berlin as employees. On 1 January 2018, a separate Department of Garden Management was set up at the BGBM, employing these 96 people. This meant a lot of work for the BGBM general administration, and for the central administration of the Freie Universität Berlin. “The process of reintegrating these staff members was quite complicated, and will continue to keep us busy for a while”, says Carola Andersen. “But everyone was pleased that they will be working for a unified BGBM again.”

Laboratory equipment at the BGBM

The laboratory services at the BGBM offer a state-of-the-art workflow-based working environment for research projects on the evolution, diversity and classification of plants, lichens and diatoms. There are 14 laboratory spaces, in which the high-definition field emission scanning electron microscope is the most technically advanced equipment. The laboratories also have several stereo microscopes with high-definition cameras. Other interesting pieces of equipment include an automated critical point drier (CPD) to prepare samples for scanning electron microscopy, a fragment analyser for quality control of the DNA samples, and several thermocyclers for PCR (polymerase chain reaction)-based analyses. A number of high-throughput sequencing methods are also used to research genetic information.

"Berlin's longest windowsill", in the exhibition *Loved, Watered, Forgotten: The Houseplant Phenomenon*, 7 December 2018 – 29 June 2019 at the Botanical Museum Berlin.

A research museum

The Botanical Museum is not just a place for exhibitions, but also for cultural history research

If we are to believe an ancient Mexican legend, then plants were originally a gift from the gods. A long time ago, the god Centeotl sank into the Earth. From his hair grew cotton and from his nose grew sage; his fingers grew into sweet potatoes and maize grew from his nails. Today these remain valuable gifts for people around the world. Mexico still has all sorts of other botanical treasures to offer, which are also investigated by botanists from Berlin. These treasures were shown at the Botanical Museum between May 2017 and February 2018, in the exhibition *Chilli and Chocolate: The Taste of Mexico*.

"The most fascinating thing about Mexican plants is their unusual variety", says Kathrin Grotz, in charge of exhibitions at the BGBM for many years. In this mountainous country between the Atlantic and the Pacific, species from the temperate latitudes of North America coexist with the

Views from the exhibition *Loved, Watered, Forgotten: The Houseplant Phenomenon.*

tropical flora of the South. The country also contains other extremely varied habitats, from bone-dry deserts to tropical rainforests. The high mountain ranges that isolate the various regions from each other have also turned Mexico into a particularly productive laboratory for investigating plant evolution.

In Mexico alone, for example, there are 120 species of pine, more than in any other country in the world. In forests at an altitude of between 1,300 and 2,400 metres grow one third of all the 900 known species of sage in the world. There are also nearly 700 different cactus species, most of which are found nowhere else on Earth. Botanists have, to date, counted around 30,000 plant species over the whole country – about three times as many as in Central Europe. "This means that Mexico is one of the five countries in the world with the most species, and also a particularly interesting research topic at the Botanic Garden", explains Dr Patricia Rahemipour, who, until 2019, was head of the Botanical Museum and the BGBM's Department of Science Communication.

From this large treasure trove of species, people, over thousands of years, have grown a very wide range of crops. According to Kathrin Grotz, this was an inevitable process: "This biodiversity hotspot finally became a hotspot of tastes." Culinary favourites, then, such as tomatoes and beans, chilli and avocados, vanilla and agave spirit, are all originally from Mexico. Many popular ornamental plants, such as dahlias, poinsettias and marigolds also originated in the country.

But many other regions of the world have also given us popular green companions for our houses and flats. Another exhibition at the Bo-

Visitors to the exhibition *Zenkeri: Photographs by Yana Wernicke & Jonas Feige*, 11 October 2018 – 6 January 2019 at the Botanical Museum Berlin.

tanical Museum, which opened in December 2018, focused on these neighbours on our windowsills. This exhibition – *Loved, Watered, Forgotten: The Houseplant Phenomenon* – lured the public into the world of houseplants, an area up to now generally neglected by cultural history. The curators Kathrin Grotz and Patricia Rahemipour, therefore, had first to identify the milestones in the history of houseplants, and then incorporate their findings into the exhibition. On Berlin's longest windowsill – about 100 metres long – visitors could admire 50 typical species. They could learn where these plants originally came from and which conditions they prefer, as well as the eventful history of people's co-habitation with plants.

The choice of species in our windows, over the years, has not just been determined by fashion. "People also first had to be able to create the right technical conditions to grow a plant successfully in their home", explains Kathrin Grotz. The sticking point was often temperature. Nineteenth-century homes, heated by tiled stoves, were usually so cold that only plants from moderate climates or the subtropics could flourish: 10–15 degrees is the perfect temperature for African hemp (*Sparrmannia africana*) or cyclamen, for example, and ferns too were more popular at the time. Tropical orchids and other heat-loving species, however, only took root in our homes with the arrival, in the twentieth century, of central heating.

Currently, indoor greenery seems to be right back in fashion. Using the buzzword "urban jungle", numerous magazines and internet sites encourage people to bring more green things back into their homes or offices – and not only for aesthetic reasons. "Plants can have a very strong psychological effect", says Patricia Rahemipour. At work they are said not only to be calming, but also to spur creativity and even increase contentment with one's boss. Surprisingly, these effects seem to work even on people who describe themselves as plant-haters. "This

could be a consequence of the shared evolutionary history of people and plants", says Kathrin Grotz. "Our ancestors may have lived so long in a plant-dominated environment that this predilection is rooted deep in our brains". So anyone who visited the houseplant exhibition discovered not just something about the history of our green companions, but also about our own history.

Research in the run-up to an exhibition is not the only scientific work done by the Botanical Museum. The museum is also a key player in cultural history research – together with many other museums and collections in Berlin. In 2015, eleven of these institutions joined together, at the initiative of the BGBM, to create the association "KOSMOS Berlin: Forschungsperspektive Sammlungen" ("KOSMOS Berlin: Collections Research Perspectives"). Their input is as varied as the city itself. It includes ethnographic objects and herbarium records, travel diaries and recordings, even historical medical equipment and stuffed animals. Yet the members of the network all share the same goal: to use their collections to write a history of Berlin. In this task, an interdisciplinary approach to the collections is essential. "Within the network, we organise regular meetings rather like salons, where we discuss possible joint research projects. Some good proposals have already emerged from this process, which we're working on further in small groups", says Patricia Rahemipour.

One of the most recent KOSMOS Berlin projects is a new series of publications on the history of Berlin collections, published by the BGBM's own publishing house, BGBM Press. The autumn of 2018 saw the publication of the first volume, *Bipindi – Berlin*. In it, the historian Katja Kaiser painted a portrait of the collector Georg August Zenker: a colonial official and later plantation owner who, at the turn of the twentieth century, collected countless plants and animals, as well as amulets, dance-rattles and other interesting ethnological objects from the then

View of the exhibition *Chilli and Chocolate: The Taste of Mexico*, 5 May 2017 – 25 February 2018 at the Botanical Museum Berlin.

German colony Cameroon, and sent them to three Berlin institutions: the Botanic Garden, the Ethnological Museum and the Museum für Naturkunde (Museum of Natural History).

In the remote town of Bipindi, in the middle of the Cameroon jungle, descendants of Zenker and his five wives still live in his former house. "Some are very proud of their ancestor, while others are more critical. Both attitudes show clearly that the colonial period still has a strong influence, and that the cultural assets in the collections, as well as the colonial past of the Botanic Garden, must be urgently and thoroughly investigated. This cannot be done by just one institution, but must also be done jointly. KOSMOS Berlin and the new series are the place to do this, as well as being the start of the whole process", says Patricia Rahemipour. The Berlin photographers Yana Wernicke and Jonas Feige have visited Zenker's family in Cameroon several times, and have photographed them. Their pictures could be seen between October 2018 and January 2019 in the *Zenkeri* exhibition at the Botanical Museum, and some were also included in the book *Bipindi – Berlin*.

Scientists from various disciplines have all pulled together to shed light on this colonial collector, from a whole range of perspectives. "This process made it clear that the colonial period is still very topical for the families in Cameroon", says Patricia Rahemipour. Zenker's legacy consists not only in the objects he collected, now kept in the Botanical Museum, the Museum für Naturkunde and the Ethnological Museum in Berlin. It is also part of colonial history, which still has an impact today and which we are only now beginning to process.

Altar to the dead (*ofrenda*) from the exhibition *Chilli and Chocolate: The Taste of Mexico*.

Since 2010, **Kathrin Grotz** has been in charge of the exhibitions/museum at the BGBM. In addition to designing and organising exhibitions, her tasks include curating the unique collection of plant models. As a trained historian, she always focuses, in the exhibitions she curates, on topics to do with the history of science and institutions. Her research interests also include the historico-cultural significance of plants, the history of botanical collections and the role of models in biology teaching.

Herbonauts' workshop at the 2017 "Long Night of the Sciences".

Hands-on science

Through citizen science projects, anyone interested can contribute to BGBM research

The man was a doctor. You can tell from his handwriting, which is just as illegible as all the clichés suggest. 150 years ago, August Leopold von Reuss carefully collected plants, pressed them, glued them on sheets of paper and labelled them. By doing so, he left a valuable legacy for today's BGBM scientists, which they can use in their own work. But first they need to be able to decipher the energetically squiggly words, and that's often a difficult and very time-consuming task.

The same problem exists for many other pressed plants stored at the BGBM. The huge collection contains about 3.8 million sheets of paper in all, labelled with the name of the species and the collector, the place where the plant was found, and many other details. To be able to use this important information properly to answer all sorts of research questions, it must be fed into a database – a mammoth task, which the BGBM team could never manage by itself. But through the citizen science project "Herbonauts", around 500 committed co-warriors have already been found to edit the scanned-in herbarium specimens on various topics. They have already, for example, followed in the virtual footsteps of Alexander von Humboldt as he travelled through South America, worked with mosses or immersed themselves in the world of carnivorous plants.

In June 2018, three generations gathered around a table at the story-telling picnic in the aquatic plants garden.

"The idea for this project originally came from the Natural History Museum in Paris", says information scientist Anton Güntsch, who set up the Herbonauts project at the BGBM. "I didn't expect too much from it at first, but now we're enthusiastic about its success". For it did not take long to find interested individuals, aspiring detectives willing to dive into investigations, decipher old scripts or translate cryptic or out-of-date location details into up-to-date GPS coordinates.

BGBM project leader Agnes Kirchhoff has been impressed by the commitment shown by the herbonauts: "These people read the diaries of nineteenth-century collectors, have internet discussions about possible finding places, and swap tips on how to decipher difficult writing", says the scientist. In her view, citizen science projects have huge potential. And in the future, the BGBM wants to use this valuable tool in other research projects. "We don't want this to be a one-sided thing, where we just tell people what to do", explains Agnes Kirchhoff. "They are more than welcome to contribute their own ideas and research questions".

This approach has already been used in "Big Picnic", an EU project coordinated by the association Botanic Gardens Conservation International (BGCI). Together with specialists from the Botanic Garden and other institutions, citizens in various countries have tackled the topic of food security. The aim of the three-year project was to explain to a wider public the importance of food security for the future of society. "Co-creation teams" developed models for doing this. At the BGBM a mobile stop-motion film studio was developed, which school classes can borrow. The loan includes a delivery bicycle to transport the studio through the city in a fully environmentally friendly way. Using the tablets, tripods and information material delivered, the students can make animated films on the topic of food waste. The only condition is that the films must be made available to a broader public on a YouTube channel.

Also as part of the Big Picnic, the BGBM has organised science cafés looking, for example, at how to preserve foodstuffs. At the story-telling picnic in the aquatic plants garden, people who lived through the post-war hunger years spoke of those times, and in return got to hear which food-related issues are of concern to younger generations. The Big Picnic too, then, brought together very different perspectives – and that's what makes citizen science projects so exciting.

Until the 1960s, the corncockle (*Agrostemma githago*) was a common wildflower. Today it is threatened with extinction and on Germany's Red List of endangered plants. To draw attention to the important contribution that botanical gardens make to the conservation of internationally endangered wild plants, the corncockle was chosen for the Association's logo.

Our symbol, the corncockle

In 2017, the Association of Friends of the BGBM celebrated its 30th anniversary

The corncockle, who'd have thought it? In the mid-twentieth century, few could have imagined that this undemanding purple-flowered plant, a member of the carnation family, would ever end up on the red list of endangered species. At that time, these flowers could still be seen growing up to a metre high in countless cornfields. When the corn was threshed, the corncockle seeds landed among the grains, so were resown year after year with them. But modern seed cleaning brought an end to this process, and corncockle numbers have been declining steadily.

The plant is now threatened with extinction. It has become a symbol – not only of the threats to biodiversity from modern land use, but also of the wish to do something to stem the rapid loss of species. And that is one of the aims of the non-profit Association of Friends of the Botanic Garden and Botanical Museum Berlin, which celebrated its 30th anniversary on 6 April 2017. Its corncockle logo is intended to point to the importance of botanical gardens for the conservation of endangered plant species.

Since its foundation, the association has won more and more people over to this idea. In 1987 it began as a group of just eleven keen plant

enthusiasts, but 30 years later, the number of members has risen to 795. With their contributions and donations, these members support the work of the BGBM. Each year, between 50,000 and 90,000 euros help to fund scientific projects, research and collection trips, and cooperation with partners in Cuba and other parts of the world. Digitisation of historical collections and the conveying of botanical knowledge are also major concerns of the Association. For this reason, it financed the visitor information system in the main tropical greenhouse.

Many successful BGBM projects would not have been possible without the help of its friends and supporters – particularly since some contribute not only financially, but also personally with their work as volunteers. However, you can never have enough friends, so new members are always welcome. The anniversary celebration therefore included a little publicity: in 2017, to attract the attention of visitors, the association set out an information desk in the Italian garden, in front of the greenhouses. Beside it, on a small raised bed, corncockles swayed in the wind: a living example of plants which arrived in Central Europe in the Neolithic period – and which, without help, may well have no future.

Prof. Brigitte Zimmer is a fern specialist, and has worked for the BGBM since 1982, in various functions. From 1998 to 2006 she was director of a department responsible for herbarium collections and public relations. Since then, she has worked as a volunteer scientist at the BGBM and is the curator of the fern herbarium. This herbarium survived the Second World War unscathed and is one of the most important collections of ferns worldwide, with a large number of types (reference specimens for scientific plant names). Since 2007, she has also been chair of the Association of Friends of the Botanic Garden and Botanical Museum Berlin, of which she has been a member since 1991.

The exhibition Green Treasure Islands is shown at the Botanic Garden in Havana.

Green treasure islands in Havana

Getting an exhibition ready in time for the opening can be a nerve-wracking experience. For the 50th anniversary of the National Botanic Garden of Cuba in 2018, Islas del tesoro verde (Green Treasure Islands), which had already had a very successful run at the BGBM, opened in Havana. The exhibition presents the joint activities of the two institutions in researching the plant life of the Caribbean. The Flora of Cuba is a central product of this collaboration, but so too is knowledge about where the ancestors of the many species that are endemic to and only thrive in Cuba came from when they colonised the island several million years ago. The stories from decades of fruitful cooperation between Cuban and German botanists also provide insights into the history of the respective botanical gardens in Havana and Berlin. So what could be more fitting than to show a Spanish/English version of the exhibition *in situ*?

Thanks to funding provided by the Association of Friends, the central elements of the exhibition were shipped to Cuba by container and other materials were procured. In Havana, the exhibition had to be installed in a very short space of time. But since everyone involved threw themselves into the task day and night, it all ended happily – with an exuberant opening ceremony.

View of the joint exhibition Green Treasure Islands in the Havana Botanic Garden.

The exhibition is hugely popular with children.

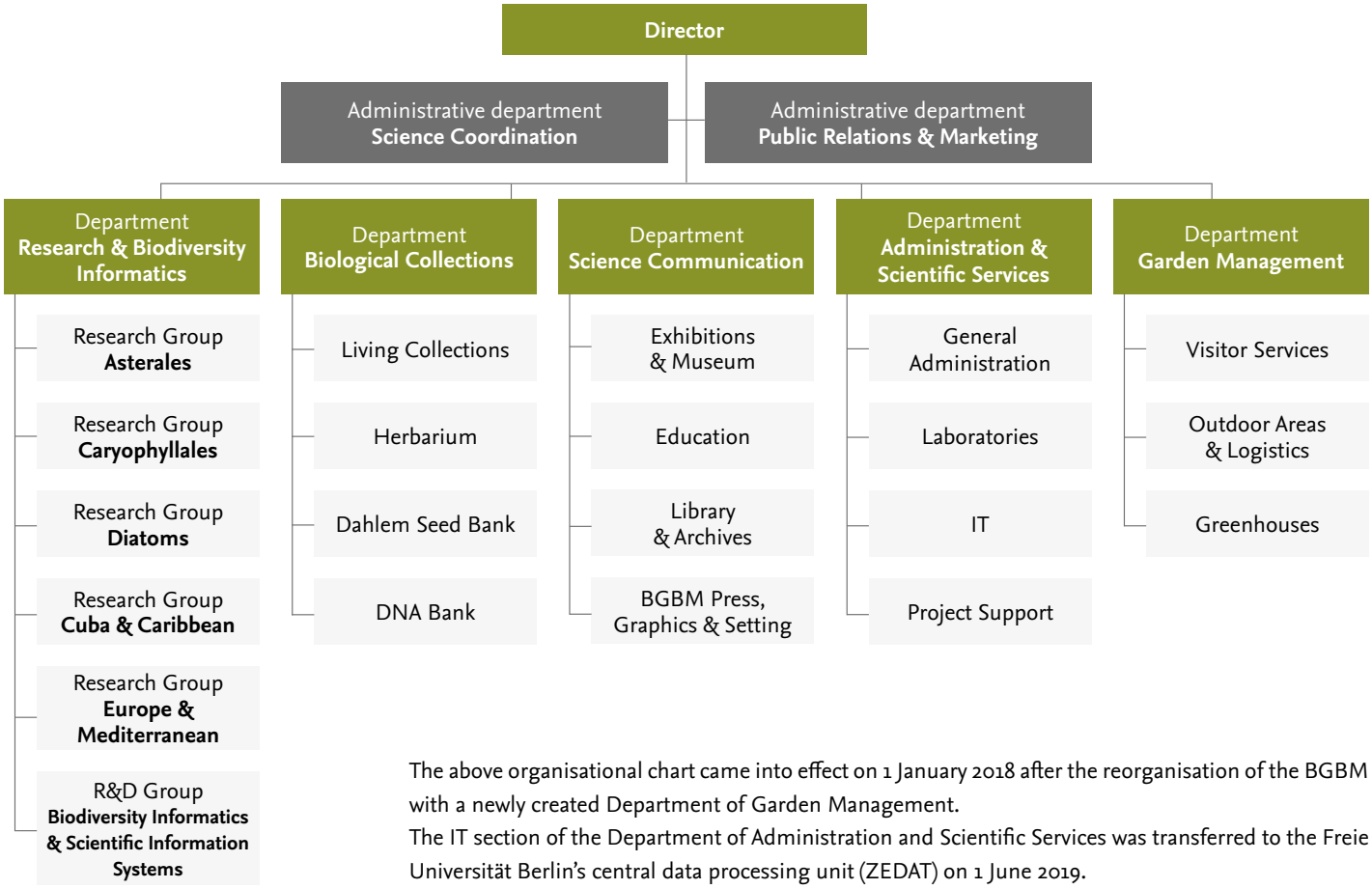
Dr Rosa Rankin Rodríguez, National Botanic Garden, Havana, reporting on the exhibition.

Speech by Nora Hernández Monterrey, director of the National Botanic Garden, Havana, on the occasion of the garden's 50th anniversary.

Prof. Thomas Borsch sends congratulations on behalf of the Botanic Garden and Botanical Museum Berlin.

Organisation

Organigram of the Botanic Garden and Botanical Museum Berlin, a central facility of the Freie Universität Berlin



The above organisational chart came into effect on 1 January 2018 after the reorganisation of the BGBM with a newly created Department of Garden Management.
The IT section of the Department of Administration and Scientific Services was transferred to the Freie Universität Berlin's central data processing unit (ZEDAT) on 1 June 2019.

Facts and figures

Staff
2017 – 2019

Staff	2017	2018	2019
Employees, total	165	218	213
scientific staff	46	50	42
other staff	99	151	156
student assistants	20	17	15
Trainees*	7	10	10
Voluntary Ecological Year*	2	3	3

* not included in number of employees

Visiting scientists*
2017 – 2019

	2017	2018	2019
national	99	90	33
international	63	80	85

* incl. visiting scientists in the herbarium

Doctoral students
2017 – 2019

	2017 – 2019
national	2
international	9

Affiliated and unsalaried scientists

2017 – 2019

Prof. Dr Werner Greuter
Prof. Dr Hans Walter Lack
Dr Thomas Raus
Dr Henricus Sipman
Dr Brigitte Zimmer (Prof. a.D.)
Prof. Dr Arne Strid
Dr Neela Enke
Prof. Dr Eckhard Willing
Peter Hirsch
Michael Ristow
Dr Regine Jahn

Volunteers

2017 – 2019

Evelin Bartels; Barbara Bartz; Lotte Burkhardt; Sonja-Maria Czérkus-Yavuz; Anne Döpfner; Regina Ehrich; Christian Feldt; Detlef Gustke; Anette Höner; Margit Jaroschewski; Margit Keipke; Hartmut Krebs; Marianne Kubicki; Erich Liebert; Gerhard Neumann; Regina Ostrower; Tjalda Picksak-Schmidt; Gudrun Scharte; Cora-Beate Schaumann; Birgit Schubert; Michael Schubert; Monika Senge; Regina Stark; Tom Stawowy; Dietmar Weinert.

Due to data protection regulations, only volunteers who have explicitly given their consent may be named here. The BGBM is supported by numerous volunteers who are not mentioned here, but all of whom deserve our thanks for their ongoing commitment.

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2017 – 2019

Name	Organism	Country of origin
Acanthothecis alba Herrera-Camp., Barcenas-Peña & Lücking[47]	lichen	Mexico
Allium oreohellenicum Tzanoud., Tsakiri & Raus[57]	vascular plant	Italy
Allographa anguilliradians Lücking ex Lücking[29]	lichen	Trinidad and Tobago
Allographa atrocelatoides J. Kalb, Lücking & Kalb[26]	lichen	Thailand
Allographa bambusicola Weerakoon, Lücking & Aptroot[58]	lichen	Sri Lanka
Allographa jayatilakana Weerakoon, Arachchige & Lücking[49]	lichen	Sri Lanka
Allographa kamojangensis Jatnika, Noer & Lücking[49]	lichen	Indonesia
Allographa kansriana J. Kalb, Lücking & Kalb[26]	lichen	Thailand
Allographa schummii J. Kalb, Lücking & Kalb[26]	lichen	Thailand
Allographa sitianoides J. Kalb, Lücking & Kalb[26]	lichen	Thailand
Allographa uruguayensis Lücking ex Lücking[29]	lichen	Uruguay
Allographa weerasooriyana Weerakoon, Arachchige & Lücking[58]	lichen	Sri Lanka
Aria phitosiana Raimondo & Greuter[55]	vascular plant	Italy
Aspidothelium silverstonei Soto-Medina, Aptroot & Lücking[16]	lichen	Colombia
Asteristion australianum I. Medeiros, Lücking, Mangold & Lumbsch[12]	lichen	Australia
Astrothelium bullatothallinum Aptroot & Sipman[44]	lichen	Venezuela
Astrothelium cayennense Aptroot & Sipman[44]	lichen	French Guiana
Astrothelium diaphanocorticatum Aptroot & Sipman[44]	lichen	Papua New Guinea
Astrothelium fuscosporum Soto-Medina, Aptroot & Lücking[16]	lichen	Colombia
Astrothelium macroeustomum Aptroot & Sipman[44]	lichen	French Guiana
Astrothelium minicecidiogenum Aptroot & Sipman[44]	lichen	Costa Rica
Astrothelium palaeoexostemmatis Sipman & Aptroot[44]	lichen	Thailand
Astrothelium tanianum Aptroot & Sipman[44]	lichen	Malaysia
Bactrospora lecanorina Herrera-Camp., Altamirano & Lücking[47]	lichen	Mexico
Brachysira altepetlensis D. Mora, R Jahn & N. Abarca[13]	diatom	Mexico
Chapsa inspersa E.L. Lima & Lücking[54]	lichen	Brazil
Cocconeis magnoareolata Al-Handal, Riaux-Gob., R. Jahn & A.K.Wulff[42]	diatom	Sweden
Coenogonium atherospermatis Kantvilas, Rivas Plata & Lücking[27]	lichen	Australia (Tasmania)
Coenogonium australiense Kantvilas & Lücking[27]	lichen	Australia (Tasmania)
Coenogonium beaverae Lücking & Diederich[5]	lichen	Seychelles
Coenogonium urceolatum Kantvilas, Rivas Plata & Lücking[27]	lichen	Australia (Tasmania)
Cora benitoana Moncada, R.-E. Pérez & Lücking[51]	lichen	Mexico
Cora buapana Moncada, R.-E. Pérez & Lücking[51]	lichen	Mexico
Cora dewisanti subsp. *mexicana* Moncada, R.-E. Pérez & Lücking[51]	lichen	Mexico
Cora galapagoensis Dal Forno, Bungartz & Lücking[3]	lichen	Ecuador (Galapagos)
Cora guzmaniana Moncada, R.-E. Pérez & Lücking[51]	lichen	Mexico
Cora ixtlanensis Moncada, R.-E. Pérez & Lücking[51]	lichen	Mexico
Cora lawreyana Moncada, R.-E. Pérez & Lücking[51]	lichen	Mexico
Cora marusae Moncada, R.-E. Pérez & Lücking[51]	lichen	Mexico
Cora totonacorum Moncada, R.-E. Pérez & Lücking[51]	lichen	Mexico
Cora zapotecorum Moncada, R.-E. Pérez & Lücking[51]	lichen	Mexico
Crocynia didymica Sipman[35]	lichen	Vanuatu
Crypthonia streimannii Sipman[35]	lichen	Vanuatu
Cryptoschizotrema minus E.L. Lima & Lücking[54]	lichen	Brazil
Cryptothecia chamelensis Herrera-Camp., Bautista & Lücking[47]	lichen	Mexico
Cyphellostereum georgianum Dal Forno, McMullin & Lücking[45]	lichen	USA

Name	Organism	Country of origin
Cyphellostereum unoquinoum Dal Forno, Bungartz & Lücking[3]	lichen	Ecuador (Galapagos)
Dictyonema barbatum Dal Forno, Bungartz & Lücking[3]	lichen	Ecuador (Galapagos)
Dictyonema darwinianum Dal Forno, Bungartz & Lücking[3]	lichen	Ecuador (Galapagos)
Dictyonema lawreyi Dal Forno, Kaminsky & Lücking[45]	lichen	USA
Dictyonema ramificans Dal Forno, Yánez-Ayabaca & Lücking[3]	lichen	Ecuador (Galapagos)
Dictyonema subobscuratum Dal Forno, Bungartz & Lücking[3]	lichen	Ecuador (Galapagos)
Diorygma sophianum E.L. Lima & Lücking[54]	lichen	Brazil
Diorygma upretii Sipman[36]	lichen	Singapore
Epithemia vandevijveri Cocquyt & R. Jahn[22]	diatom	Réunion
Fissurina aperta Herrera-Camp., Barcenas-Peña & Lücking[47]	lichen	Mexico
Fissurina atlantica T.A. Pereira, M. Cáceres & Lücking[30]	lichen	Brazil
Fissurina jaliscoensis Herrera-Camp., Barcenas-Peña & Lücking[47]	lichen	Mexico
Fissurina linoana Lücking, Moncada & G. Rodr.[50]	lichen	Colombia
Fissurina reticulata R. Miranda, Herrera Camp. & Lücking[47]	lichen	Mexico
Fissurina seychellensis Lücking & Diederich[5]	lichen	Seychelles
Fissurina tenuimarginata Herrera-Camp., Barcenas-Peña & Lücking[47]	lichen	Mexico
Gomphoneis tegelensis R. Jahn & N. Abarca[37]	diatom	Germany
Gomphonella acsiae R. Jahn & N. Abarca[24]	diatom	Hungary
Gomphonella coxiae R. Jahn & N. Abarca[24]	diatom	Germany
Gomphonema clavatuloides Rimet, D.G. Mann, Trobajo & N. Abarca[33]	diatom	France (Mayotte)
Graphis alba Dantas, Lücking & M. Cáceres[4]	lichen	Brazil
Graphis albocarpa J. Kalb, Lücking & Kalb[26]	lichen	Thailand
Graphis amaliana Amórtegui, Moncada & Lücking[52]	lichen	Colombia
Graphis carmenelisana Moncada, Motta & Lücking[52]	lichen	Colombia
Graphis emersella J. Kalb, Lücking & Kalb[26]	lichen	Thailand
Graphis flosculifera Weerakoon, Lücking & Aptroot[58]	lichen	Sri Lanka
Graphis kavintuca Motta, Moncada & Lücking[52]	lichen	Colombia
Graphis khaojoneana J. Kalb, Lücking & Kalb[26]	lichen	Thailand
Graphis lindsayana Lücking & Diederich[5]	lichen	Seychelles
Graphis lurizana Lücking, Moncada & Celis[50]	lichen	Colombia
Graphis mokanarum Lücking, Moncada & M.C. Martínez[50]	lichen	Colombia
Graphis omiana J. Kalb, Lücking & Kalb[26]	lichen	Thailand
Graphis rajapakshana Weerakoon, Lücking & Aptroot[58]	lichen	Sri Lanka
Graphis rimosothallina Weerakoon, Lücking & Aptroot[58]	lichen	Sri Lanka
Graphis rosalbinana Moncada, Amortegui & Lücking[52]	lichen	Colombia
Graphis santanderiana Motta, Moncada & Lücking[52]	lichen	Colombia
Graphis schummiana J. Kalb, Lücking & Kalb[26]	lichen	Thailand
Graphis solmariana Motta, Moncada & Lücking[52]	lichen	Colombia
Graphis subaltamirensis Passos, M. Cáceres & Lücking[30]	lichen	Brazil
Graphis subfiliformis E.L. Lima & Lücking[54]	lichen	Brazil
Graphis sublitoralis J. Kalb, Lücking & Kalb[26]	lichen	Thailand
Graphis subschroederi J. Kalb, Lücking & Kalb[26]	lichen	Thailand
Graphis thunsinhalayensis Weerakoon, Arachchige & Lücking[58]	lichen	Sri Lanka
Gyalideopsis aptrootii Xavier-Leite, M. Cáceres & Lücking[39]	lichen	Brazil
Gyalideopsis caespitosa Barcenas-Peña, Herrera-Camp. & Lücking[47]	lichen	Mexico
Gyalideopsis marcellii Xavier-Leite, M. Cáceres & Lücking[39]	lichen	Brazil
Halegrapha paulseniana Luch & Lücking[28]	lichen	USA (Hawaii)
Halegrapha redonographoides Dantas, Lücking & M. Cáceres[4]	lichen	Brazil

Name	Organism	Country of origin
Herpothallon alae Sipman[35)]	lichen	Vanuatu
Heterocapsa steinii Tillmann, Gottschling, Hoppenrath, Kusber & Elbr.[17)]	dinoflagellate	Germany
Lawreymyces bogotensis Lücking & Moncada[9)]	fungus	Colombia
Lawreymyces columbiensis Lücking & Moncada[9)]	fungus	Colombia
Lawreymyces confusus Lücking & Moncada[9)]	fungus	Colombia
Lawreymyces foliaceae Lücking & Moncada[9)]	fungus	Colombia
Lawreymyces palicei Lücking & Moncada[9)]	fungus	Colombia
Lawreymyces pulchellae Lücking & Moncada[9)]	fungus	Colombia
Lawreymyces spribillei Lücking & Moncada[9)]	fungus	Colombia
Leucanthemum ×aramisii Florian Wagner, Vogt & Oberpr.[19)]	vascular plant	France
Leucanthemum ×athosii Florian Wagner, Vogt & Oberpr.[19)]	vascular plant	France
Leucanthemum ×marchii Konowalik, Vogt & Oberpr.[38)]	vascular plant	Italy
Leucanthemum ×porthosii Florian Wagner, Vogt & Oberpr.[19)]	vascular plant	Italy
Leucodecton granulosum Sipman[34)]	lichen	Australia
Libinhania discolor A.G. Mill., R. Sommerer & N. Kilian[8)]	vascular plant	Yemen
Libinhania fontinalis A.G. Mill., R. Sommerer & N. Kilian[8)]	vascular plant	Yemen
Libinhania hegerensis A.G. Mill. & N. Kilian[8)]	vascular plant	Yemen
Libinhania nivea A.G. Mill., R. Sommerer & N. Kilian[8)]	vascular plant	Yemen
Libinhania pendula A.G. Mill., R. Sommerer & N. Kilian[8)]	vascular plant	Yemen
Lobariella flynniana Lücking, Moncada & C.W. Sm.[10)]	lichen	USA (Hawaii)
Lobariella robusta Lücking, Moncada & C. W. Sm.[10)v]	lichen	USA (Hawaii)
Lobariella sandwicensis Lücking, Moncada & C. W. Sm.[10)]	lichen	USA (Hawaii)
Micarea squamulosa Aptroot, Lücking & M. Cáceres[48)]	lichen	Brazil
Myriotrema hypoconstictum van den Boom & Sipman[18)]	lichen	Panama
Myriotrema protofrustillatum Sipman34)	lichen	Australia
Neidium beatyi P.B. Ham., Savoie, C.M. Sayre, Skibbe, J. Zimm. & R.D. Bull[46)]	diatom	Canada
Neidium collare P.B. Ham., Savoie, C.M. Sayre, Skibbe, J. Zimm. & R.D. Bull[46)]	diatom	Canada
Neidium lavoieanum P.B. Ham., Savoie, C.M. Sayre, Skibbe, J. Zimm. & R.D. Bull[46)]	diatom	Canada
Neidium vandusenense P.B. Ham., Savoie, C.M. Sayre, Skibbe, J. Zimm. & R.D. Bull[46)]	diatom	Canada
Neoprotoparmelia nigra L.A.Santos, Lücking & Aptroot[56)]	lichen	Brazil
Neoprotoparmelia pseudomultifera L.A.Santos, Lücking & Aptroot[56)]	lichen	Brazil
Neoprotoparmelia purpurea L.A.Santos, Lücking & Aptroot[56)]	lichen	Brazil
Neoprotoparmelia rubrofusca Lücking & L.A.Santos[56)]	lichen	Brazil
Nitzschia biundulata Al-Handal, J. Zimmerman, R. Jahn, Torstensson & A. Wulff[43)]	diatom	Antarctic
Ocellularia cipoensis L.A. Santos, M. Cáceres & Lücking[30)]	lichen	Brazil
Ocellularia etayoi van den Boom & Sipman[18)]	lichen	Panama
Ocellularia sosma T.A. Pereira, M. Cáceres & Lücking[30)]	lichen	Brazil
Ocellularia submordenii Lücking[30)]	lichen	Brazil
Ocellularia tomatlanensis Herrera-Camp., Colín & Lücking[47)]	lichen	Mexico
Ocellularia upretii S. Joshi, Divakar, Lumbsch & Lücking[25)]	lichen	India
Phaeographis galeanoae Lücking, Moncada & B. Salgado-N.[50)]	lichen	Colombia
Phaeographis sarcographoides Herrera-Camp., N. Sánchez & Lücking[47)]	lichen	Mexico

Name	Organism	Country of origin
Planothidium cryptolanceolatum R. Jahn & N. Abarca[7]	diatom	South Korea
Planothidium naradoense R. Jahn & J. Zimmermann[7]	diatom	South Korea
Planothidium suncheonmanense R. Jahn & J. Zimmermann[7]	diatom	South Korea
Planothidium taeansa R. Jahn & N. Abarca[7]	diatom	South Korea
Porina lumbschii Naksuwankul & Lücking[53]	lichen	Thailand
Porina sorediata Aptroot, Lücking & M. Cáceres[48]	lichen	Brazil
Porina subatriceps Naksuwankul & Lücking[53]	lichen	Thailand
Porina thailandica Naksuwankul & Lücking[53]	lichen	Thailand
Pseudochapsa aptrootiana M. Cáceres, T.A. Pereira & Lücking[30]	lichen	Brazil
Pseudocyphellaria deyi Lücking[11]	lichen	USA
Pseudocyphellaria holarctica McCune, Lücking & Moncada[11]	lichen	USA
Pseudocyphellaria punctata Lücking & Moncada[11]	lichen	USA
Pyrenula subvariabilis Aptroot & Sipman[20]	lichen	Guyana
Ramalina europaea Gasparyan, Sipman & Lücking[6]	lichen	Sweden
Ramalina labiosorediata Gasparyan, Sipman & Lücking[6]	lichen	USA
Rhytidhysteron columbiense Soto-Medina & Lücking[15]	fungus	Colombia
Sarcographa atlantica E.L. Lima & Lücking[54]	lichen	Brazil
Sarcographa praslinensis Lücking & Diederich[5]	lichen	Seychelles
Sarcographa subglobosa Lücking & Diederich[5]	lichen	Seychelles
Saussurea glandulosissima Raab-Straube[14]	vascular plant	China
Saussurea hengduanshanensis Raab-Straube[14]	vascular plant	China
Saussurea kawakarpo Raab-Straube[14]	vascular plant	China
Saussurea septentrionalis Raab-Straube[14]	vascular plant	China
Saussurea sichuanica Raab-Straube[14]	vascular plant	China
Saussurea sikkimensis Raab-Straube[14]	vascular plant	India
Saussurea sunhangii Raab-Straube[14]	vascular plant	China
Sellaphora queretana D. Mora, N. Abarca & J.Carmona[13]	diatom	Mexico
Sprucidea granulosa M. Cáceres, Aptroot & Lücking[1]	lichen	Brazil
Sprucidea rubropenicillata M. Cáceres, Aptroot & Lücking[1]	lichen	Brazil
Sticta aongstroemii Dal Forno, Moncada & Lücking[23]	lichen	Brazil
Stirtonia borinquensis Perlmutter, Rivas Plata & Lücking[31]	lichen	Puerto Rico
Stirtonia caribaea Perlmutter, Rivas Plata & Lücking[31]	lichen	Cuba
Sulcopyrenula biseriata Aptroot & Sipman[20]	lichen	Guyana
Sulzbacheromyces chocoensis Coca, Lücking & Moncada[21]	lichen	Colombia
Sulzbacheromyces tutunendo Coca, Lücking & Moncada[21]	lichen	Colombia
Surirella coei Cocquyt, J.C. Taylor & Kusber[2]	diatom	Kenya
Tamarix humboldtiana Akhani, Borsch & N. Samadi[41]	vascular plant	Iran
Thelotrema pachysporoides Dantas, Lücking & M. Cáceres[4]	lichen	Brazil
Vigneronia mexicana Herrera-Camp., Bautista & Lücking[47]	lichen	Mexico
Xanthoparmelia krcmarii Sipman & V. Wirth[40]	lichen	South Africa

Families and genera newly described by BGBM authors

2017 – 2019

Name	Organism	Country of origin
Astartoseris N. Kilian, Hand, Hadjik., Christodoulou & M. Bon Dagher-Kharrat[59]	vascular plant	Cyprus and Lebanon
Austrotrema I. Medeiros, Lücking & Lumbsch[12]	lichen	worldwide
Cryptoschizotrema Aptroot, Lücking & M. Cáceres[48]	lichen	pantropical
Cystocoleaceae Locq. ex Lücking, B.P.Hodk. & S.D.Leav.[62]	lichen	worldwide
Flabelloporina Sobreira, M. Cáceres & Lücking[61]	lichen	neotropics
Lawreymyces Lücking & Moncada[9]	fungus	worldwide
Libinhania N. Kilian, Galbany, Oberpr. & A.G. Mill.[8]	vascular plant	Socotra
Sprucidea M. Cáceres, Aptroot & Lücking[1]	lichen	neotropics
Tainus Torr.-Montúfar, H. Ochot. & Borsch[60]	vascular plant	Caribbean

Sources (for the complete bibliographical references, see the lists of publications on pp. 59–77):

[1] Cáceres et al. 2017 – Bryologist 120: 202–211. [2] Cocquyt et al. 2017 – Fottea 17: 34–56. [3] Dal Forno et al. 2017 – Fungal Divers. 85: 45–73. [4] Dantas et al. 2017 – Phytotaxa 331: 289–294. [5] Diederich et al. 2017 – Herzogia 30: 182–236. [6] Gasparyan et al. 2017 – Lichenologist 49: 301–319. [7] Jahn et al. 2017 – Diatom Research 32: 75–107. [8] Kilian et al. 2017 – Bot. J. Linn. Soc. 183(3): 373–412. [9] Lücking et al. 2017 – Fungal Divers. 84: 119–138. [10] Lücking et al. 2017 – Lichenologist 49: 673–691. [11] Lücking et al. 2017 – Bryologist 120: 441–500. [12] Medeiros et al. 2017 – Fieldiana Life Earth Sci. 9: 1–31. [13] Mora et al. 2017 – PhytoKeys 88: 39–69. [14] Raab-Straube 2017 – Englera 34: 1–274. [15] Soto-Medina et al. 2017 – Revista Acad. Colomb. Ci. Exact. Nat. 41: 59–63. [16] Soto-Medina et al. 2017 – Cryptogamie, Mycologie 38: 253–258. [17] Tillmann et al. 2017 – J. Phycol. 53: 1305–1324. [18] Van den Boom et al. 2017 – Sydowia 69: 47–72. [19] Wagner et al. 2017 – Mol. Ecol. 26: 4260–4283. [20] Aptroot et al. 2018 – Lichenologist 50: 77–87. [21] Coca et al. 2018 – Bryologist 121: 295–305. [22] Cocquyti et al. 2018 – Cryptogam., Algol. 9: 35–62. [23] Dal Forno et al. 2018 – Lichenologist 50: 691–696. [24] Jahn et al. 2018 – Plant Ecol. Evol. 152: 219–247. [25] Joshi et al. 2018 – Lichenologist 50: 627–678. [26] Kalb et al. 2018 – Phytotaxa 377: 1–83. [27] Kantvilas et al. 2018 – Lichenologist 50: 571–582. [28] Luch et al. 2018 – Willdenowia 48: 415–423. [29] Lücking et al. 2018 – Herzogia 31: 525–561. [30] Pereira et al. 2018 – Biota Neotrop. 18(1): e20170445. [31] Perlmutter et al. 2018 – Bryologist 121: 80–86. [32] Raab-Straube et al. 2018 – Willdenowia 48: 195–220. [33] Rimet et al. 2018 – Fottea 18: 37–54. [34] Sipman 2018 – Australas. Lichenol. 82: 92–105. [35] Sipman 2018 – Australas. Lichenol. 82: 106–129. [36] Sipman 2018 – Crypt. Biodivers. Assess., Special Issue (2018): 01–05. [37] Skibbe et al. 2018 – Diatom Res. 33: 251–262. [38] Vogt et al. 2018 – Willdenowia 48: 221–226. [39] Xavier-Leite et al. 2018 – Bryologist 121: 32–40. [40] Wirth et al. 2018 – Herzogia 31: 505–509. [41] Akhani et al. 2019 – Willdenowia 49: 127–139. [42] Al-Handal et al. 2019 – Eur. J. Taxon. 497: 1–16. [43] Al-Handal et al. 2019 – Nova Hedwigia 108: 281–290. [44] Aptroot et al. 2019 – Lichenologist 51: 27–43. [45] Dal Forno et al. 2019 – Plant Fungal Syst. 64: 383–392. [46] Hamilton et al. 2019 – Phytotaxa 419: 39–62. [47] Herrera-Campos et al. 2019 – Bryologist 122: 62–83. [48] Hyde et al. 2019 – Fungal Divers. 96: 1–242. [49] Jatnika et al. 2019 – Lichenologist 51: 227–233. [50] Lücking et al. 2019 – Caldasia 41: 194–214. [51] Moncada et al. 2019 – Plant Fungal Syst. 64: 393–411. [52] Motta et al. 2019 – Phytotaxa 401: 257–266. [53] Naksuwankul et al. 2019 – Phytotaxa 400: 51–63. [54] Lima-Nascimento et al. 2019 – Bryologist 122: 414–422. [55] Raimondo et al. 2019 – Bot. Chron. 22: 15–37. [56] Santos et al. 2019 – Bryologist 122: 539–552. [57] Tzanoudakis et al. 2019 – Willdenowia 49: 231–239. [58] Weerakoon et al. 2019 – Lichenologist 51: 515–559. [59] Kilian et al. 2017 – Willdenowia 47: 115–125. [60] Torres-Montúfar et al. 2017 – Willdenowia 47: 259–270. [61] Sobreira et al. 2018 – Phytotaxa 358: 67-75. [62] Lücking et al. 2017 – The Bryologist 119: 361–416.

Online resources and databases

The BGBM makes available databases and online resources that, on the one hand, are used for the cataloguing of our own collections and, on the other, present fundamental biodiversity data on groups of organisms or geographical regions. More general service portals are also hosted at the BGBM:

1. Digitised collections at the BGBM

Virtual Herbarium – Digital Specimen Images at the Herbarium Berolinense – access to the Berlin data in the JACQ system (see below) ***http://ww2.bgbm.org/herbarium/default.cfm***

BoGART – database of the BGBM's living collection
http://ww2.bgbm.org/bogartdb/BogartPublic.asp

BioCASE-BGBM – Biological Collection Access Service for Europe. Portal for BGBM Collections
http://search.biocase.org/bgbm

LICHCOL – Lichen (& Fungus) Herbarium Database ***http://archive.bgbm.org/scripts/ASP/lichcol*** (will be integrated into the BGBM Herbarium database in the JACQ system – see below)

DNA-Bank – information system for the BGBM's DNA collection
http://data.ggbn.org/ggbn_portal/search/result?institution=BGBM%2C+Berlin

MuseumPlus database of the BGBM in the Europeana Collections Portal
https://www.europeana.eu/portal/en/search?q=europeana_collectionName%3A%2811635_Ag_EU_OpenUp%5C%21_MuseumPlus%29

2. Taxonomic information systems on organismal groups

AlgaTerra – Information System on Terrestrial and Limnic Micro Algae
http://www.algaterra.net

Campanula Portal – global online monograph of the genus *Campanula* (bellflowers) (regularly updated)
https://campanula.e-taxonomy.net/portal

Cichorieae Portal – global online monograph of the *Cichorieae* (daisy family) (regularly updated)
http://cichorieae.e-taxonomy.net/portal

Caryophyllales Portal – global synthesis of species diversity in the angiosperm order *Caryophyllales* (regularly updated) ***http://caryophyllales.org***

3. Floras and checklists

Euro+Med PlantBase – The Information Resource for Euro-Mediterranean Plant Diversity (regularly updated)
http://ww2.bgbm.org/EuroPlusMed/query.asp

Med-Checklist – A Critical Inventory of Vascular Plants of the Circum-Mediterranean Countries (as published in book form) ***http://ww2.bgbm.org/mcl***

Flora Hellenica Database (Arne Strid) ***http://www.florahellenica.com***

Flora of Greece Web – annotated checklist of the vascular plants of Greece
http://portal.cybertaxonomy.org/flora-greece/

Flora of Cyprus – A Dynamic Checklist (online Flora of the vascular plants of Cyprus with illustrations, distribution maps and identification keys – regularly updated)
http://www.flora-of-cyprus.eu

Flora of Cuba Database – Base de Datos de Especímenes de la Flora de Cuba – con Mapas de Distribución Versión 10.0 (2014) a Versión 11 (2016) (database of Cuban flora herbariumspecimens with distribution maps)
http://ww3.bgbm.org/FloraOfCuba

The Spermatophyta of Cuba – A Preliminary Checklist
http://wfospecimens.cybertaxonomy.org
http://portal.cybertaxonomy.org/flora-cuba

4. Service portals for collections data

BioCASE – Biological Collection Access Service for Europe. Portal for European Biodiversity
http://search.biocase.org/europe (direct access to search catalogue)

BioCASE – Biological Collection Access Service for Europe. Portal for German Phytodiversity
http://search.biocase.de/botany (direct access to search catalogue)

EDIT – Specimen and Observation Explorer for Taxonomists (access portal for collection data worldwide, optimised for taxonomists)
http://search.biocase.org/edit

GBIF-D Algae & Protozoa Datenportal (database for algae and single-celled organisms)
http://protists.gbif.de/protists

VH/de – Virtuelles Herbarium Deutschland (digitised collections information from German herbaria)
http://vh.gbif.de/vh

GGBN – Global Genome Biodiversity Network
http://www.ggbn.org

WFO Specimens – World Flora Online Initiative, Specimen Explorer for Phytotaxonomists (Prototype)
http://wfospecimens.cybertaxonomy.org

Botanic Garden Berlin Observations (BoBO)
http://bobo.biocase.org

Caucasus Plant Biodiversity Initiative, Specimen explorer with focus on Caucasian Plants
http://caucasus.e-taxonomy.net/

5. Web services

UTIS – Unified Taxonomic Backbone for the European Biodiversity Observation Network (EU BON)
http://cybertaxonomy.eu/eu-bon/utis

Name catalogue REST API (access to the data held in the databases of the EDIT platform, e.g. including the "Catalogue of Life")
https://cybertaxonomy.eu/cdmlib/rest-api-name-catalogue.html

BioCASe – Biological Collections Access Service (machine-readable access to the collections data of the BGBM)
http://ww3.bgbm.org/biocase

6. Software

EDIT Platform for Cybertaxonomy – Open Source Software Tools and Services Covering All Aspects of the Taxonomic Workflow
www.cybertaxonomy.eu

BioCASE Network Software Components (for the networking and preparation of collections data in the BioCASE, GBIF and GGBN network)
http://biocase.org/products/index.shtml

AnnoSys – Web-based system for correcting and enriching biological collection data
https://annosys.bgbm.fu-berlin.de

JACQ Virtual Herbaria – Unified and jointly administered specimen management system for herbaria (in collaboration with the Natural History Museum and University of Vienna)
http://herbarium.univie.ac.at/database/collections.htm

Die Herbonauten – Das Herbar der Bürgerwissenschaften (botanical missions for citizen scientists)
https://herbonauten.de

7. Archived systems

The following information systems are still available for consultation, but are no longer updated:

Bohlmann Files – A Database of Natural Substances in the *Compositae* Access: *n.kilian@bgbm.org*

DERMBASE – Names of *Dermateaceae* (*Ascomycetes*)
http://ww2.bgbm.org/projects/dermbase/query.cfm

IOPI-GPC – International Organization for Plant Information, Provisional Global Plant Checklist
http://archive.bgbm.org/IOPI/GPC/default.asp

Names in Current Use for Extant Plant Genera (NCU-3e) (standard list of generic names and publication citations for algae, fungi and plants) ***http://archive.bgbm.org/iapt/ncu/genera/Default.htm***

IAPT Registration of Plant Names (International Association for Plant Taxonomy's trial database for the registration of newly published plant names) ***http://archive.bgbm.org/registration/QueryForm.htm***

Research

Externally funded projects

Funding organisation	Project title	Project manager(s)	Term
BfN	R & D project: Research for the preparation of the Red Lists 2020 – preparatory phase. Sub-project: Cooperation checklists (FKZ 3515 860301).	Berendsohn	2015–2018
BfN	Implementation of EU regulation 511/2014: Identification of potential users of genetic resources in Germany (Az Z 1.2532 02/2016/F/18Z).	Borsch	2016–2017
BfN	GSPC Symposium: Protection of threatened plant species in Central Europe – genetic basis and nature conservation practice.	Borsch	2016–2017
BfN	WIPs-De II: Reintroducing and supporting populations of endangered species for which Germany has a special responsibility (WIPS-De II) (FKZ 3518685B01)	Stevens	2018–2023
BfN	WIPS-De joint project: Establishment of a national network for the protection of endangered wild plant species for which Germany has a special responsibility. Sub-project: Sampling region Northeast, seed collection and storage (FKZ 3513685B04).	Stevens	2013–2018
BMBF	CAUCDESTR – Pilot study for the integration of a taxonomic checklist and geo-referenced distribution data, with subsequent production of distribution maps (01DK17038).	Berendsohn/ Korotkova	2017–2019
BMBF	VietBio: Innovative methods of recording biodiversity: capacity building with partner countries in Southeast Asia using the example of Vietnam.	Borsch	2018–2020
BMBF	ColCari – Cooperation with the Universidad del Norte Barranquilla on integrative biodiversity research in the Colombian Caribbean (01DN19004).	Borsch	2019–2021
BMBF	ColBioDiv – Cooperation with the Botanic Garden of Bogotá and the Universidad del Norte Barranquilla (01DN17006).	Borsch	2017–2020
BMBF	German Barcode of Life II (GBOL-2): From Science to Application. Sub-project 4: Verification of seeds and tree nursery products (FKZ 01LI150E).	Borsch	2016–2019

Funding organisation	Project title	Project manager(s)	Term
BMBF	EvoBoGa – Joint project: Plants of botanical gardens: Living resources for integrative evolution research. Sub-project: Cacti: analysis of evolution, species conception and development of the living collection as a resource for research and species protection (01 UQ1708A).	Borsch/ Güntsch	2017–2020
BMBF	EDAPHOBASE – Information system, data repository, data infrastructure and service platform for soil zoology. Sub-project 6 BGBM: Integration and link-up with GBIF (FKZ 01LI1301F). (FKZ 01LI1301F).	Güntsch	2013–2017
BMBF	German Barcode of Life II (GBOL-2) – DNA barcoding of diatoms in the context of the EU Water Framework Directive: Diatoms (FKZ 01LI150E).	Jahn	2016–2019
Embassy of Mexico	Exhibition – Chilli and Chocolate: The Taste of Mexico	Grotz	2017–2018
DFG	AnnoSys II – A generic annotation system for biodiversity data (LIS programme: Scientific literature provision and information systems) (BE 2283/4-2).	Berendsohn/ Güntsch	2014–2018
DFG	GFBio III – German Federation for the Curation of Biological Data (GU 1109/3-3).	Güntsch	2018–2021
DFG	GFBio II – German Federation for Biological Data (GU 1109/3-2).	Güntsch	2015–2018
DFG	ABCD 3.0 – A community platform for the development and documentation of the ABC standard for natural history collections data (GU 1109/6-1).	Güntsch	2014–2019
DFG	StanDAP-Herb – A process-optimised standard method for the indexing of digital herbarium specimens (BE 2283/12-1).	Güntsch/ Berendsohn	2014–2017
DFG	IDS 2018 – 25th International Diatom Symposium, Berlin, 25–30 June 2018.	Jahn	2018–2018

Funding organisation	Project title	Project manager(s)	Term
DFG	Algae registration: Establishment of a global registration and an index of scientific names and types of algae (LIS programme: Scientific literature provision and information systems) (JA 874/8-1).	Jahn/Güntsch/ Berendsohn	2016–2019
DFG	Development and optimisation of innovative phylogenomic methods for the elucidation of biodiversity and evolution in the tribe *Cichorieae* (*Compositae*/daisies), which provide important information on the phylogenetic tree of the daisy family (JO 1534 / 1-1).	Jones	2018–2019
DFG	Permanent linking of structured taxonomic characteristics data with individual collection objects so as to achieve additivity (LIS) (KI 1175/2-1).	Kilian	2017–2019
DFG	Development of a subject indexing system for collections of the northern hemisphere flowering plant genus *Campanula* (LIS programme: Scientific literature provision and information systems) (KI 1175/1-1).	Kilian	2012–2017
DFG	SPP 1991 – Creation and validation of a bioinformatic pipeline for species delimitation and for phylogenetic network reconstruction in polyploid complexes (Taxon-OMICS VO 1595/3-1).	Vogt	2017–2020
DFG	SPP 1158 – Biodiversity and biogeography of marine benthic diatoms in Antarctic and Arctic shallow water coastal zones to evaluate the degree of endemism using fine-grained taxonomy and eDNA metabarcoding (ZI 1628/2-1).	Zimmermann	2019–2022
EU	Access to digital resources of European heritage (Europeana DSI 2) (GA Nr. CEF-TC-2015-1-01).	Berendsohn	2016–2017
EU	SYNTHESYS III – Synthesis of systematic resources (Network Activities) (GA Nr. 312253).	Berendsohn	2013–2017
EU	SYNTHESYS PLUS – Synthesis of systematic resources, Network Activities (Horizon 2020-INFRAIA) (GA Nr. 823827).	Güntsch	2019–2023
EU	EU BON – Building the European Biodiversity Observation Network (GA Nr. 308454).	Güntsch/ Berendsohn	2012–2017

Funding organisation	Project title	Project manager(s)	Term
EU	DNAqua-Net – Developing new genetic tools for bioassessment of aquatic ecosystems in Europe (COST Action CA15219).	Jahn	2016–2021
EU	SYNTHESYS III – Synthesis of systematic resources (DE-TAF Access) (GA Nr. 312253).	Jahn	2013–2017
EU	Big Picnic. Big Questions – engaging the public with Responsible Research and Innovation on Food Security (GA Nr. 710780).	Rahemipour	2016–2019
EU	SYNTHESYS PLUS – Synthesis of systematic resources, DE-TAF Access (Horizon 2020-INFRAIA) (GA Nr. 823827).	Vogt	2019–2023
EU	MOBILISE – Mobilising Data, Policies and Experts in Scientific Collections (COST Action CA17106).	Berendsohn	2018–2022
Friederike-Schaumann Stiftung	Moss garden at the Botanic Garden and Botanical Museum.	Stevens	2012–2017
KSB	Light, Air and Shit: Archaeologies of Sustainability. Bauhaus exhibition 2019 (BHF.0127).	Rahemipour	2018–2020
KSL/Lotto Stiftung	Acquisition of a culturally and historically significant collection of mycological literature from Christian Volbracht.	Kilian	2018–2019
State of Berlin	Preparation and delivery of programmes for the IGA classroom as part of the IGA campus – IGA (International Garden Exhibition) 2017.	Rahemipour	2017
Landestalsperren-verwaltung Sachsen	Verification of taxonomic determinations of phytoplankton species.	Jahn/ Zimmermann	2015–2017
Smithsonian Institution	GGBN – Data standards and data quality.	Güntsch	2019–2021
Smithsonian Institution	Global Genome Biodiversity Network 2016 Conference (GGBN), 19–25 June 2016.	Güntsch	2016–2017
Verein der Freunde	Comparison of the morphological and genetic diversity of freshwater diatoms from central Mexico with southern Mexico, North America and Europe.	Abarca Mejía	2019
Verein der Freunde	Collection trip in support of the project “Systematics and phylogeny of Andean sandworts (*Arenaria*, *Caryophyllaceae*)”.	Berendsohn/ v. Mering	2017

Funding organisation	Project title	Project manager(s)	Term
Verein der Freunde	Implementation of the global synthesis of the biodiversity of the *Caryophyllales*: *Limonium*.	Berendsohn/ v. Mering	2017
Verein der Freunde	The genus *Dianthus* (*Caryophyllaceae*) in Greece and work on a treatment for the Flora of Greece.	Borsch	2019
Verein der Freunde	Continuation of the *Flora de Cuba* project and the project to research the endemism of the flora of Cuba and the Caribbean.	Borsch	2017–2019
Verein der Freunde	Acquisitions for the library of the BGBM.	Kilian	2018–2019
Verein der Freunde	Research Group Asterales collecting and research trip in northern Peru with a collection focus on the *Gynoxys* group.	Kilian	2018
Verein der Freunde	Research trip to the North Caucasus 2019.	Korotkova/ v. Raab-Straube	2019
Verein der Freunde	Flora of Cuba: cataloguing and DNA barcoding of lichen fungi from historical type localities.	Lücking	2018
Verein der Freunde	Flora of Cuba: monographs of the lichen families *Graphidaceae* and *Lobariaceae*.	Lücking	2019
Verein der Freunde	Development of the fundamentals and preparation of a DFG proposal to research the historical background for the project “Botanic Garden and Botanical Museum Berlin-Dahlem during the National Socialist era”.	Rahemipour	2017–2018
Verein der Freunde	Lichenological-botanical research and collecting trip to the islands of Amorgos and Skiros (Aegean, Greece).	Sipman	2018
VolkswagenStiftung	Kaukasus II – Developing tools for conserving the plant diversity of the South Caucasus (Az 89 950).	Borsch	2017–2020

Hosted scientific events 2017 – 2019

Scientific events at the Botanic Garten and Botanical Museum Berlin

Schutz bedrohter Pflanzenarten in Mitteleuropa: Genetische Grundlagen und Naturschutzpraxis [Protection of Threatened Plant Species in Central Europe: Genetic Foundations und Nature Conservation Practice]. Specialist symposium, 23–25 February 2017, 75 pts.

Collection Management & Botanical Garden Curation. Workshop for participants from the South Caucasus, 18–30 September 2017, 7 pts.

5th General Assembly of the German Federation for Biological Data (GFBio). Organiser: German Federation for Biological Data (GFBio), 28–30 November 2017, 45 pts.

CEN concept development meeting „WG29 on DNA and eDNA" in CEN/TC 230. Event funded by EU COST Action "DNAqua-NET", 8 February 2018, 12 pts.

25th International Diatom Symposium. International conference. Organiser: International Society for Diatom Research (ISDR). Funded by the Deutsche Forschungsgemeinschaft [German Research Foundation] (DFG), International Union of Biological Sciences (IUBS), International Society for Diatom Research (ISDR) and EU COST Action "DNAqua-NET", 25–30 June 2018, 212 pts.

DNAqua-NET Information/Group Meeting COST Action 15219. Event funded by EU COST Action "DNAqua-NET", 27–28 June 2018, 30 pts.

Freshwater Symposium. Organiser: Alliance for Freshwater Life, 5–7 November 2018, >100 pts.

Wildpflanzenschutz in Deutschland II (WIPs-De II) [Wild Plant Conservation in Germany]. Kick-off meeting in partnership with the project leader, the Regensburg Botanic Garden, 27–28 March 2019, 75 pts.

"Antarktisforschung" [Antarctica Research] DFG Priority Programme coordination meeting. 20 November 2019, 5 pts.

Partnership events organised outside the BGBM

Developing Tools for Conserving the Plant Diversity of the Transcaucasus. Mid-term project status seminar, Botanical Institute of Ilia State University, Tbilisi, 11–13 October 2017, 30 pts.

Colombian-German Biodiversity Network for Integrated Biodiversity Management in Exemplar Regions of Columbia (ColBioDiv). Kick-off workshop, Jardín Botánico de Bogotá "José Celestino Mutis", Bogotá, 7–9 November 2017.

Manejo Integrado de la Biodiversidad en el Caribe Colombiano [Integrated management of biodiversity in the Colombian Caribbean]. Workshop at the Universidad del Norte, Barranquilla, 27–29 June 2018.

Sammeln von Wildpflanzen-Saatgut nach ENSCONET-Richtlinien [Collecting of wild plant seeds according to ENSCONET guidelines]. Workshop at the Hochschule Sachsen-Anhalt, Bernburg, 18 March 2019.

Saatgutbanken für den botanischen Artenschutz – Möglichkeiten und Grenzen von Saatgutbanken, Techniken des Sammelns und Lagerns [Seed banks for botanical species conservation: possibilities and limitations of seed banks, collecting and storage techniques]. Workshop for the Environment Agency of Saxony as well as representatives of the subsidiary nature conservation authorities, Nossen, 25 October 2019.

pts = participants

Collections

Living collection (outdoor areas and greenhouses)

Living collections holdings	2017	2018	2019
Families	310	313	315
Genera	3 184	3 230	3 282
Taxa (species, subspecies, varieties etc.)	17 776	18 238	18 689
Accessions	30 741	31 717	32 654
of which wild provenances (%)	58.4	59.1	59.6

Living collections arrivals/releases	2017	2018	2019
Accessions	1 647	1 567	1 428
De-accessions	2 870	591	491
Accessions released to other gardens	237	159	277
Plant (parts) released to other gardens	289	252	493

Plant (parts) made available	2017	2018	2019
Accessions for teaching	374	275	314
Plant (parts) for teaching	8 394	6 520	7 748
Accessions for research	196	411	302
Plant (parts) for research	841	1 316	880

Dahlem Seed Bank	2017	2018	2019
Holdings (number of accessions)	11 265	12 015	12 948
New additions (number of accessions)	674	750	382
Projects	1 060	1 106	149
Base Collection (long-term storage)	706	691	448
Access Collection (for seed exchange)	674	750	ca. 400
Inclusions in the Index Seminum, of which	3 053	3 053	3 053
seed samples sent out	455	1 557	792
domestic	72	363	257
international	383	1 190	535
Recipients of seed samples	25	93	42

Herbarium Berolinense B

Herbarium holdings	2017	2018	2019
Total number of specimens	c. 3.84 m	c. 3.87 m	3.88 m
Type specimens	> 40 000	> 40 000	> 40 000
Garden herbarium	50 969	51 306	51 672

Herbarium new additions	2017	2018	2019
Total new additions, of which	28 104	32 118	15 318
through donation	20 098	19 779	2 044
through exchange	6 710	6 064	1 713
through purchase	108	50	9 221
through our own collecting activities	893	5 887	2 193
New additions to the garden herbarium	295	337	366

Herbarium – loans, exchanges	2017	2018	2019
Loan requests	230	251	225
Loans from B to other institutions, number of specimens	1 607	2 176	1 551
Number of shipments	104	101	102
Loans to B from other institutions, number of specimens	5 799	268	632
Number of shipments	58	16	12
Number of institutions with which we had loan exchanges	164	154	134
Specimens permanently given to exchange partners	14 995	6 882	5 299

Digital herbarium	2017	2018	2019
Newly digitised specimens, of which	1 470	26 549	48 713
as a result of loan requests	581	301	760
in the context of projects	889	26 248	47 953
Total number of specimens available online	171 814	182 568	611 381
Hits / downloads	74 765	82 456	104 753

DNA Bank

	2017	2018	2019
Holdings (number of DNA samples)	23 853	30 820	36 666
New additions, of which	4 576	6 967	5 846
through donation, exchange with partners	0	0	0
through our own research activities	4 576	6 967	5 766
DNA samples sent out (number)	69	80	104
DNA samples sent out (recipients)	11	10	13

Library

Holdings and catalogues

	2017	2018	2019
Monographs and journal volumes	212 762	214 535	216 201
Current journals with print editions	660	640	576
Offprints	144 312	144 490	144 724
CD-ROMs, DVDs und video cassettes	456	458	460
Microfilm and microfiche titles	4 178	4 178	4 178

New additions

	2017	2018	2019
Monographs, of which	929	899	1 019
through purchase	153	152	185
through exchange / donation	776	747	834
Bound journals, of which	1 053	973	770
through purchase	266	176	169
through exchange / donation	787	797	601
Offprints	237	178	228
CD-ROMs and DVDs	9	2	3
Expenditure on contributions to databases and online journal packages	8 652 €	14 290 €	7 554 €

BGBM Press: Publications
2017 – 2019

2017

Willdenowia

Willdenowia 47(1) https://bioone.org/journals/willdenowia/volume-47/issue-1
Willdenowia 47(2) https://bioone.org/journals/willdenowia/volume-47/issue-2
Willdenowia 47(3) https://bioone.org/journals/willdenowia/volume-47/issue-3

Englera

Raab-Straube E. von 2017: **Taxonomic revision of *Saussurea* subgenus *Amphilaena* (*Compositae, Cardueae*).** – Englera 34. – Berlin: Botanic Garden and Botanical Museum Berlin, Freie Universität Berlin.

Annual Report

Mission grüne Vielfalt. BGBM-Jahresbericht 2015 – 2016. – Berlin: Botanischer Garten und Botanisches Museum Berlin, Freie Universität Berlin.

Other publications

Greuter W. & Rankin Rodríguez R. 2017: Plantas vasculares de Cuba: inventario preliminar. Segunda edición, actualizada, de Espermatófitos de Cuba con inclusión de los Pteridófitos. Vascular plants of Cuba: a preliminary checklist. Second updated edition of The *Spermatophyta* of Cuba with *Pteridophyta* added. – Berlin: Botanischer Garten & Botanisches Museum Berlin; La Habana: Jardín Botánico Nacional, Universidad de La Habana. https://doi.org/10.3372/cubalist.2017.1

Greuter W. & Rankin Rodríguez R. (ed.) 2017: Flora de la República de Cuba. Fascículo 22. *Dioscoreaceae. Ericaceae. Zygophyllaceae.* – Berlin: Botanischer Garten und Botanisches Museum Berlin.

Grotz K., Ochoterena H. & Rahemipour P. (ed.) 2017: Chili & Schokolade. Der Geschmack Mexicos. Ausstellungstexte »für die Tasche«. – Berlin: Botanischer Garten und Botanisches Museum Berlin, Freie Universität Berlin.

Rahemipour P. & Grotz K. 2017: Chili & Schokolade. Der Geschmack Mexicos. Ein botanisches Kochbuch. – Berlin: Botanischer Garten und Botanisches Museum Berlin, Freie Universität Berlin.

2018

Willdenowia

Willdenowia 48(1) https://bioone.org/journals/willdenowia/volume-48/issue-1
Willdenowia 48(2) https://bioone.org/journals/willdenowia/volume-48/issue-2
Willdenowia 48(3) https://bioone.org/journals/willdenowia/volume-48/issue-3

Annual Report

Diversity is our mission. BGBM Annual report 2015–2016. – Berlin: Botanic Garden and Botanical Museum Berlin, Freie Universität Berlin.

Other publications

Burkhardt L. 2018: Verzeichnis eponymischer Pflanzennamen – Erweiterte Edition. Index of Eponymic Plant Names – Extended Edition. Index de Noms éponymiques des Plantes – Édition augmentée. – Berlin: Botanic Garden and Botanical Museum Berlin, Freie Universität Berlin. https://doi.org/10.3372/epolist2018

Greuter W., Rankin Rodríguez R. & González Gutiérrez P. A. (ed.) 2018: Flora de la República de Cuba. Fascículo 23. *Combretaceae. Oxalidaceae.* – Berlin: Botanischer Garten und Botanisches Museum Berlin.

Kasten J., Kusber W.-H., Riedmüller U., Tworeck A., Oschwald L. & Mischke U. 2018: Steckbriefe der Phytoplankton-Indikatortaxa in den WRRL-Bewertungsverfahren PhytoSee und PhytoFluss mit Begleittext – 1. Lieferung: 50 Steckbriefe ausgewählter Indikatortaxa. – Berlin: Botanic Garden and Botanical Museum Berlin, Freie Universität Berlin. https://doi.org/10.3372/spi.01

Kusber W.-H., Abarca N., Van A. L. & Jahn R. (ed.) 2018: Abstracts of the 25th International Diatom Symposium, Berlin 25–30 June 2018. – Berlin: Botanic Garden and Botanical Museum Berlin, Freie Universität Berlin. https://doi.org/10.3372/ids2018

Rahemipour P. (ed.) 2018: Bipindi – Berlin. Ein wissenschaftshistorischer und künstlerischer Beitrag zur Kolonialgeschichte des Sammelns. – KOSMOS Berlin – Forschungsperspektive Sammlungen, Bd. 1. – Botanischer Garten und Botanisches Museum Berlin, Freie Universität Berlin.

Willing R. & Willing E. 2018: A Willing Contribution to Flora Hellenica. Field records 2014. – Berlin: Botanic Garden and Botanical Museum Berlin. https://doi.org/10.3372/wfr2014

Willing R. & Willing E. 2018: A Willing Contribution to Flora Hellenica. Field records 2015. – Berlin: Botanic Garden and Botanical Museum Berlin. https://doi.org/10.3372/wfr2015

Willing R. & Willing E. 2018: A Willing Contribution to Flora Hellenica. Field records 2016. – Berlin: Botanic Garden and Botanical Museum Berlin. https://doi.org/10.3372/wfr2016

Willing R. & Willing E. 2018: 38th Willing Contribution to Flora Hellenica. Crete, April 2017. – Berlin: Botanic Garden and Botanical Museum Berlin. https://doi.org/10.3372/wfr2017.1

Willing R. & Willing E. 2018: 39th Willing Contribution to Flora of Greece. June–July 2017. – Berlin: Botanic Garden and Botanical Museum Berlin. https://doi.org/10.3372/wfr2017.2

2019

Willdenowia

Willdenowia 49(1) https://bioone.org/journals/willdenowia/volume-49/issue-1
Willdenowia 49(2) https://bioone.org/journals/willdenowia/volume-49/issue-2
Willdenowia 49(3) https://bioone.org/journals/willdenowia/volume-49/issue-3

Englera

Casper S. J. 2019: The insectivorous genus *Pinguicula* (*Lentibulariaceae*) in the Greater Antilles. – Englera 35. – Berlin: Botanic Garden and Botanical Museum Berlin, Freie Universität Berlin.

Dowe J. L. 2019: Wendland's Palms. Hermann Wendland (1825–1903) of Herrenhausen Gardens, Hannover: his contribution to the taxonomy and horticulture of the palms (*Arecaceae*). – Englera 36. – Berlin: Botanic Garden and Botanical Museum Berlin, Freie Universität Berlin.

Other publications

Greuter W. & Rankin Rodríguez R. 2019: Inventario de las plantas cubanas silvestres parientes de las cultivadas de importancia alimenticia, agronómica y forestal. A Checklist of Cuban wild relatives of cultivated plants important for food, agriculture and forestry. – Berlin: Botanischer Garten und Botanisches Museum Berlin; La Habana: Jardín Botánico Nacional, Universidad de La Habana. https://doi.org/10.3372/cubalist.2019.1

Greuter W., Rankin Rodríguez R. & González Gutiérrez P. A. (ed.) 2019: Flora de la República de Cuba. Fascículo 24. *Malpighiaceae*. – Berlin: Botanischer Garten und Botanisches Museum Berlin.

Greuter W., Rankin Rodríguez R. & González Gutiérrez P. A. (ed.) 2019: Flora de la República de Cuba. Fascículo 25. *Gesneriaceae. Surianaceae*. – Berlin: Botanischer Garten und Botanisches Museum Berlin.

Botanical Museum

Special exhibitions

27 May 2016 – 26 February 2017

Grüne Schatzinseln: Botanische Entdeckungen in der Karibik [Green Treasure Islands: Botanical Discoveries in the Caribbean]
Curators: K. Grotz and S. Fuentes
Design: Yvonne Rieschl
Partners: Jardín Botánico Nacional, Universidad de la Habana, Cuba; Jardín Botánico Nacional Santo Domingo, Dominican Republic. Funded by the Association of Friends of the Botanic Garden and Botanical Museum Berlin-Dahlem e.V.

5 May 2017 – 25 February 2018
Chili und Schokolade. Der Geschmack Mexikos [Chilli and Chocolate: The Taste of Mexico]
Curators: K. Grotz, P. Rahemipour and H. Ochoterena
Design: Yvonne Rieschl
Partners: Instituto de Biología of the Universidad Autónoma de México, Mexico City (UNAM); Universum, Museo de las Ciencias de la UNAM; Goethe-Institut Mexico. Funded by the Mexican Embassy in Germany as part of the Mexico-Germany Dual Year.

16 June – 31 August 2018
Victoria Kabinett. 166 Jahre in 100 Bildern [Victoria Cabinet: 166 Years in 100 Pictures]
Curators: K. Grotz, P. Rahemipour
Design: Yvonne Rieschl

7 December 2018 – 29 June 2019
Geliebt, gegossen, vergessen: Phänomen Zimmerpflanze [Loved, Watered, Forgotten: The Houseplant Phenomenon]
Curators: K. Grotz,P. Rahemipour
Design: Yvonne Rieschl

16 August 2019 – 27 October 2019
Licht Luft Scheiße: Perspektiven auf Ökologie und Moderne [Light Air Shit: Perspectives on Ecology and Modernity]
Curators: Sandra Bartoli, Marco Clausen, Silvan Linden, Åsa Sonjasdotter & Florian Wüst (nGbK-Projektgruppe)
Kathrin Grotz & Patricia Rahemipour (BGBM)
Design: Büros für Konstruktivismus, Berlin

Gallery exhibitions

29 September 2016 – 8 January 2017
Dove vai? / Wohin gehst du?: Collagen, Malerei und Zeichnungen von Gudula Fisauli [Where are you going? Collages, Paintings and Drawings by Gudula Fisauli]

9 March 2017 – 14 May 2017
„Herbarium" Objekte von Anne Carnein ["Herbarium" Objects by Anne Carnien]
Botanical Museum and Anne Carnein

2 June 2017 – 24 September 2017
IK & die vielen anderen: schafft diese Welt das? Arbeiten von Mark Swysen [ME & the many others: Will this world cope? Works by Mark Swysen]
Botanic Garden and Botanical Museum Berlin in collaboration with the Kulturamt Steglitz-Zehlendorf

29 June 2018 – 2 September 2018
Sometimes I hear the plants whisper: Objekte und Installationen von Karine Bonneval [Objects and Installations by Karine Bonneval]
Botanic Garden and Botanical Museum Berlin in collaboration with the Kulturamt Steglitz-Zehlendorf

11 October 2018 – 6 January 2019
Zenkeri: Fotografien von Yana Wernicke & Jonas Feige [Photographs by Yana Wernicke & Jonas Feige]
In partnership with Frantic Gallery, Tokyo

26 January – 8 April 2018
México lindo. Botanische Illustrationen von Elvia Esparza [Beautiful Mexico. Botanical Illustrations by Elvia Esparza]
Botanical Museum Berlin and Mexican Embassy in Germany

External Exhibitions

18 March 2016 – 1 January 2017
"Der Apfel. Kultur mit Stiel" [The Apple: Culture with Style (or a Stalk)]
Museum im Herrenhaus, Domäne Dahlem, Berlin

30 September 2016 – 8 January 2017
"Gestaltung" [Design]
Martin-Gropius-Bau, Berlin

8 October 2016 – 9 January 2017
"Der Britische Blick: Deutschland – Erinnerungen einer Nation" [The British View: Germany – Memories of a Nation]
Martin-Gropius-Bau, Berlin

14 October 2016 – 14 May 2017
"Deutscher Kolonialismus – Fragmente seiner Geschichte und Gegenwart" [German Colonialism – Fragments of its Past and Present]
Deutsches Historisches Museum, Berlin

2 November 2016 – 26 February 2017
"Extreme! Natur und Kultur am Humboldtstrom" [Extremes! Nature and Culture on the Humboldt Current]
Humboldt-Box, Berlin

13 April 2017 – 15 October 2017
"Palms" exhibition as a contribution to the International Garden Exhibition
Kathrin Grotz, Patricia Rahemipour and Stephanie Henkel
Gärten der Welt, Berlin

7 July 2017 – 14 January 2018
"Vorsicht Kinder! Geschützt, geliebt, gefährdet" [Caution, Children! Protected, Loved, Endangered]
Kathrin Grotz and Patricia Rahemipour

20 October 2017 – 14 January 2018
"Form follows flower. Moritz Meurer, Karl Blossfeldt und Co."
Kunstgewerbemuseum, Berlin

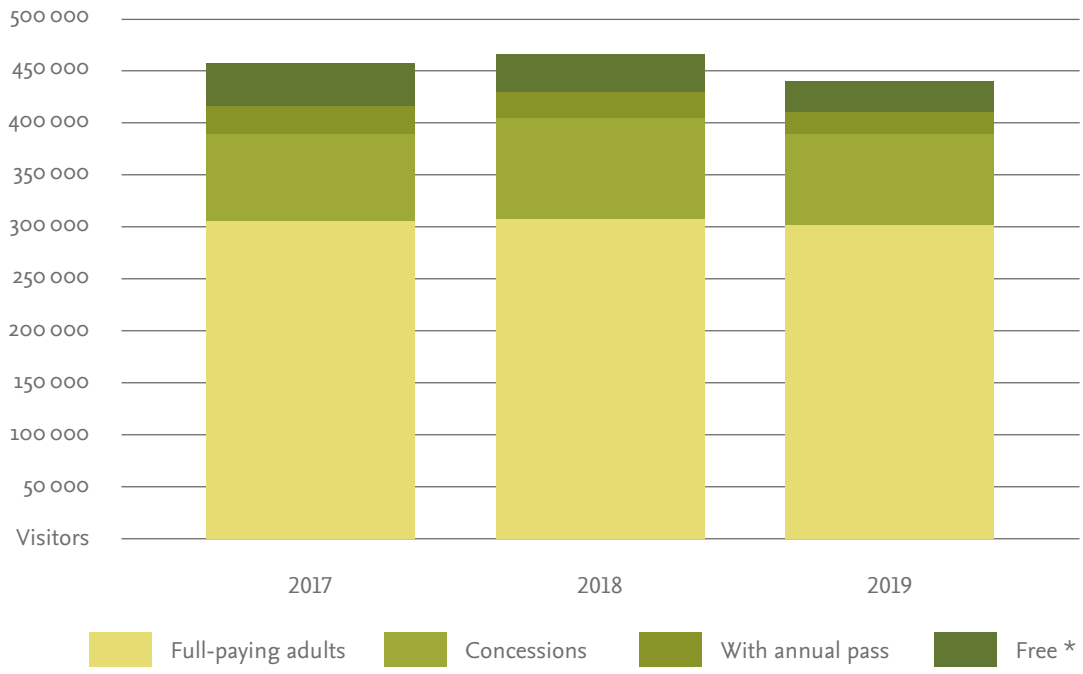
21 September 2018 – 13 January 2019
"Aus Westfalen in die Südsee. Katholische Mission in den deutschen Kolonien" [From Westphalia to the South Seas: Catholic Mission in the German Colonies]
Stadtmuseum Münster

Press and public relations*

	2017	2018	2019
Press releases	28	28	19
Newsletters	12	10	12
Print mentions	606	601	479
TV reports	56	48	40
Radio reports	120	90	57
Online posts	272	319	335

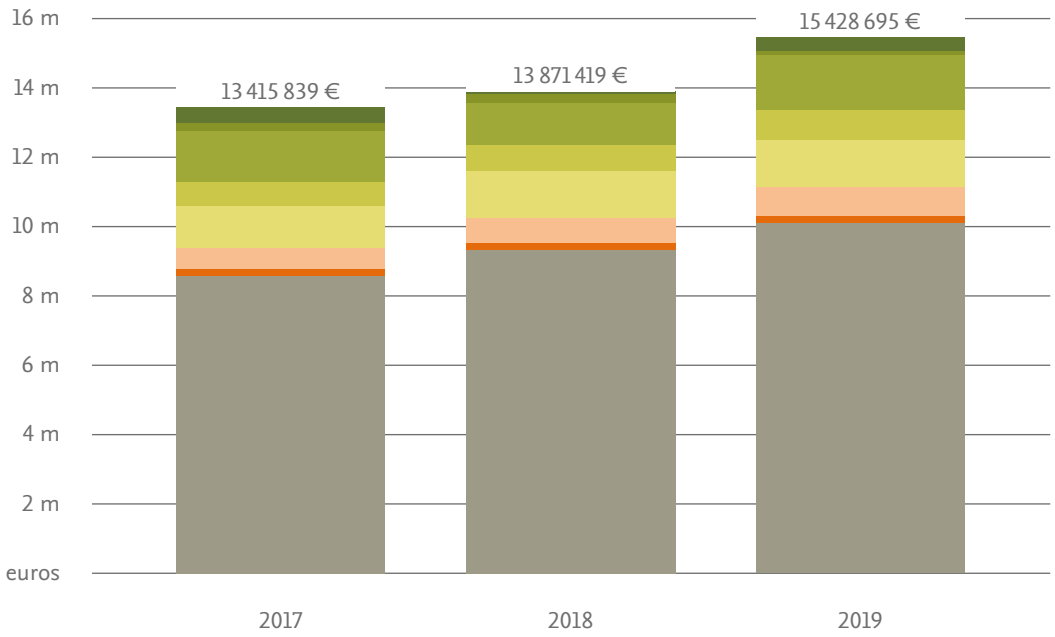
* Figures without using clipping service

Visitor numbers Botanic Garden and Botanical Museum



* e.g. children and students of the Freie Universität Berlin (Department of Biology, Chemistry and Pharmacy)

Budget



State grant, consumption*
State grant, investment
GRW investment grant**
Income (entrance fees)
Income (events, hires)
External funding***
Donations, other contributions
Bequests

* From 2018 onwards, the state consumption grant included special funding from the Institutional Contract (Sondertatbestand Hochschulvertrag) as well as €200,000 from FU Berlin central funds to compensate for the tariff-related additional costs of the former BGBM operating company.

** GRW is the national scheme for improving regional economic structures

*** BMBF, DFG, EU, VolkswagenStiftung, among others

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